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MEDACTA ORTHOPAEDIC RESEARCH AND EDUCATION

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Foreword

The Medacta Orthopaedic Research and Education (M.O.R.E.) Institute was created to provide continuous support to healthcare professionals in the field of Research and Education. As part of Medacta's on-going commitment to Continuous Medical Education, it was our great pleasure to organize the 8th M.O.R.E. International Symposium in the beautiful city of Lugano, on the 22nd and 23rd of April, 2016.

Over the two days, dedicated to joint replacement and spine surgery, we were joined at this wonderful event by over 1,200 people originating from more than 30 countries. We are honored to have had the support of an esteemed international faculty that shared with us their expertise, enthusiasm and experience, presenting on contemporary topics in Orthopaedics and Neurosurgery. This Symposium concentrated on how implant design, techniques and patient specific treatment can improve outcomes and patient satisfaction.

The entire program focused on maximizing patient satisfaction by adopting both Patient Specific Solutions and Optimized Care Pathways. For the first time at a M.O.R.E. event, we had a Sports Medicine symposium reviewing evidence, trends and contemporary techniques in hip preservation procedures.

The positive feedback we received from the 7th M.O.R.E. International Symposium in 2014 encouraged us to do even better this year and we hope that all attendees had a memorable experience.

We are also delighted to have celebrated the following important milestones of our history and success:

• After an intense clinical evaluation period that began in 2011, more than 15,000 GMK Sphere Knees have been implanted in the last 5 years, allowing patients to return to the life they once lived - free from pain and disability.

• Over 60% of Medacta Knees are implanted using the MyKnee Technology. To date, we can count more than 40,000 MyKnee cases with many peer reviewed publications testifying the quality and the benefits of this innovation.

• More than 200,000 patients have received implants through the AMIS technique and the AMIS Revision Program is today a solid reality. Thanks to our M.O.R.E. Educational platform, more than the 85% of our hips are performed through AMIS.

Many other products, developed over the years, show consistent results with more than 10 years of clinical evidence.

MySpine is confirming the expectation and the Award, received at the NASS Congress in 2014, for the Best Technology in Spine Surgery, affirms the value Medacta provides with its innovation.

Your trust and support in Medacta has resulted in more than 1,000,000 implanted devices today that are positively impacting the wellbeing of many patients and the efficiency of Healthcare systems all around the world.

Thank you for your attendance and support.

You can find the entire congress content in the Medacta M.O.R.E. APP and on the congress website www.8more.medacta.com, and experience the 8th MORE Symposium interactively!

Yours sincerely,

Dr. Alberto Siccardi
Founder, President & CEO
Medacta International SA

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Introduction

The organizing committee of the 8th Medacta Orthopaedic Research and Education (M.O.R.E.) International Symposium, sincerely believes that the quality and breadth of the scientific program exceeded attendees expectations, by emphasizing education, research and the sharing of information and current developments in orthopaedics and spine surgery.

This event featured separate days dedicated to spine surgery, knee replacement and hip replacement, including a special session dedicated to hip preservation technologies and procedures.

The primary goal of this conference was to explain how the healthcare scenario is changing, with the introduction of new models of patient care (e.g. outpatient), new trends for surgical procedures (e.g. minimally invasive procedures) and cutting edge technologies (e.g. patient matched technologies and single use instruments). Moreover, the topic of patient satisfaction emerged, as patients are more and more active and demanding. All of these topics were presented and discussed by a world-leading faculty.

This book is a compendium of the voluntarily submitted abstracts from all of the invited speakers. We know that the time spent by those who care for patients, carry out research, teach and travel is very demanding and we express our gratitude to all of our colleagues who prepared and submitted an abstract, contributing to this publication and to the overall success of the Symposium.

We extend a special thanks to the 1,200+ symposium attendees. Your presence helped to make this event a great success. Your enthusiasm and positive spirit made the meeting an enriching scientific experience, giving us the opportunity to share ideas for the next advancement of orthopaedic and neurosurgical care.

Prof. Michael Freeman
Honorary Chairman
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Dr. med. Dezsö Jeszenszky
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Lugano April 22-23, 2016

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Knee Day - 22 April 2016

Hip Day - 23 April 2016

Hip Preservation Day - 22 April 2016

Spine Day I - 22 April 2016

Spine Day 2 - 23 April 2016

MyKnee

PATIENT MATCHED TECHNOLOGY
IN KNEE REPLACEMENT

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40,000
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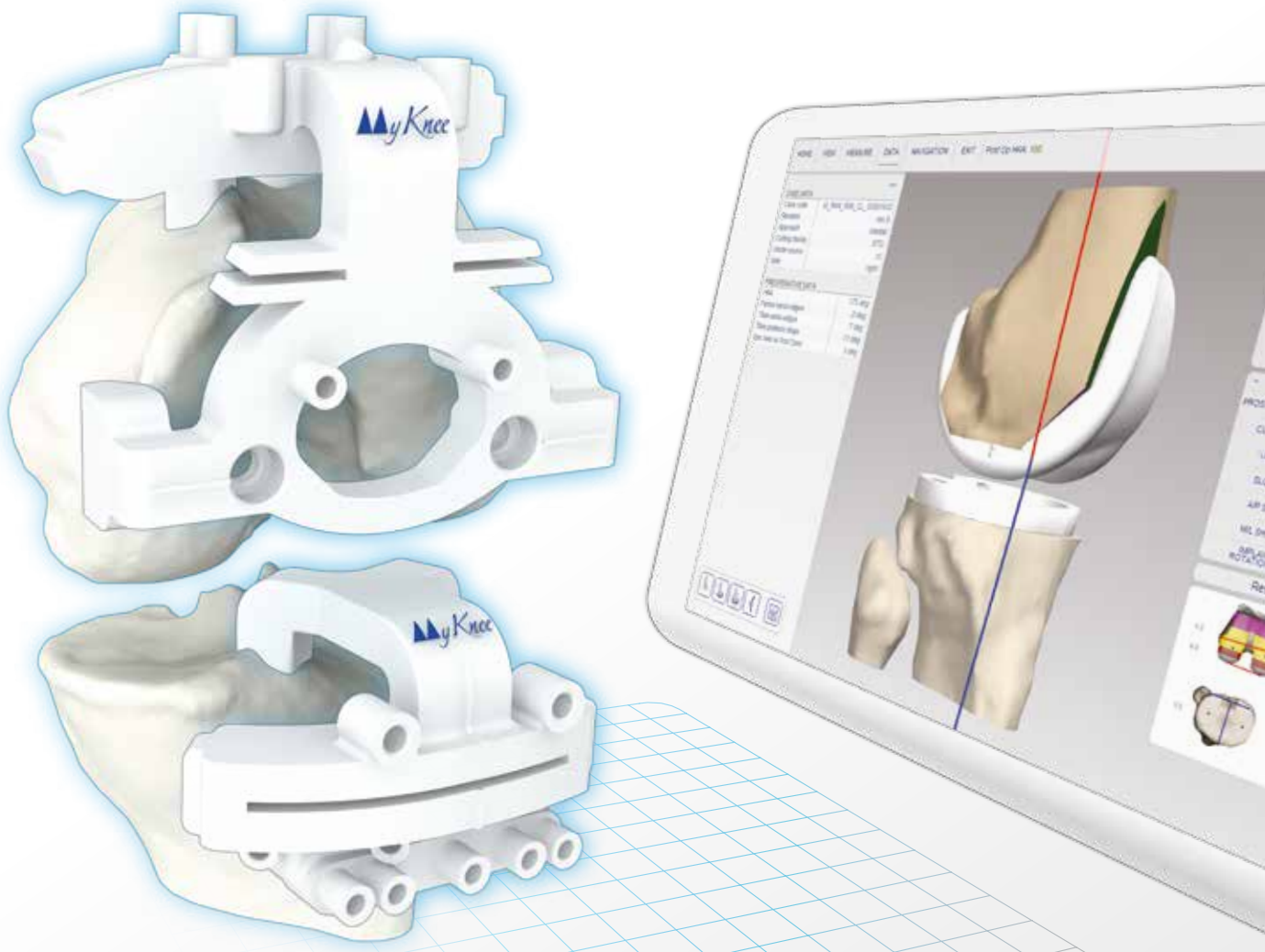

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Knee Day - 22 April 2016

Welcome

Session 1 - Knee Day

CURRENT AND FUTURE TRENDS IN TKR

C. S. Ranawat
Hospital For Special Surgery, New York, US

I will be discussing the current and future trends in Total Knee Arthroplasty (TKA) and give my perspective on 5 important topics concerning TKA. 1) The cruciate retaining (CR) and posterior stabilized (PS) knee controversy surrounding the cemented TKA from a historical perspective. 2) 10 important technical features for a successful TKA including pain control protocol and proper cement technique. 3) Factors governing the durability of TKA such as fixation, instability and wear. 4) Controversy on anterior knee pain and patient satisfaction. 5) Finally, I will project my thoughts on the future direction of TKA.

1) CR and PS Controversy
a. Cruciate Preservation was and is the preferred method of TKA for knees with moderate to advanced DJD without significant deformity, however cruciate substituting knees allow for correction of moderate to severe deformities in a more predictable manner with superior results
i. “all good things ultimately prevail”

2) I will discuss 10 tips to perform TKA. The important features are:
a. Pre-emptive analgesia and post-operative pain control to facilitate post-operative recovery
b. I will describe the highlights of tibial cut at 90º to mechanical axis and balance the knee in extension first and flexion gap balance by the technique of cutting the posterior condyles parallel to the tibial cut and maintain the joint line.
c. Details of the cement technique will be described
d.Preventative measure to reduce infection

3) Durability of the cemented TKA has been established up to 15-20 years
a. Published literature to support the long term durability will be discussed
b. Current status of the non-cemented fixation will be compared to cement fixation which is the gold standard

4) Anterior Knee Pain and Patient Satisfaction are two important issues which we still do not have full understanding. I will present my point of view.
5) The TKA continues to improve and I believe in the future we will be doing more non-cemented TKA. Use of AO poly and HXLP may become more prevalent

References

1. Insall J, Scott WN, Ranawat CS. The total condylar knee prosthesis: A report of two hundred twenty cases. J Bone Joint Surg Am. 1979 61(2) 173-180
2. Meftah M, Wong AC, Nawabi DH, Yun RJ, Ranawat A, Ranawat CS. Pain management after total knee arthroplasty using a multimodal approach. Orthopedics. 2012 35(5)e660-e664
3. Ranawat CS, Meftah M, Windsor EN, Ranawat AS. Cementless fixation in total knee arthroplasty. J Bone Joint Surg Br 2012;94-B, Supple A:82–4.
4. Ranawat AS, Ranawat CS. Pain management and accelerated rehabilitation for total hip and total knee arthroplasty. J Arthroplasty. 2007 22 (7 Suppl 3): 12-5
5. Rasquinha VJ, Ranawat CS, Cervieri CL, Rodriguez JA. The Press-fit condylar modular total knee system with a posterior cruciate-substituting design: a concise follow-up of a previous report. J Bone Joint Surg Am. 2006 88(5):1006-1010
6. Rodriguez JA, Bhende H, Ranawat CS. Total condylar knee replacement: A 20-year followup study. Clin Orthop Relat Res. 2001 Jul (388): 10-7.

Patient satisfaction: the role of implant design

Session 2 - Knee Day

PATIENT PREFERENCES IN TOTAL KNEE PROSTHESES

J. W. Pritchett
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Background
The most common choices for total knee replacement are posterior stabilized (PS) or posterior cruciate retaining (CR) prostheses. Much less commonly a more anatomically correct design such as the bicruciate (ACL-PCL) prosthesis or the medial pivot (MP) is chosen. In the bicruciate-retaining prosthesis the stability comes from the preserved ligaments. In the MP knee the shape of the polyethylene itself guides the motion. There are other possibilities such as the mobile bearing knee (MB) where the tibial base plate rotates on the fixed tibial tray.

For the first generation of knee replacement surgery patients were satisfied if they obtained a secure, stable and durable knee with reasonable pain relief and function. Surgeons reported positive results using surgeon collected data. Patient reported outcomes are not the same as surgeon reported outcomes and are now the most useful way to describe a surgical result. Asking patients about their total knee experience with different knee implants began with our work in 1987.

Methods
The most believable and useful information comes from randomized prospective studies. In bilateral studies patients serve as their own controls eliminating the effects or personality, age, gender, diagnosis, bone quality and activity level. If the same surgeon using the same technique, indications and treatment methods performs the care then the highest level of confidence in the data is warranted.

640 patients (1280 knees) were prospectively enrolled to evaluate patient preferences in total knee prostheses. Staged bilateral total knee replacement surgery was performed using a different randomly selected prosthesis on each side. 6 different prostheses were used. Each procedure was performed the same way with just slight variation as needed to accommodate the different implants and travel through time. Fair and poor results were excluded to provide a valid comparison and a minimum of four years of follow-up was required for inclusion. 551 patients (1102 knees) met our inclusion criteria. The noise patients experience after their knee replacement was also evaluated. Using a temperature probe the heat of the synovial fluid was measured in 50 patients.

Results
The range of motion, pain relief, alignment and stability did not vary by prosthesis except there was improved pain relief and stability with a knee design that came out in 2011 (Medial Congruent). The ACL-PCL prosthesis had the least amount of heat generation and least noise. The PS knee had the most noise and second most heat and was the least preferred knee. The MP was equal to the ACL-PCL as most preferred and also had the second fewest noise concerns. There was more heat generation with MP consistent with its degree of constraint. Patients gave the following reasons for their preference: feels more normal; stronger on stairs; superior single leg weight bearing; flexion stability; fewer clunks, pops, clicks and; don't know. Overall 89% of patients preferred the ACL-PCL and MP knees over the PS and CR designs. In particular, the Medial Pivot design was preferred by 81% patients over the PCL retaining design, 70% over the PS design, 61% over the mobile bearing design.

Discussion
Evaluating knee prostheses requires perspective. All knee prostheses perform well but they are not equal. To compare knee prostheses it takes time, strict control on variables, and a deep effort to gather patient rather than surgeon reported outcomes. The simplicity of patient preference studies stands out from the clutter of joint implant and registry data.

Conclusion
The ACL-PCL and MP prostheses both provide anatomic contours and preserve the value of the strategic ligament relationships. The MP and ACL-PCL are preferred over the other available designs. The newest generation of Medial Congruent of (Medial Pivot) knee prostheses are a closer approximation to what patients want than their predecessors. Surgical effort during implantation is less with a MP knee compared to ACL-PCL designs.

CAN THE NATURAL KINEMATICS BE REPRODUCED IN TKR?

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Patient satisfaction after TKR is typically lower than that after THR and the incidence of the so called "forgotten knee" is fairly rare.
Pritchett[1] analyzed patient preferences in bilateral TKR. Most of the patients thought one knee was worse than the other. All knees that patients considered better had a-p stable designs.
Could we attribute the inferior results to:
1) a-p instability and/or
2) faulty kinematics?
Therefore, is natural kinematics important for patient satisfaction? If so, can normal kinematics be reproduced in TKR?
Hyperextension
Towards full extension the medial femoral condyle "rocks" onto the tibial extension facet. However, our observations suggest that the resultant anterior contact may be responsible for anteromedial OA[2]. There is therefore a real possibility that the same anterior rocking reproduced in a prosthesis might lead to anteromedial polyethylene damage, and it should thus be avoided.
Active arc of flexion
In the active arc of flexion longitudinal rotation occurs around the medial axis[3]. Nevertheless in forced rotation at 90dg flexion the axis of longitudinal rotation moves laterally[4] and coincides with the position of tight PCL which may act as a pivot for this rotation.
For this reason PCL resection in medially stabilized TKR is recommended.
Hyperflexion
In the natural knee, hyperflexion is possible only through the medial subluxation[4]. In our experiment the prosthesis was implanted into a cadaveric knee. In full flexion, by analogy with the natural knee, a possible impingement occurs between the femur and the posterior lip of the prosthesis. This conflict could result in damage to the tibial polyethylene insert. This finding has clinical implications in that careful removal of posterior osteophytes should be performed during TKR, to create space to accommodate the posterior lip of the polyethylene insert in full flexion.
The GMK Sphere medial ball in socket design provides a-p stability and natural kinematics in the arc of active flexion. In hyperextension, the ball-in-socket geometry, combined with a flat lateral surface, allows full extension accompanied by terminal rotation. As this avoids the aforementioned rocking motion, it eliminates any danger of overloading in the antero-medial aspect of the joint. In full flexion, by analogy with the natural knee both femoral condyles roll back.

Literature

1. Pritchett JW: Patient preferences in knee prostheses. J Bone J Surg, 86-B, 979-982, 2004
2. B. J. A. Lankester, H. L. Cottam, V. Pinskerova, J. D. J. Eldridge, and M. A. R. Freeman
Variation in the anatomy of the tibial plateau: A possible factor in the development of anteromedial osteoarthritis of the knee
J Bone Joint Surg, 90-B, 330-333, 2008
3. Pinskerová V et al: The shapes and relative movements of the femur and tibia in the unloaded cadaveric knee.
In: Surgery of the Knee - Third Edition. Edited by Insall JN, MD, Scott WN, MD.
Published: WB Saunders Co, Philadelphia, 2000
4. Hill P, Vedi V, Williams A, Iwaki H, Pinskerová V, Freeman MAR: Tibio-femoral movement 2: the loaded and unloaded living knee studied by MRI.
J Bone J Surg, 82-B, 2000, 1196-98
5. Pinskerova V, Samuelson KM, Stammers J, Maruthainar K, Sosna A and Freeman MAR
The Knee in Full Flexion: An Anatomical Study
J Bone Joint Surg 91-B, 830-834,2009

MEDIALLY STABILIZED DESIGN: THE PATELLO-FEMORAL JOINT KINEMATICS

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The patella-femoral joint can be the bell weather of a well functioning knee. Optimal functioning of the patella-femoral joint requires proper femoral and tibial implant positioning in all planes (sagittal, coronal, and axial), proper femoral-tibial balance in the coronal and sagittal plane and kinematics that provide femoral roll back with progressive knee flexion. Unfortunately, most TKA designs are by definition, sag-ittally unstable as they lack bi-cruciate function and patients may complain of anterior knee pain with weight bearing in flexion activities, a sense of instability and recurrent effusions with increased activity. This may be the reason several investigators have identified less than optimal satisfaction following TKA and the least satisfaction being with weight bearing in flexion activities. The medially stabilized TKA provides enhanced sagittal stability and the patella-femoral joint is the benefactor.
Our impression of medially stabilized TKA patella-femoral kinematics is formed by 2 recent studies we performed at Northwestern and Ohio State Universities. The first study examined 18 cadaveric normal knees that underwent Sphere TKA with a custom infrared guidance system to assess passive kinemat-ics and specific force translation relationships at 0, 20, 60 and 90 degrees of flexion. The second study is a randomized, prospective single blinded study of PS vs. Sphere TKA. 51 patients were successfully randomized to receive GMK PS vs.

Sphere TKA and have 1-2 year follow-up. Outcomes included clini-cal scores (knee society score, VR12, forgotten knee score, Oxford knee score) as well as KT 1000 sagittal plane stability testing and a battery of custom questions. The custom battery of questions (scored on a likert 1-10 scale) was split equally between 2 groups (6 questions each). 1 group focused on patient satisfaction with weight-bearing-in-flexion actives and the other on non-flexion activities. Each question was compared between PS and Sphere groups and total score for weight-bearing-in-flexion and non-flexion activities (max 60 points each) were compared between PS and Sphere groups.

In the cadaveric study, the normal knee and the post reconstruction Sphere TKA were identical in var-us-valgus stability at each range of flexion tested at up to 10 N. (p=0.57-0.25). Anterior-posterior (sag-ittal plane) stability was also statistically identical to the native state in mid flexion (20 and 60 degrees flexion) at up to 100N (p=0.29 - 0.37). Internal-External motion throughout the arc of flexion was also statistically identical to native state (p=0.11).

In the clinical study, to no surprise, we found no difference in clinical scores with the small number of patients studied. These blunt instruments have routinely been unable to identify differences in clinical outcome between prosthesis due to almost universally good outcomes. However, sagittal plane stability was significantly enhanced in the Sphere group in mid flexion. KT1000 readings for the PS group aver-aged 10.3 mm at 30 degrees knee flexion at 30Lb force while the Sphere knees averaged 5.7mm ($p<0.0001$). The custom battery of questions (Weight-bearing-in-flexion group: satisfaction with kneel, squat, descend stairs, ascend stairs, out of chair, and off toilet; Non-flexion group: satisfaction with sit-ting, light housework, walking, standing, bending, and lying) showed a clear preference for Sphere TKA during flexion activities. Sphere total weight-bearing-in-flexion score was significantly higher than that for PS (p=0.04) while no difference was identified in non-flexion activities between the groups.

In conclusion the medially stabilized TKA design affords sagittal plane stability akin to the native knee in mid flexion allowing patients to excel during weight bearing in flexion. This relationship is favorable to the patella femoral joint, improves quadriceps power and efficiency and decreases anterior knee pain when femoral and tibial implants are appropriately placed.

WHAT HAVE WE LEARNED ABOUT POLYETHYLENE WEAR?

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Wear of the articulating materials has been a concern for the longevity of the TKA. We have learned that the “number” of the polyethylene (PE) particles in the periprosthetic tissue is the major contributing factor for the pathogenesis of osteolysis. Based on these finding, design modifications should be focused on the reduction of the total number of PE wear particles generated. Results of our particle retrieval study from the joint fluid of the well-functioning TKA patients have shown that the TKA design characteristics significantly contribute to the difference in the number, size, and shape of the wear particles. Medial-pivot design TKA produced the least number of PE wear particles among the currently available designs. It should be emphasized that, in this specific design concept, further improvement of the wear performance is expected through the introduction of proven technologies (e.g. cross linked PE, MPC polymer coating) accumulated in THA.

Alignment and soft tissue management

Session 3 - Knee Day

KINEMATIC ALIGNMENT: COULD THERE BE A BETTER WAY TO DO KNEES?

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Background
Total knee arthroplasty (TKA) using the mechanical alignment technique inevitably modifies the patient's native knee anatomy and impact ligament balance, patellar tracking, quadriceps function and overall joint kinematics. Another alignment option is Kinematic TKA, which aims to restore the pre-arthritic knee's anatomy by making measured bone resections equivalent to implant thickness. However, the question remains as to whether all patient anatomy is suitable for kinematically aligned TKA.

Questions
We wanted to evaluate the variations in lower limb anatomy of a patient population scheduled for TKA and determine the different anatomical modifications associated with mechanical or kinematically aligned TKA techniques. We also wanted to verify the use of a proposed safe range algorithm to perform kinematic TKA and the resultant modifications required.

Methods
We used a database of 4884 CT scans of lower limbs scheduled for TKA with "My Knee" personalized instruments. Using anatomical landmarks including the lateral distal femoral angle (LDFA) and the medial proximal tibial angle (MPTA) and the hip knee ankle angle (HKA). Then, we applied our proposed kinematic "safe range'' protocol, defined by the following criteria: Independent tibial and femoral cuts within ±5° of the bone neutral mechanical axis and a resulting HKA within ±3° of neutral. We determined how do the anatomical modifications produced by mechanical and kinematic alignment techniques compared for this population. Last, we tested this proposed safe range protocol in 100 consecutive and unselected TKAs performed with computer navigation.

Results
In the 4884 osteoarthritic knees database, the mean pre-operative MPTA was 2.9°in varus, LDFA was 2.7° in valgus and overall HKA was 0.1° in varus. Applying our kinematic protocol, 2475 knees (51%) required no adjustments. Mean anatomy corrections of 0.5° for MPTA and 0.3° for LDFA were needed to fit 4062 cases (83%) in our "safe range". A small group of knees (17%) presented unusual anatomy i.e. with both the femur and tibia joint orientation being in varus or valgus. Mean anatomical modifications in mechanical TKA were 3.3° for MPTA and 3.2° for LDFA and significantly larger than kinematic TKA ($p<0.001$).

For the clinical cohort of 100 TKAs performed with navigation, mean pre-op LDFA was 2.1° valgus and 1.8° valgus post-op ($P=0.41$). The mean pre-op MPTA was 3.0° varus and 2.4° varus post-op ($P=0.03$). The mean WOMAC score improved from 49 (29–85) to 25 (0–73, $P<0.001$). Five knees required ligament release, four with valgus OA and one with varus OA. Two knees required lateral retinacular release for patellar tracking.

Conclusions
This study demonstrates that the knee anatomy range, in patients presenting for TKA, is wide. Mechanical alignment leads to significantly greater deviations from normal anatomy when compared with kinematic alignment. Our proposed safe range protocol allows partial correction of a more extreme anatomy that might be unsuitable for recreation during TKA. This closer restoration of normal anatomy from kinematic TKA theoretically provides an opportunity to improve the surgery outcomes.

SOFT TISSUES GUIDED SURGERY IN TKA

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Little consideration has been given to the importance of maintaining the soft tissue geometry and function through a full arc of motion and thereby optimizing stability, kinematics, kinetics and proprioception in the knee.
Traditional surgical techniques have been addressed to change patient's hard tissue anatomy altering soft tissue geometry and tension and knee biomechanics. The bone resections are made trying to create a mechanical axis that passes through the center of the knee. Bone resections from the condyles commonly differ in thickness because of anatomical variations in patient's hard tissue anatomy. Some degree of ligament imbalance is created by the asymmetry of these resections. Ligament releases and change in insert thickness are then performed in order

to re-establish total knee arthroplasty stability, balance and kinematics. Soft tissue releases are performed more often when the prosthesis component are not positioned correctly.
In other words, knee arthroplasty changes the patient's hard tissue anatomy independent from their soft-tissue balance. All these factors could end up in a less favorable clinical outcome due to knee pain or undesired knee motion.
We should place the prosthesis components where the patient's own unique motion wants them to be allowing the knee joint to have the patient laxity in order to find the physiological balance between external and internal loads.
In order to achieve soft tissue guided surgery we need to understand the relationship between lower limb alignment and soft tissue behaviour, the loading pattern on the knee during full range of motion. We assess and quantify the knee alignment and loading of the knee in extension driven by the X-Ray imaging. During daily living activity we load the knee at varying degrees of flexion and the alignment is not the same as in full extension because it is linked to articular surface geometry and distal femur rotation. Moreover, the lower limb alignment and loading change when ligament is absent or sacrificed by the surgeon driven by TKR type. Patient specific ligament attachment and length can be abnormal due to epiphysial deformities. Consequently tibio-femoral and patello-femoral kinematics are mismatched.
The aim of the soft tissue guided surgery is to use the compartment soft tissue functions in order to define a more patient specific positioning of the prosthetic components. To perform this surgery it is mandatory to have special devices enabling the surgeon to quantify the soft tissue function during knee flexion.

IS THERE MORE THAN ONE WAY TO BALANCE A TKR?

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INTRODUCTION

The normal knee is not balanced. It presents a natural lateral femoral condylar lift-off in flexion, which has no impact on the normal cartilage and the knee function.
But the prosthetic knee is not a normal knee.
Many articles in the literature support the concept that the lift-off is harmful for the prosthetic knee, but there is no article about the interest of conserving a residual laxity.
Freeman and Insall already highlighted the importance of ligament balancing in the seventies and it is now a well-known fact that the lift-off is responsible for polyethylene wear and loosening, feeling of discomfort, instability, medial tibial pain and iterative swelling.

Perfectly balancing the knee in extension and flexion is the only way to avoid the lift-off.

DISCUSSION

There is actually no consensus regarding the best method to perfectly balance the knee. We can consider two main methods:

- The measured resection technique
Femoral and tibial preparations are performed independently.
In extension, the thickness of resected distal femur and proximal tibia corresponds to the thickness of the prosthesis.
Posterior osteophytes and osteophytes of the concavity are removed.
In flexion, femoral landmarks provide the femoral rotation (transepicondylar axis, antero-posterior axis (Whiteside line), posterior condylar axis).
Trial implants are inserted and the knee is tested in extension and flexion.
Gap asymmetry is corrected (or not) by releasing soft tissues of the concave side of the knee and sometimes by replacing the tibial insert for a thicker one.

- The gap balancing technique
Proximal tibial and distal femoral resections are made first.
Posterior osteophytes and osteophytes of the concavity are removed.
The knee is placed in extension and symmetrical tension is applied on both collateral ligaments using a spacer device (lamina spreaders, spacer blocks, mechanical or electronic tensor, knee balancer…) or CAS. If necessary, soft tissue releases are performed on the concave side of the knee to obtain a rectangular gap.
Then the knee is placed in 90° flexion and soft tissues are never released at this stage.
By applying a symmetrical tension on both collateral ligaments using the same spacer device automatically sets the femoral rotation and again a rectangular gap.

The main problem of the measured resection technique is the use of bony landmarks with very random precision.
On the other hand, the gap balancing technique requires a perfect tibial cut. This could be obtained with patient specific instruments or CAS.

However the technique and the tools to perfectly balance a knee require a perfect knowledge of the step-by-step release procedure:
- Which structures are to be released specifically for the varus, the valgus and the flexion contracture?

- In what order?
- What is a good balance (ideally <1 mm of laxity on both sides in extension and in flexion)?

As all specific techniques, these procedures need to be learned.

CONCLUSION

The human knee is naturally imbalanced but its natural lift-off is harmful for the prosthetic knee. It is therefore a huge aim for the surgeon to eliminate this lift-off during a knee replacement. This can be obtained by recreating precise equal square gaps in flexion and extension, whatever the technique used, either measured resections or gap balancing

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SIMULATION ANALYSIS OF DESIGN AND ALIGNMENT VARIABLES IN KNEE ARTHROPLASTY

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INTRODUCTION

Although Total Knee Arthroplasty (TKA) surgery enjoys 80% of outcomes with good to excellent results, some patients have difficulty adjusting their gait to accommodate the new articulations inherent in contemporary implant designs. This study employs a computational kinematic simulator to compare TKA component motions for a medial pivot and cruciate retaining design during walking gait. The effect of two different surgical alignment methods are also investigated, mechanical alignment and kinematic alignment.

METHODS

KneeSIM software provides a dynamic, physics-based, musculoskeletal modeling environment of a nominal sized, male, Caucasian virtual patient. Activities of daily living, such as level walking gait, are propelled by flexor and extensor muscle groups and restrained by the capsular and ligamentous structures surrounding the knee. A generalized contact algorithm allows the TKA components to articulate in a natural manner during a full activity cycle.

Three-dimensional solid models of the femoral, patellar and tibial insert components were obtained for each total knee design investigated. The modeled components were “implanted” in the virtual joint space per each manufacturer’s mechanical alignment surgical procedure. A standardized ISO level walking gait activity was conducted for both designs. The tibial and femoral components for each design were then rotated 3 degrees valgus to represent a kinematic surgical alignment and the experiment repeated.

RESULTS

Synchronized animations of component motions for both TKA designs were compared side by side from a top down view, with the tibial insert fixed and the relative motion of the femoral component visualized. The femoral motions for mechanical alignment and kinematic alignment scenarios were visually compared.

DISCUSSION AND CONCLUSION

When comparing the effect of surgical alignment on component motions, the motion results varied little for both designs regardless if they were mechanically or kinematically aligned. Both TKA designs are functionally insensitive to surgical alignment during the highly loaded stance portion of walking gait, although some variation was apparent during the less loaded swing phase.

Differences were apparent when comparing the motions of the medial pivot design to the cruciate retaining design. The medial pivot design appeared stable in comparison to the cruciate retaining design, eliminating the paradoxical motions of anterior sliding and lateral pivot displayed by the cruciate retaining design that allowed contact regions to traverse a large distance during an activity cycle.

LESSONS LEARNED ABOUT SOFT TISSUE BALANCE WITH A MEDIALLY STABILIZED KNEE

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AZ Maria Middelares, Gent, BE

Introduction

Medially conforming knee designs such as the bi-cruciate substituting GMK Sphere (Medacta International, Castel San Pietro, Switzerland) offer an alternative design which aims to minimize paradoxical movement thereby mimicking the native kinematics. With medially stabilized prostheses, a dedicated algorithm different from the other TKA designs is needed during surgery in order to stabilize soft tissue. However, little is known which lateral structures must be preserved during surgery with a medially stabilized implant and which structures can be safely released.

Methods

Starting from the clinical experience, with a surgical workflow that starts with the extension gap first, we started with releases of postero-lateral structures influencing

extension to move then anteriorly. The adopted technique is inside out, starting from the back of the knee. We therefore analyzed the effect of a progressive selective release of the soft tissues, both laterally and medially, in six cadaveric knees implanted with a medially stabilized prosthesis. Aim of the study was to investigate the role of individual medial and lateral soft tissues of the knee in recreating this natural balance and whether this role is somehow dependent on the preoperative deformity, either varus, valgus or neutral.

Results

On the medial side, progressive medial release could be performed as long as at least the anterior fibers of superficial medial collateral ligament (sMCL) remained intact.

With regard to lateral release, in all instances the progressive release of the lateral soft tissue envelope did not affect sagittal stability, which apparently relies mainly on the medial ball-in-socket design of the implant. Progressive lateral release could be performed as long as the anterior one third of the iliotibial band (ITB) remained intact.

Discussion

Additional studies will be required to further investigate the subject. First, future studies are needed to develop algorithms for progressive releases for selective soft tissue management in a medially stabilized prosthesis. Second, studies are needed to observe the effect of medial and lateral releases on the tibia rotation and natural roll back of the knee implanted with a medially stabilized prosthesis. Third, studies are needed to determine the effect of medial and lateral releases on the intra-articular pressure of the knee implanted with a medially stabilized prosthesis and to quantify the resulting forces (Newton) and gap opening (mm). Fourth, the association between laxity and functional outcome needs to be established.

Conclusion

In conclusion, as long as the anterior fibers of sMCL and the anterior fibers of the ITB remain intact, the anterior-posterior stability of the medially conforming implant remains granted. The current study found that the sagittal stability of the implant relies mostly on the medial ball-in-socket design of the implant.

Round table discussion
Sagittal stability: a reason to change?

Session 4 - Knee Day

IMPLANT STABILITY: EVIDENCE AND DISCUSSION

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Background
Kinematics and implant stability vary greatly with different total knee arthroplasty designs. Guided motion knee systems were developed to guarantee stability of the knee and restore natural knee kinematics. The medial stabilized TKA design is supposed to replicate physiological kinematics more than the posterior stabilized TKA system. We conducted this study to compare a newly developed medial stabilized design (GMK Sphere) with a conventional posterior stabilized design (GMK PS) in terms of femorotibial kinematics and contact patterns in vitro.

Methods
Twelve fresh frozen knee specimens were tested in a weight bearing knee rig after implantation of a posterior stabilized and medial stabilized total knee arthroplasty under a loaded squat from 20°-120° of flexion. Femorotibial joint contact pressures in the medial and lateral compartments were measured by pressure sensitive films and knee kinematics were recorded by an ultrasonic 3-dimensional motion analysis system.

Results
The medial stabilized design (GMK Sphere) showed a reduction of medial femorotibial translation compared to posterior stabilized design (GMK PS), (mean 3.5 mm compared to 15.7 mm, $p < 0.01$). In the lateral compartment both designs showed a posterior translation of the femur with flexion, but less in the medial stabilized design (mean 14.7 mm compared to 19.0 mm, $p < 0.01$). In the medial femorotibial compartment of medial stabilized design we observed an enlarged contact area and lower peak pressure, in contrast in the lateral compartment there was a reduced contact area and an increased peak pressure.

Discussion and Conclusion
While GMK PS enforces a medio-lateral posterior translation the GMK Sphere enables a combination of a lateral translation with a medial pivot, which restores the physiological knee kinematics better. Patients may benefit from this higher medial stability provided to the knee by the implant design of GMK Sphere.

IMPLANT STABILITY: EVIDENCE AND DISCUSSION

D. Scott
Orthopaedic Specialty Clinic, Spokane, US

During my training in New York City (Hospital for Joint Diseases), I was exposed primarily to non-mobile bearing PS knees (Osteonics, J&J). In my fellowship with Aaron Hofmann in Salt Lake City, I was exposed to the polar opposite: the "ultracongruent" implant, as well as cruciate-retaining implants. During my early years of practice, I used a majority of Ultracongruent implants, a smaller minority of CR.

As time went by, I came to believe that very few patients are good candidates for CR knees, and utilized various designs of "ultracongruent" implants for 95%+ of my patients (Intermedics/Sulzer, PLUS, OMNI). I was involved in the design of the latter, the OMNI Apex Knee. I was also on the design team for the Stryker Triathlon "Cruciate-Substituting" (CS) insert, and I performed a randomized, prospective trial comparing Stryker's Triathlon PS vs CS, in which I did not find any measurable differences in clinical outcomes at 2 years.

Additionally, I use the measured-resection, Anatomic approach to alignment and balancing, implanting the femur in zero degrees external rotation, matching posterior slope and (to some reasonable extent) proximal tibia varus. I try to recreate the pre-arthritic joint line, and make my bone cuts accordingly, with minimal ligament releases. In other words, I don't try to impose an artificial anatomic situation on my knees, instead I work with the anatomy.

I changed to the Sphere because it's design closely mimics the anatomy and kinematics of the normal knee; it seems to me that all other knee designs essentially force the knee to obey their own less than anatomic design/kinematics.

The Sphere is essentially a very "ultracongruent" insert on the medial side, with 1:1 femur/tibial poly congruency

(something lacking from most other "ultra" implants), and a CR implant laterally.

The Sphere works extremely well with the Anatomic/ Kinematic surgical approach. I am very satisfied with the intraoperative stability and kinematics, and the early clinical results are as good as I have ever seen.

I am performing a randomized trial (Sphere/PS), a multicenter outcomes study, and an xray stability study, and look forward to sharing those results in the future.

IMPLANT STABILITY: EVIDENCE AND DISCUSSION

L. Stewart
Kingsbury Hospital, Claremont, ZA

Numerous publications have reported that a large percentage (20-25%) of patients are not satisfied after their primary total knee arthroplasty (T.K.A). A variety of factors influence the rate of satisfaction - implant design and/or surgical technique being two of them.
My personal "trip" to decide on the design principles of a knee implant, goes back more than 20 years. I am running a private orthopaedic practice doing exclusively arthroplasties and over the years, I have used a variety of knee implants such as the LCS (mobile bearing implant) and the Genesis (both the posterior cruciate-substituting and PCL retaining variations). While I had good results with the usage of these prostheses, my search was focusing on an implant that will enhance stability especially 0°-30° in mid-flexion. I was then introduced to the M.R.K implant from Finsbury, which was employing the principle of a medial pivot joint with a constant femoral radius. Intuitively, this design concept would lead to an improvement in stability and indeed my results were very good. However, that implant was not constrained enough on the medial side and too constrained on the lateral side (no femoral rollback) - something that I realised after starting using the GMK Sphere. Sizing and patellar tracking were also concerning issues. To date I have implanted approximately 150 GMK Spheres and following up my patients I can report (admittedly anecdotally and in short time) the following:
a) Greater sense of stability and improved Range of Motion (doing the swing and hop tests in 3 and 6 weeks).
b) Improvement with the patella tracking.
d) Radiologically a "blend sign" is easier to achieve.
e) Reduction in errors with tibial external rotation.
In conclusion, I have no contraindications of any architectural abnormalities to use the GMK Sphere implant and therefore it has become my implant of choice.

IMPLANT STABILITY: EVIDENCE AND DISCUSSION

D. Waters
Memorial Medical Center, Adelaide, AU

I was asked to present on my experience with the GMK Sphere knee replacement.

Over the last 29 years, I have used Zimmer, Smith & Nephew and Howmedica cruciate retaining and cruciate sacrificing knees.

I was satisfied with the outcomes but 1 in 5 patients would come back dissatisfied with a description of the knee clunking, catching, feeling unstable. They described "feeling like I am walking like an old man", walking on ice or wet floor and had a general feeling of dissatisfaction with the stability of the knee.

Three years ago, I heard a paper presented by Vera Pinskerova and Michael Freeman, regarding the kinematics of the normal knee. This was a Eureka moment for me. I believe this is truly disruptive technology showing that there was no roll back on the medial side of the normal knee. They showed evidence of anatomical studies, MRI studies and fluoroscopic studies confirming no roll back on the medial side.

I then examined the kinematics of the Zimmer, Vanguard, Stryker and Mathis prostheses in my hands in the mid flexion range from 20 to 70 degrees and could quite easily show anterior-posterior translation of 15mm with all of the designs.

Subsequently we reviewed 14 intraoperative cases and looking from the medial side assessed the roll back of the Zimmer Cruciate retaining knee and have shown an average roll back of 14mm with a range of between 10-20mm. This was compared to no measurable roll back with the GMK Sphere knee at 120 degrees of flexion.

Performing an anterior-posterior draw between 30 degrees and 60 degrees over 1cm of anterior translation can be reproduced with the conventional knee prosthesis design but not with the Sphere design.

Subsequently we used the Verasense pressure sensitive plate technology in only 3 cases, but this confirms anterior-posterior translation on the medial side over 14mm.
In summary, I believe the GMK Sphere has superior anterior-posterior Sagittal plane stability and this can be observed intra operatively, especially when viewing from the medial side.

My patients who have had a GMK Sphere knee in one knee and a conventional knee in the other, thus far have universally chosen the Sphere design, but this series is small with only 6 cases.

I have started examining my unhappy patients with a Lachman test and pivot shift test and have frequently found, clunking, catching and can reproduce their pain and believe that many of the patients with normal appearing x-rays, with good alignment and well positioned prosthetics can appreciate this mid range aberrant posterior translation which is different to their pre operative knee kinematics.

I believe this problem can be solved with more constraint offered by the Sphere knee on the medial side.

Team work is the essence - a highly skilled surgeon, excellent prosthetic design, excellence in materials, a trained OR team and exceptional Company support for Nursing, patient, surgeon and hospital education.

Every link in the chain is equally as important in achieving a winning outcome.

GMK SPHERE: INTERNATIONAL, MULTI-CENTRE, PROSPECTIVE, OBSERVATIONAL STUDY - ODEP STUDY

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The research department at the South West London Elective Orthopaedic Centre (SWLEOC) co-ordinates UK and international, multi-surgeon, multi-centre surveillance studies of hip and knee implants to provide medium and long-term outcome data on implant performance and survival. Studies are designed to comply with the UK Orthopaedic Data Evaluation Panel (ODEP) recommendations. Data obtained from these ODEP surveillance studies can be benchmarked against data on our institution's database containing outcome information from over 35000 hip and knee replacement patients.

The GMK sphere ODEP study started in October 2012. To date, 283 operations have been entered into the study. The study group comprises 172 female and 111 male subjects. At surgery, the average Age and BMI of the study subjects was 67.4 years (range 31-88 yr) and 30.33 (range 19.04 – 43.58) respectively. The operations were undertaken by eight surgeons, at four centres - the Royal National Orthopaedic Hospital, Stanmore; the Royal London Hospital, London; The South West London Elective Orthopaedic Centre, Epsom and AZ Maria Middelares, Ghent, Belgium.

To date, 4 study subjects have withdrawn, three have died and two knees have been revised. Euroqol (EQ5D), and Oxford Knee Scores, and Knee Society scores have been collected. Radiographic analysis has been undertaken. By the middle of March 2016, 6 month, 1, 2 and 3 year data had been obtained for 236, 171, 81 and 20 study subjects, respectively. The average EQ5D, Health State Scores, Oxford Knee Scores, IKSS Knee score & IKSS Function scores are shown below:

	Pre-op	6 Months	1 Year	2 Years	3 Years
EQ5D	0.446 (SD 0.271)	0.709 (SD 0.239)	0.766 (SD 0.230)	0.732 (SD 0.283)	0.789 (SD 0.230)
Health State	64 (SD 19.78)	73 (SD 16.66)	77 (SD 19.04)	76 (SD 20.96)	77 (SD 19.76)
Oxford	19.31 (SD 8.04)	34.96 (SD 8.46)	37.50 (SD 9.41)	36.55 (SD 10.50)	39.75 (SD 7.98)
IKSS Knee Score	41.0 (SD 16.05)	73.9 (SD 14.28)	N/A	N/A	84.6 (SD 9.21)
IKSS Function Score	48 (SD 18.35)	80 (SD 20.48)	N/A	N/A	85 (SD 21.29)

One of the analyses that we undertake in our early evaluation of implants is to examine the patient reported pre-operative to post-operative improvements in each of the twelve domains of the Oxford knee score. Our early data-set shows that GMK sphere patients enjoy a greater increase in several domains when compared to other designs of knee replacement. Patient matching and evaluation of more cases, at more time points will identify whether this early observation is confirmed by rigorous statistical analysis.

GMK Sphere: the body of evidence

Session 5 - Knee Day

GMK SPHERE: INTRAOPERATIVE OBSERVATIONS USING NAVIGATION

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Introduction
The kinematics of the native healthy knee shows a rollback of the lateral femoral condyle concomitant with tibial internal rotation during flexion. The medial femoral condyle however hardly moves anteroposteriorly from full extension to 120° of flexion. From 120° to full flexion, both condyles roll back onto the posterior horn of the medial meniscus.
Mimicking the natural knee kinematics in an artificial prosthesis is thought to be important in improving patient outcomes and may also determine the long-term survival. The type and the design of the prosthesis along with the surgical procedure can affect the final kinematics of the knee, which can eventually influence outcome.
The GMK Sphere Total Knee System is an innovative design which has a highly conforming medial "ball-in-socket" femoro-tibial articulation intended to deliver anterior-posterior stability. On the contrary the lateral femoro-tibial articulation is unconstrained to accommodate the rollback observed in the natural human knee. These design features may reduce paradoxical motion and provide more natural kinematics.

Material and methods
The purpose of this study is to evaluate GMK Sphere kinematics in vivo and, using a computer, measure medial AP stability, rotation and lateral shift during active flexion and extension movements. An infrared-based navigation system (iMNS, Medacta International, Castel San Pietro, Switzerland) has been used to measure the translation of the medial and lateral compartments of the knee. 50 patients undergoing GMK Sphere total knee arthroplasty will be enrolled in the study.
The translation of the medial and lateral compartments is calculated from the Femoral Flexion Facets (FFCs) translations projected, with the aid of dedicated software, perpendicular to the tibia cut plane, as previously checked and validated. Anterior/posterior translation (mm) of the projection of the medial and lateral FFCs on the tibial cut plane will be plotted in relation to leg flexion. The acquisition of the kinematic diagram is performed though a flexion/extension movement. Antero-posterior behaviour through the entire ROM of the medial and lateral FFCs will be graphically represented in terms of linear displacement (mm), starting from the initial position up to maximum flexion. In this study a sensitive, non-motor spinal bock anesthesia was used, with active, non-weight-bearing motion recorded.

Results and discussion
15 patients have been enrolled for this preliminary analysis. The only quantitative outcome that we can draw today is that the overall range between the initial position and 90° is significantly different between the medial and lateral compartments. In particular, the lateral compartment shifts much more than the medial (8.133 Vs 2.000), and overall both translate posteriorly. These findings seem to prove the expected AP stability of the medial ball-in-socket design especially in the arc of mid-flexion, but this finding should be verified on a wider sample.
This study has some limitations: the patient is not under load, motor block anaesthesia could influence the physiological joint movement during passive flexion-extension of the leg, the physiological lengthening of thigh muscles can be affected by the use of tourniquet with possible changes of the joint movement.

SAGITTAL STABILITY EVALUATION ON A MEDIALLY STABILIZED KNEE DESIGN

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Introduction
Total knee arthroplasty is a well-established procedure to treat the pain and disability associated with osteoarthritis of the knee, but many patients still experience dissatisfaction with this surgery, possibly due to some subtle instability needed for higher order activity such as stair climbing. Patient satisfaction after a total knee replacement is likely multifactorial, but instability of the components is a likely cause of postoperative pain and dissatisfaction.

Material and methods
Medial stabilized knee designs offer enhanced sagittal stability through the arc of flexion. We used a custom infrared navigation system and stability assessment rig to examine the passive kinematics of femur with respect to the tibia and to obtain force displacement data in the anterior–posterior (AP), varus-valgus (VV), and internal–external (IE) rotation planes using an instrument handle

with a load cell. The passive kinematics for the femur and tibia were collected using the navigation system that measured the forces applied to the lower limb as it was moved in the sagittal, frontal, and transverse planes independently. Knee stability data were collected before and after arthroplasty when the knee was flexed at 0o, 20o, 60o, and 90o in 18 cadaveric specimens. Before the components were cemented in the knee, the orientation of the bone cuts was recorded using the navigation system. Paired t-tests were used to test for differences in maximum anterior displacement during passive kinematics and in ranges of motion during knee stability tests before and after TKA. The data was quality-checked for normality, and non-normal data was either transformed or tested using a non-parametric Mann-Whitney test.

Results and discussion

During passive kinematics, maximum anterior displacement after TKA ($\mu = 12.61$ mm) was significantly greater than maximum anterior displacement before TKA ($\mu = 6.90$ mm) ($p<0.001$), and the knee were in deeper flexion when this maximum occurred ($p < 0.001$) likely related to the increased translation of the lateral compartment of the knee. We found no statistical difference in AP translation between the preoperative state with both cruciate ligaments intact and the medial stabilized total knee replacement. In addition, increased IE rotation of the tibia with respect to the femur was found in the post reconstruction knee. Our findings show a tendency for increased sagittal stability of a medial stabilized knee design with increased rotation of the tibia with respect to the femur in the post reconstruction state.

WHAT DOES FLUOROSCOPIC ANALYSIS TELL US ABOUT MEDIALLY STABILIZED KNEES?

S. Fucentese
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Introduction

Recent studies have demonstrated that in the human knee the medial condyle is spherical in shape and articulates against a concave tibial socket whereas the lateral tibial bearing surface is rather flat or convex. This different geometry combined with a different soft tissue envelop medially and laterally, featuring a tight MCL throughout the entire ROM and an LCL loose in flexion, lead to a kinematics that is stabilized medially and allows for mobility laterally, accommodating the natural roll back of the femur.

A Medially Stabilized knee design seems indeed to better mimic the natural kinematics of the human knee as described above. I was exposed to the medially stabilized knee prosthesis GMK Sphere and tried it first in 2013, coming from the experience of Posterior Stabilized fixed bearing knee. The main clinical advantage expected was to improve AP stability, particularly in mid-flexion, and limit the so called anterior paradoxical motion as seen in some PS patients, since it may be a potential source of postoperative dissatisfaction. The main remaining question was the actual difference in kinematic behavior of such a prosthesis in vivo.

Methods

A moving-fluoroscopy study is conducted at the ETH Laboratory in Zurich comparing different prostheses designs. The aim of the study is to compare in vivo tibio-femoral kinematics in TKA patients implanted at least 1 year before with three different implant types. 8/10 patients for each group will be enrolled, all with good clinical outcome. The three groups feature different implant designs: Medially Stabilized fixed bearing (MS), Posterior Stabilized fixed bearing (PS), Ultracongruent Mobile bearing (UC). During the fluoroscopic analysis each patient is required to do three different motion tasks: level, downstairs and downhill walking. The 3D model is then reconstructed and finally plotted in terms of AP displacement Vs % gait cycle and flexion angle.

Results

The preliminary results do not include Ultracongruent Mobile Insert yet. 4 Medially stabilized patients Vs 8 PS patients are compared. The AP displacement for each motion task, averaged on the totality of patients measured, is reported in the table below divided by Gait Cycle phase and medial or lateral compartment.

Motion Task		Level Walking	Downstairs Walking	Downhill Walking
Stance	Med.	7.4±1.4	4.2±1.0	7.5±1.8
	Lat.	7.6±1.7	5.9±1.9	6.4±0.6
Swing	Med.	10.7±3.2	13.1±1.3	11.0±4.1
	Lat.	8.6±3.5	14.1±2.5	9.8±2.3
Full Gait Cycle	Med.	12.1±2.2	13.6±1.3	12.6±2.9
	Lat.	11.4±2.0	14.3±2.3	11.5±3.0

GMK Primary PS - AP Displacement (mm)

Motion Task		Level Walking	Downstairs Walking	Downhill Walking
Stance	Med.	1.7±0.1	2.7±1.8	1.8±0.4
	Lat.	4.1±0.5	6.3±2.7	5.0±1.2
Swing	Med.	3.2±1.3	3.7±2.1	2.5±1.1
	Lat.	7.0±1.9	10.9±3.8	7.6±2.3
Full Gait Cycle	Med.	3.4±1.0	4.1±1.8	2.9±0.7
	Lat.	7.5±1.8	11.25±3.6	8.4±2.5

GMK Sphere - AP Displacement (mm)

Discussion

The in vivo kinematic pattern of the MS knee compares very favorably with the expected performance i.e. a medial compartment which is stable throughout the entire ROM and a lateral compartment which allows for mobility. The amount of this mobility is highly patient specific. The pattern of motion is comparable amongst the three motion task measurements.

Conclusion

The preliminary results of this moving fluoroscopy analysis show that a medially stabilized design can reproduce in vivo the natural kinematics better than a posterior stabilized design.

Developments in surgical process

Session 6 - Knee Day

LIVE SURGERY HIGHLIGHTS - GMK SPHERE, MYKNEE AND GMK EFFICIENCY: A WINNING SYNERGY

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Introduction
The problem of patient satisfaction after TKA can be addressed by improving implant design and surgical technique. GMK Sphere is a medially stabilized implant designed to provide stability and pain relief. MyKnee is a set of patient specific cutting guides, which has been proven to improve accuracy compared to conventional instrumentation. The combination of MyKnee and GMK Efficiency single-use instrumentation delivers a complete patient matched and single use instrument set that is meant to make the perioperative management more efficient, while lowering the risks for the patient.

Methods
For every TKR case the 3D model of the patient's knee is reconstructed based on CT or MRI images. Pre-operative planning is then carried out by the MyKnee engineers and validated by the surgeon through a web based platform. The MyKnee set is delivered with the related GMK Efficiency instrumentation of the planned size, which is always sterile and brand new, potentially lowering the risk of infection. A small number of instruments are required in the OR, streamlining the operative table setup and breakdown, as well as completely eliminating all the cost and time related to cleaning and sterilisation processes. Since every resection parameter has been planned pre-operatively, the procedure is very straightforward: the surgeon should carefully position the guide on the bone, pin and cut, thus maximising the comfort of implantation. Multiple intra-operative checks are available to maintain intra-operative flexibility: bone resection level and contact points are marked on the patient's bone models, that are always part of the MyKnee set; limb alignment can be checked through GMK Efficiency telescopic rod. In addition, recut blocks are available to adjust the cuts, when needed. A knee implanted with GMK Sphere should show a highly stable medial side and a lateral side that opens slightly through flexion. We routinely use the MyKnee LBS femoral guide in our practice, which allows for intra-operative adjustment of femoral component rotation and proper ligament balance. The ergonomic design and proven reliability make GMK Efficiency instruments user-friendly and accurate, thus allowing for reproducible procedures.

Conclusions
MyKnee is an accurate and reliable instrument to reproduce 3D pre-operative planning, providing good comfort of use in every surgical scenario. GMK Efficiency single-use instrumentation further enhances MyKnee potential to streamline the surgical procedure and simplify perioperative management of TKA. The synergy of GMK Sphere, MyKnee and GMK Efficiency has the potential to improve outcomes and patient satisfaction in TKA.

ANALYSIS OF 1600 GMK-TOTAL KNEE ARTHROPLASTIES: IS MYKNEE STILL JUSTIFIABLE?

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Purpose
The aim of this prospective study was to compare accuracy of limb alignment, and three-dimensional (3D)-component positioning between conventional (CVI) and computed tomography (CT)-based patient-specific instrumentation (PSI) in primary mobile-bearing total knee arthroplasty.

Methods
Between 2010 and 2015, 2100 total knee arthroplasties for the treatment of severe, debilitating osteoarthritis have been performed at our department with the GMK Primary System (Medacta International S.A., Castel San Pietro, Switzerland) using either conventional (n=650) or patient-specific instrumentation (MyKnee, Medacta International S.A., Castel San Pietro, Switzerland; n=1450). For the purpose of the present study, postoperative radiographs of 1200 patients who underwent total knee arthroplasty with patient-specific instruments were compared with radiographs of 400 patients who had surgery using conventional instrumentation. To evaluate the accuracy of conventional and patient-specific instrumentation, the hip-knee-ankle angle (HKA) and 3D-component positioning (frontal femoral component position, FFC; frontal tibial component position, FTC; lateral femoral component positioning, LFC; lateral tibial component positioning, LTC) were assessed on postoperative radiographs and femoral component rotation (FCR) was assessed using CT-images. Furthermore, 150 patients

of each group were clinically assessed before and two years after surgery according to the Knee-Society-Score (KSS), a visual-analog-scale for pain (VAS), the Western Ontario McMaster Universities Osteoarthritis Index (WOMAC), and the Oxford-Knee-Score (OKS).

Results
The mean HKA-deviation from the targeted neutral mechanical axis (CVI: 2.4±1.7 vs. PSI: 1.5±1.4, p<0.001) and the rate of HKA-outliers (CVI: 24%; PSI: 9%; p<0.001) were significantly lower in the patient-specific instrumentation group. Furthermore, we found a significantly reduced number of 3D-component positioning outliers in all planes in the patient-specific instrumentation group (FFC, FTC, LFC, LTC, p<0.05). After a mean follow-up of 29 months, clinical outcome (KSS, VAS, WOMAC, OKS) was comparable between the two groups. However, non-outliers (HKA: 180±3°) showed better clinical results than outliers at the 2-year follow-up.

Conclusions
CT-based MyKnee patient specific instrumentation significantly improved the accuracy of mechanical alignment restoration and 3D-component positioning in primary total knee arthroplasty compared to conventional instruments. The use of patient-specific instruments also reduced the number of HKA-outliers and component positioning in all planes significantly. While clinical outcome was comparable between the two instrumentation groups at early follow-up, significantly inferior outcome was found in the subgroup of HKA-outliers.

CT-BASED PATIENT MATCHED TECHNOLOGY: WORKS WHEN OTHERS WON'T?

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Introduction
Total knee arthroplasty is safe and effective in ameliorating pain and restoring joint function for patients with end-stage degenerative arthritis. Multiple studies link implant alignment to prosthesis survival and clinical outcomes. Significant postoperative malalignment of the hip-knee-ankle (HKA) angle generally reduces prosthesis longevity due to abnormal stresses at the bearing surfaces. A varus or valgus deviation ≤3° from neutral is generally considered an acceptable "safe zone" whereas malalignment >3° in either direction is associated with chronic postoperative pain, higher component failure rates, and lower survival rates.
Multiple techniques have been developed to perform TKA. Conventional TKA utilizes extensive use of visual landmarks and manually aligned instrumentation in an attempt to restore a neutral mechanical axis. Computer-assisted surgery (CAS) was introduced over a decade ago as a means to increase surgical precision during TKA. CAS uses an intraoperative computer to assist the surgeon in resections and implant placement. Both of these techniques have benefits and disadvantages.
Three-dimensional (3D) reconstructions of preoperative computed tomography (CT) or magnetic resonance imaging (MRI) scans have recently been used to develop "patient-specific" instrumentation (PSI) to be used during TKA. However, patients with existing metal implants near the knee joint are contraindicated for PSI technologies that utilize MRI since the spatial encoding mechanisms are often severely compromised, resulting in image degradation and imprecise model reconstructions. CT-based protocols are not subject to the same metal artifact and, therefore, can be used for patients with existing metal at or near the knee. We present a retrospective case series that evaluates the clinical utility of a novel, patient-matched technology based on 3D CT reconstructions in patients undergoing TKA with pre-existing metal implants near the knee.

Methods and Results
We retrospectively enrolled 9 patients (11 knees) with pre-existing metallic hardware near the knee who underwent total knee arthroplasty (TKA) using computed tomography (CT)-based patient-specific cutting blocks. The instrumentation was successfully used in all cases with no changes to the preoperative plan, intraoperative recuts, or complications. Knee Society Knee scores increased from 43±10 to 84±9 and Function scores improved from 51±13 to 79±8 (both p<0.01). Post-operative alignment averaged 179° and all patients were within 3° of neutral. No postoperative complications were reported and no reoperations were performed over a median follow-up period of 15 months (range: 6 to 28 months).

Discussion
The use of CT scans provides superior image quality over MRI, particularly at the femorotibial boundaries and identification of the bony joint line. MRI only estimates cartilage thickness and does not visualize the bony anatomy as well as CT reconstruction, so identification of the joint line is difficult. This can result in reconstruction errors, cutting block mismatch, and lack of accuracy. Bone models generated from CT scans are more accurate with less distorting artifact. The present study shows promising results for CT-based PSI technology for patients with metal hardware and warrants further investigation.

Conclusion
CT-based PSI using MyKnee technology is feasible, safe, and accurate in patients undergoing TKA with pre-existing metal hardware near the knee.

Treating unicompartmental disease

Session 7 - Knee Day

EXTENDED INDICATIONS IN LATERAL UKR

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Introduction
It is well documented in literature that very good results of lateral unicompartmental knee arthroplasty (UKA) are met when the standard accepted indications are followed. Our hypothesis was that these indications can be extended to 1. Post-traumatic osteoarthritis (OA) with malunion secondary to tibial plateau fracture, 2. Mild lateral patellofemoral OA associated with monocompartmental femoro-tibial OA, 3. Degenerative changes of the contralateral compartment after ipsilateral UKA in the same knee (subsequent Bi-UKA)

Methods
We collected data from the University of Marseille (Prof Argenson) and Lyon (Prof Neyret) in order to analyze the clinical and radiological results

Results
We report our results concerning 35 UKAs in these particular situations. Our results in the short to medium term are excellent.

Discussion Conclusion
Our results support the concept that the selection criteria for UKA can be extended to include these indications. A longer follow up is required before they can be routinely included in the conventional selection criteria for UKA.

IS OUTPATIENT KNEE REPLACEMENT VIABLE AND SENSIBLE: WHY, WHO AND HOW?

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Background
Outpatient Unicompartmental Knee Arthroplasty (OUKA) as a treatment for unicompartmental arthritis of the knee is growing in popularity in the United States. We sought to determine if patient Population Disease Severity Stratification (PDSS) and Patient Optimization (PO) coordinated by the operating surgeon could influence the patient selection process in OUKA.

Materials and Methods
A retrospective review of 1,437 consecutive patients that underwent unilateral medial UKA performed by a single surgeon between January 2009 and March 2016 was performed. Average patient age at time of surgery was 72 years. Patients were 54% Male/46% Female. All surgeries were performed in a single hospital facility or freestanding outpatient surgical center. 824 Patients were operated on as hospital inpatients, 613 as same-day outpatients.

Results
Between 2009 and 2010, 169 UKA were performed, of these 68.7% were done as outpatients. In 2011, 134 UKA's were performed and 54.5% were outpatients. Between 2012 and 2015, 1,020 UKA's were performed, 25.9% were outpatients. In Q1 of 2016, 114 UKA's performed, 75.7% were out patients.
The average number of co-morbidities of OUKA patients during the period Q1 2009 to Q2 2015 was 2.2 with a range of 0-3. The average time from diagnosis to surgery during this period was 5 weeks. The average number of co-morbidities of OUKA patients from Q3 2015 through Q1 2016 increased to 3.7 with a range of 0-5. The average time to surgery from diagnosis increased to > 10 weeks.

Discussion
Between 2009 and 2014, the selection of patients for inpatient or outpatient surgery was initiated by the surgeon and finalized by the anesthesia team. The primary determining criteria utilized was the ASA Physical Status Classification, patients who were ASA I or ASA II were accepted for OUKA, this determination was performed by the Anesthesia provider at a pre-op visit 2 weeks prior to surgery. This led to a plateau in patient acceptance for the program. The cause of the plateau was multifactorial and influenced by the anesthesia provider, the patient, the surgeon and the OUKA process itself. In 2015 a new Population Specific Disease Severity Stratification was instituted. The patients grouping triggered a patient optimization pathway that allowed the patients medical providers to impact the patient's health status prior to anesthesia evaluation and surgical intervention. The average time from surgical diagnosis to time of surgery more than doubled after instituting the new stratification process. The number of co-morbidities in the patients selected for outpatient surgery increased from an average of 2.2 to 3.7 without an increase in the outpatient 90-day complication rate.

Conclusion

Population disease severity stratification and patient optimization impact the lag time between diagnosis and intervention in outpatient UKA but lead to improved patient selection in the outpatient setting.

SMALL IMPLANTS IN KNEE RECONSTRUCTION

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In these last years a new interest in less invasive reconstructive surgery has involved the entire orthopaedic world. The shifting demographics of patients with localized knee arthritis, including younger, more active patients, is a major impetus for growing interest in conservative surgical alternatives. Minimally invasive total knee replacement is growing in popularity because of a theoretical reduced blood loss, faster recovery and reduced economical costs. However less invasive surgery has been often identified both by surgeons and manufacturers as shorter surgical approaches to implant the same total prostheses used with traditional approaches. New more conservative surgical approaches have been proposed such as quad-sparing or mid-vastus or sub-vastus. These new approaches, advocated to spare skin and quadriceps tendon, could increase the possibilities to damage muscles and nerves coping with a biological contradiction. Giulio Bizzozero, an Italian pioneer biologist, already in the early years of the last century classified the tissues and the cells in three categories. He identified the "reproducible" tissues, like epithelium (skin) and endothelium, the "stable" tissues, like mesenchyima (tendons and ligaments) that recover very well, and the "noble tissues" (muscles and nerves), which should be not damaged as "perpetual" tissues.

On this purpose it has been hypothesized that real mini-invasive surgery should not be associated only with shorter incisions but with a new respect for all the tissues and with a preserved joint kinematics using new tools and smaller implants, and then redefine it as Tissue Sparing Surgery.

Unicompartmental knee replacement (UKR) and Patello-femoral replacement (PFR) are well-accepted surgical procedures for the treatment of knee arthritis. Furthermore few surgeons in the world experienced association of different small implants matching a philosophy of real less invasive procedures.

Small implants and a preserved joint biomechanics could represent a new development in reconstructive surgery and the approaches described in this special issue could be a very attractive approach. Using computer assistance may help the surgeon in reproducing this high demanding surgery in standardized techniques. The Authors strongly believe that this "personalized on time treatment" for each patient according to severity of the disease using different implants option in association to computer assistance could be one of the most interesting new improvements in the next years.

Bibliography

1. Choong PF, Dowsey MM. (2011)Update in surgery for osteoarthritis of the knee. Int J Rheum Dis. May;14(2):167-74
2. Dieppe P, Lim K, Lohmander S. (2011) Who should have knee joint replacement surgery for osteoarthritis? Int J Rheum Dis. May;14(2):175-80
3. Chapple CM, Nicholson H, Baxter GD, Abbott JH. (2011) Patient characteristics that predict progression of knee osteoarthritis: a systematic review of prognostic studies. Arthritis Care Res (Hoboken). Aug;63(8):1115-25
4. Pandit H, Aslam N, Pirpiris M, Jinnah R. (2006)Total knee arthroplasty: the future. J Surg Orthop Adv. Summer;15(2):79-85.
5. Archibeck MJ, White RE Jr. (2006) What's new in adult reconstructive knee surgery. J Bone Joint Surg Am. Jul;88(7):1677-86
6. Pavone V, Boettner F, Fickert S, Sculco TP (2001). Total condylar knee arthoplasty: a long term follow-up. Clin Orthop; 388: 18-25
7. Dennis MG, Di Cesare PE. (2003)Surgical management of the middle age arthritic knee. Bull Hosp Jt Dis.; 61(3-4):172-8
8. Pagnano MW, Clarke HD, Jacofsky DJ, Amendola A, Repicci JA. (2005) Surgical treatment of the middle-aged patient with arthritic knees. Instr Course Lect.; 54:251-9
9. Berger RA, Sanders S, Gerlinger T, Della Valle C, Jacobs JJ, Rosenberg AG. (2005) Outpatient total knee arthroplasty with a minimally invasive technique. J Arthroplasty. Oct; 20 7(Suppl 3): 33-8
10. Haas SB, Cook S, Beksac B. (2004) Minimally invasive total knee replacement through a mini midvastus approach: a comparative study. Clin Orthop Relat Res. Nov;(428): 68-73
11. Laskin RS. (2005) Minimally invasive total knee arthroplasty: the results justify its use.
Clin Orthop Relat Res. Nov; 440:54-9
12. Lonner JH. (2006) Minimally invasive approaches to total knee arthroplasty: results. Am J Orthop. Jul; 35 (7 Suppl): 27-33
13. Berend KR, Lombardi AV Jr. (2005) Avoiding the potential pitfalls of minimally invasive total knee surgery. Orthopedics. Nov;28(11):1326-30
14. Dalury DF, Dennis DA. (2005) Mini-incision total knee arthroplasty can increase risk of component malalignment. Clin Orthop Rel Res; 440: 77-81
15. Confalonieri N, Manzotti A, Montironi F, Pullen C. (2008) Tissue sparing surgery in knee reconstruction: unicompartmental (UKA), patellofemoral (PFA), UKA + PFA, bi-unicompartmental (Bi-UKA) arthroplasties. J Orthop Traumatol. Sep;9(3):171-7
16. Confalonieri N, Manzotti A, Pullen C. (2007) Navigated shorter incision or smaller implant in knee arthritis? Clin Orthop Relat Res. Oct;463:63-7
17. Confalonieri N, Manzotti A. (2005) Mini-invasive computer assisted bi-unicompartimental knee replacement. Int J Med Robot. Dec;1(4):45-50
18. Confalonieri N, Manzotti A, Cerveri P, De Momi E. (2009) Bi-unicompartmental versus total knee arthroplasty: a matched paired study with early clinical results. Arch Orthop Trauma Surg. Sep;129(9):1157-63
19. Heyse TJ, Khefacha A, Cartier P.Tria AJ Jr. (2010) Bicompartmental arthroplasty of the knee. Instr Course Lect.;59:61-73 UKA in combination with PFR at average 12-year follow-up. Arch Orthop Trauma Surg. 2010 Oct;130(10):1227-30.
20. O'Rourke MR, Gardner JJ, Callaghan JJ, Liu SS, Goetz DD, Vittetoe DA, Sullivan PM, Johnston RC. (2005) The John Insall Award: unicompartmental knee replacement: a minimum twenty-one-year followup, end-result study. Clin Orthop Relat Res. Nov;440:27-37
21. Swienckowski JJ, Pennington DW. (2004) Unicompartmental knee arthroplasty in patients sixty years of age or younger. J Bone Joint Surg. Sep; 86-A Suppl 1(Pt 2): 131-42

22. Newman J, Pydisetty RV, Ackroyd C. (2009) Unicompartmental or total knee replacement: the 15-year results of a prospective randomised controlled trial. J Bone Joint Surg Br. Jan;91(1):52-7
23. Heyse TJ, Khefacha A, Cartier P. (2010) UKA in combination with PFR at average 12-year follow-up. Arch Orthop Trauma Surg; 130(10):1227-30
24. Parratte S, Pauly V, Aubaniac JM, Argenson JN. (2010) Survival of bicompartmental knee arthroplasty at 5 to 23 years. Clin Orthop Relat Res; 468(1):64-72
25. Konyves A, Willis-Owen CA, Spriggins AJ. The long-term benefit of computer-assisted surgical navigation in unicompartmental knee arthroplasty. J Orthop Surg Res. 2010 Dec 31;5:94.
26. Jenny JY. Navigated unicompartmental knee replacement. Sports Med Arthrosc. 2008 Jun;16(2):103-7
27. Rolston L, Siewert K. (2009) Assessment of knee alignment after bicompartmental knee arthroplasty. J Arthroplasty. Oct;24(7):1111-4
28. Buechel FF, Pappas MJ (1984). New Jersey low contact stress knee replacement system. Ten-year evaluation of meniscal bearings. Orthop Clin North Am. Apr;20(2):147-77
29. Lewallen DG, Bryan RS, Peterson LF (1984). Polycentric total knee arthroplasty. A ten-year follow-up study. J Bone Joint Surg Am. Oct;66(8):1211-8
30. Cloutier JM, Sabouret P, Deghrar A. (1999)Total knee arthroplasty with retention of both cruciate ligaments. A nine to eleven-year follow-up study. J Bone Joint Surg Am. May;81(5):697-702.
31. Andriacchi TP, Andersson GB, Fermier RW, Stern D, Galante JO. (1980) A study of lower-limb mechanics during stair-climbing. J Bone Joint Surg Am. Jul;62(5):749-57
32. Freeman MA, Pinskerova V. (2005) The movement of the normal tibio-femoral joint. J Biomech. Feb;38(2):197-208. Review
33. Martelli S, Pinskerova V. (2002) The shapes of the tibial and femoral articular surfaces in relation to tibiofemoral movement. J Bone Joint Surg Br. May;84(4):607-13
34. Pinskerova V, Samuelson KM, Stammers J, Maruthainar K, Sosna A, Freeman MA. (2009) The knee in full flexion: an anatomical study. J Bone Joint Surg Br. Jun;91(6):830-4
35. Banks SA, Frely BJ, Boniforti F, Reischmidt C, Romagnoli S. (2005) Comparing in vivo kinematics of unicondylar and bi-unicondylar knee replacement. . Knee Surg Sports Traumatol Arthrosc; 13: 551-6
36. Fuchs S, Tibesku CO, Frisse D, Genkinger m, Laaß H, Rosenbaum D (2005) Clinical and functional of uni-and bicondylar sledge prostheses. Knee Surg Sports Traumatol Arthrosc; 13: 197-202
37. Fehring TK, Odum S, Griffin WL, Mason JB, Nadaud M. (2001) Early failures in total knee arthroplasty. Clin Orthop Relat Res. Nov;(392):315-8
38. Rand JA, Coventry MB. (1988) The accuracy of femoral intramedullary guides in total knee arthroplasty. Clin Orthop; 232:168-173
39. Zanasi S. (2011)Innovations in total knee replacement: new trends in operative treatment and changes in peri-operative management. Eur Orthop Traumatol.; 2(1-2):21-31
40. Springer BD, Scott RD, Thornhill TS. (2006) Conversion of failed unicompartmental knee arthroplasty to TKA. Clin Orthop Relat Res. May; 446: 214-20
41. Châtain F, Richard A, Deschamps G, Chambat P, Neyret P. (2004) Revision total knee arthroplasty after unicompartmental femorotibial prosthesis: 54 cases. Rev Chir Orthop Reparatrice Appar Mot. Feb; 90(1): 49-57
42. Weale AE, Halabi OA, Jones PW, White SH. (2001) Perceptions of out-comes after unicompartmental and total knee replacements. Clin Orthop; 382: 143-153
43. Patil S, Colwell CW, Ezet KA, D'Lima DD (2005) Can normal knee kinematics be restored with Unicompartmental Knee Replacement? J Bone Joint Surg; 87A: 332-338
44. Fast A, Mendelsohn E, Sosner J. (1994) Total knee arthroplasty in Parkinson's disease. Arch Phys Med Rehabil. Nov;75(11):1269-70
45. Macaulay W, Geller JA, Brown AR, Cote LJ, Kiernan HA. (2010) Total knee arthroplasty and Parkinson disease: enhancing outcomes and avoiding complications. J Am Acad Orthop Surg. Nov;18(11):687-94

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Hip Day - 23 April 2016

The hip replacement patient: what makes him happy? Do's and dont's

Session 1 - Hip Day

WHAT DOES MAKE A PATIENT HAPPY

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Happiness is a mental or emotional state of well being defined by positive or pleasant emotions ranging from contentment to intense joy. Few studies of Orthopaedic Surgery even use the word Happiness, referring instead to Satisfaction. Ware et al suggested 3 variables in satisfaction: personal preferences of the patient, their expectations, and the realities of care received. Mancuso reported that the highest satisfaction rate was seen in patients expecting psychological benefit from their hip replacement, pointing to the realms of pain relief, functional restoration, and finally body image restoration. Dorr et al showed that patients' expectations with a small incision were greater than with a long incision, and preoperatively this affected confidence, positive attitude, and expected satisfaction for greater than 80% of the patients. On the other hand, Baker et al found that only 22% of patients described their total knee as excellent, in spite of the fact that 71% of them described their knee as "much better" following surgery. Psychologist Martin Seligman has suggested that happiness correlates with: pleasure, engagement, relationships, meaning and accomplishments. The degree to which surgery can help bring them closer to these goals will likely influence their state of happiness.

UNDERSTAND THE REGISTRY TO UNDERSTAND IMPLANT RESULTS AND PATIENT SATISFACTION

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There are many factors known to influence the outcome of joint replacement surgery. Some of these include age, gender, diagnosis of patients and the type of prosthesis and surgical technique used. Superimposed on this is the rapid rate of change in medical technology.

Orthopaedic registries are valuable for monitoring patient outcomes in real-world settings. Registries are useful for identifying procedure incidence and device utilization, evaluating outcomes, determining patients at risk for complications and reoperations, identifying devices in recall situations, assessing comparative effectiveness of procedures and devices, and providing data for research studies.

The Mayo Clinic was the first institution to establish a registry in 1969. The first nationwide orthopaedic registry was created in Sweden in 1975 to collect data on total knee arthroplasty (TKA). Since then, several countries have established registries, with varying degrees of success.

Scandinavian countries have been maintaining orthopaedic registries for over four decades (since 1975). The first English-language orthopaedic registry was not created until 1998 (in New Zealand), and both the US and many European countries are still struggling to establish orthopaedic registries.

Although registry data is less satisfactory, prospective clinical studies are challenging to perform in the field of prosthetic surgery, and the considerable time needed to obtain and disseminate their results precludes the effective detection of early failure of implantable medical devices.

According to Robertsson, to obtain 80% power for detecting a significant difference for an implant whose revision rate is 30% above the mean (e.g., 6.5% instead of 5%), 4000 patients must be randomized then followed-up for 10 years.

Web-based registries constitute an effective solution to this problem. Recording new implantable medical devices in registries allows comparisons of their early outcomes to those of the reference standard implants, thereby ensuring the detection of suboptimal performance within a few years.

The majority of Registries and research publications do not correlate patient reported outcome studies with the rate of revision.

Romero et al reviewed studies that looked at patient reported outcome measures as they correlate to revision rates and found of the nineteen registry reports and 1052 articles examined, only one report and two studies mentioned the use of patient-reported outcome measures

and minimum clinically important differences in the context of revision rates of total knee arthroplasty and total hip arthroplasty.

The New Zealand Joint Registry collected data from 78,283 primary hip procedures that took place from 1999 to 2011. An Oxford hip score 12-item questionnaire was administered six months, five years, and ten years after total hip arthroplasty to 20% of that cohort, and patients who had undergone revision surgery were excluded from participating.

At six months, the risk for revision arthroplasty was fifteen times higher for those whose Oxford hip score was <27 points, compared with those whose score was >42 points. Likewise, at five years after total hip arthroplasty, there was a higher risk of revision arthroplasty in the same groups (5.88% for scores of <27 points compared with 0.37% for scores of >42 points).

When reading the Registry one needs to appreciate that the introduction of new techniques may significantly impact the early results of a particular implant despite the fact that the implant is a tried and tested design. The early Quadra-H results in Australia had a significantly higher revision rate compared to the average hip implant on the registry. This was evident in the first 3 years of its introduction and then as the numbers increased the revision rate dropped to similar levels to the average implant on the registry.

The Australian Registry became aware of the fact that over 95% of the Quadra-H stems/cups were implanted through the Direct Anterior Approach. This approach was made popular by the introduction of the Quadra to the Australian market. On deeper analysis the registry reported that the higher revision rate was only evident in the first 2 weeks post surgery and then was equivalent to the general well performing implants. It concluded that the 'new' approach was likely to have caused this elevated revision rate rather than the implant itself.

In summary, surgeons need to understand the true value of Joint Replacement Registries including their strengths and limitations. Results should always be interpreted with considered understanding.

EXPECTATION GOING THROUGH THE HIP APPROACHES - EVIDENCES OF THE ANTERIOR APPROACH

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Abstract
The anterior approach has been gaining popularity for over 10 years around the world. Many significant advantages of the anterior approach have been reported, including rapid recovery, less muscle damage, low dislocation rates, correct implantation of the cup, among others. We have performed all THAs using the anterior approach since 2004 and have been very impressed with a high level of patient satisfaction. One of the most interesting findings in our studies is that the anterior approach could limit the time of dislocation to the very early postoperative period. We retrospectively investigated the occurrence of all dislocations following THAs using the anterior approach in over 1000 consecutive patients who were followed up for more than 5 years. As a result, the cumulative risk of dislocation was 0.92% at 1 month, 1.00% at 1 year, and 1.18% at 5 years postoperatively. In this study, although the dislocation rate wasn't lower than that of other studies, it was noteworthy that the time of dislocation was limited to the very early postoperative period. Rapid recovery of the preserved muscles through the anterior approach could contribute to the dynamic stability of the hip joint and result in this finding. We can expect that late dislocation would rarely occur even in long term results of the anterior approach. In this presentation, we reviewed evidence of the anterior approach in published papers and added new knowledge through our experiences.

OUTPATIENT JOINT REPLACEMENT: TREND OR HERE TO STAY?

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There has been a natural evolution in orthopedics to move more procedures to the outpatient setting. This began years ago with arthroscopy and has evolved to include joint replacement. This trend has followed a gradual reduction in hospital stay for joint replacement over the past decade. A number of factors have led to this evolution including regional anesthesia, periarticular injections, multimodal medications, reduced narcotic usage, MIS techniques, as well as rapid recovery programs. Some proposed benefits to outpatient joint replacement surgery include potentially lowering infection risk, patient

preference, more surgeon control over the episode of care, as well as economic factors that include cost savings to the healthcare system, as well as possible profitability for surgeon owners. This presentation outlines a number of steps for success including selection of appropriate candidates, setting expectations, education, preoperative anesthesia evaluation, medical clearance by primary care, as well as a preoperative visit with physical therapy. Our specific protocols are all reviewed, including preoperative considerations, anesthesia, blood conservation, postoperative medications, and other safety issues. Discharge criteria are discussed which include independent gait with an appropriate ambulatory aid, good pain control on oral medication, a dry bandage, the ability to urinate independently, and a safe discharge plan with home support. Once a surgeon is through the learning curve, anterior approach hip replacement is well-suited to the ambulatory surgery setting. There is a growing body of evidence supporting the clinical and economical advantages of this technique. Medacta's AMIS technique and their support for surgeons includes an extensive educational program as well as a leg positioner which is provided complementary for each case, eliminating the need for the capital expenditure of a special operating table. Results from our ambulatory surgery center, including patients of my partner (Dr. Robert Greenhow) are reviewed. In conclusion, we feel that outpatient joint replacement is safe, cost-effective for patients and the healthcare industry, leads to high patient satisfaction, gives surgeons more control of the episode of care, is financially attractive for surgeons, and is a trend that appears to be here to stay.

AMIStem clinical evidence

Session 2 - Hip Day

DIFFERENT NEEDS... DIFFERENT OPTIONS

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Introduction
Cementless total hip arthroplasty is believed to reduce the prevalence of periprosthetic osteolysis and component loosening, preserve bone stock and thus lead to easier revisions, and be less technically demanding. Different stem options can be implanted depending on the patient's femoral anatomy, which in turn depends on the patient's age, gender, weight, etc. In my clinical practice, I implant approximately 90% of cementless stems, including straight, short and anatomic shapes, cementing approximately 10% of my patients. Considering cementless stems, the AMIStem-H is my first choice.
The aim of the current clinical study is to evaluate the clinical and radiological performance of AMIStem-H five years after implantation. The AMIStem was developed to satisfy the growing demand for minimally invasive options in THR. The short, curved stem design facilitates implantation when utilizing the anterior approach and allows bone stock preservation, especially in the trochanteric region.

Materials and methods
Inclusion criteria in retrospective study. A consecutive series of 81 patients (83 hips) bearing a cementless AMIStem-H stem (Medacta International SA, Castel San Pietro) was reviewed 5 years after THR surgery. All surgeries were performed using the AMIS technique (Anterior Minimally Invasive Surgery, Medacta International SA) with the aid of the AMIS Mobile Leg Positioner. Radiographic evaluation was performed by an independent radiologist. Hip pain and level of activity were also recorded. At 5-year follow-up, 2 patients died and 2 were lost to follow-up. From a radiological point of view, particular attention has been paid to the osteointegration of the stem, incidence of greater trochanter fractures and the presence of radiolucencies. The area around the stem has been divided in 7 different zones on the anteroposterior view as described by Gruen.

Results
At the 5-year follow-up visit 97% of patients reported none or slight hip pain, the remaining 3% reported mild pain: 95% of the patients didn't use pain treatment. Two traumatic femoral fractures (1 month and 4 years after surgery) were observed: none of them required stem replacement. Ossification around the stem neck was observed in one patient at their 5-year follow-up. In this series no signs of stem fracture, subsidence, tilt of stem, endosteal cavitations or resorption of medial neck were observed in 1 and 5-year x-rays. No revision surgery for any reason was reported in this series. The survival rate of the stem 5 years after surgery is 100% considering aseptic loosening and stem revisions as endpoint.

Conclusion
No intrinsic defect can be attributed to the femoral cementless AMIStem five years after implantation. This study indicates that the AMIStem cementless femoral stem can be safely and effectively used for general surgical treatment of hip diseases by total joint replacement in a wide variety of patients with good reliability. The stem will be revaluated ten years after implantation.

AMISTEM-H RADIOLOGIC RESULTS AT 5 YEARS

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Background
The aims of this analysis were (1) to compare the presence of radiolucency at five year follow-up with the one-year follow-up, (2) to evaluate if radiolucency signs are correlated with clinical aspects (discomfort or pain), anatomical shape of the femur, patient characteristics (age, gender, BMI and activity level) and implant characteristics (type and size), and (3) to determine the cumulative five year survivorship of the hip after total hip arthroplasty.

Methods
A total of 178 primary total hip arthroplasties (169 patients) were performed by four surgeons between December 2009 and February 2011. Thereof 140 hips (135 patients, 68 women and 67 men) were analyzed at five year follow-up (range, 3.3-6.3 years). Radiolucency lines presence has been measured according to Gruen zone classification. Anatomical shape of the femur has been classified by using Dorr classification. Hip pain has been measured by a surgeon using a six point Likert scale. The level of activity has been classified in a five point Likert scale.

Results
Radiolucency signs between the one- and five-year follow-up changed particularly in the proximal part of the stem (Gruen zones 1, 7, 8 and 14). In the Gruen zones 1, 7 and 14 the percentage of patients with radiolucencies increased about 10-15%. The Gruen zone 8 the percentage of patients dropped

about 7%. Apart from that, the frequencies of radiolucency signs remained almost unchanged. No correlation between radiolucency presence and clinical aspects has been determined. A total of 28 patients (20%) had at least a radiolucency of higher than 2 mm in one Gruen zone, therefore only 5 of them (4%) were symptomatic (3 slight, 1 moderate and 1 marked pain). Two patients required a femoral revision (one aseptic loosening and one due to fracture). Consequently, the cumulative 5 year survivorship of the stem was 98.88% at 5 years.

Conclusions

No correlation between the measured variables and the presence of radiolucencies has been detected. The survivorship of 98.8% shows a good survival rate which is comparable to the annual report of the National Joint Registry for England and Wales of 2015 for uncemented ceramic-on-polyethylene (CoP) devices (97.88%).

Outlook

The analysis will be repeated in five years for the 10 year follow-up.

AMISTEM-H MULTICENTRIC PROSPECTIVE OBSERVATIONAL STUDY - ODEP STUDY, AT 3-5 YEARS

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We report the 3-5 year results of an international, multi-surgeon, multi-centre surveillance study of the AMIStem-H that has been co-ordinated through the research department at the South West London Elective Orthopaedic Centre (SWLEOC). The study was designed to comply with the UK Orthopaedic Data Evaluation Panel (ODEP) recommendations.

The Medacta AMIStem-H surveillance study was initiated in February 2010. With ethics and research committee approval, study subjects have been recruited at the Uniklinik Balgrist, Zurich, Switzerland, the South West London Elective Orthopaedic Centre (SWLEOC), Epsom, UK and Northampton General Hospital, Northampton, UK. Patients undergoing primary hip replacement, with all pathologies, have been recruited. Patients undergoing revision procedures and those with pre-existing co-morbidities likely to preclude long-term follow-up have been excluded.

To date, 421 patients have been recruited, with implantation of the AMIStem-H femoral stem and Versafit acetabular cup. 150 cases have been undertaken at Uniklinik Balgrist, 236 at SWLEOC and 35 at Northampton General Hospital. The operations have been performed by twelve surgeons.

The mean age of female study subjects was 64.2 years (range 33-85) with a mean BMI of 27.3 (range 17.3-41.4). The mean age of male study subjects was 62.9 (range 18-84) with a mean BMI of 28.7 (range 17.8-40). The pre-operative diagnosis was osteoarthritis in 394 (93.6%), AVN in 16 (3.8%), inflammatory arthritis in 3 (0.7%), rheumatoid arthritis in 1 (0.2%), fracture in 1 (0.2%) and unreported in 6 (1.4%).

At most recent review, 4 (1%) of the study subjects have died, 10 (2.4%) have withdrawn and 7 (1.7%) have undergone revision. Of the 7 AMIStem-H component revisions, 4 have been for failed osseointegration, 1 for recurrent dislocation, 1 for deep infection and 1 for an undersized component. The study population constitute a total of 1394 observed implant years with a revision rate of 0.5/100 observation years. This compares favourably with 0.71 revisions/100 observation years for cementless stems reported in the UK National Joint Registry, NJR. The survival rate at 5 years after surgery is 97.75% with any reason for revision as the endpoint.

The mean, pre-operative, Oxford score was 21.8. This improved to 41.4 at six months, 42.6 at three years and 42.8 at five years. The mean, pre-operative, Modified Harris Hip score was 45.6. This increased to 89.9 at six months, 90.9 at three years and 94.3 at five years. The mean, pre-operative, EQ-5D score was 0.46. This improved to 0.86 at six months, 0.87 at three years and showed a slight decline to 0.84 at five years. The latter being attributed to increasing study subject age. Radiological analysis of 187 study subjects, at six months, revealed Zone 1 radiolucency of <1mm in 2 cases. Radiological analysis of 85 study subjects at three years revealed radiolucent lines of <2mm in Zones 1,2,6 & 7 of seven cases and radiolucent lines of >2mm in Zone 1,2,6 & 7 of one case.

The early results obtained through the AMIStem surveillance study have been obtained from a broad spectrum of patients with degenerative hip disease, from two countries, three surgical teams and should reflect the experience that a typical hip surgeon could expect in their normal practice. The cumulative revision rate of this AMIStem series is comparable to the optimal cumulative revision rate, at 5 years of all cementless stems published by the 12th Annual Report (2015) of the English NJR Registry (2,12 to 3,28% excluding metal on metal and ceramic on metal bearings). Three to five year surveillance data indicates that the AMIStem-H, implanted using the AMIS (Anterior Minimally Invasive Surgery) approach provides a safe and reliable solution for cementless total hip arthroplasty and provides very good medium term results for implant survival and clinical outcome evaluations.

Which implant for which patient?

Session 3 - Hip Day

THE BONE - IMPLANT INTERFACE

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Introduction
The external forces imposed to any medical device from manufacturing, sterilisation, implantation, and functional in life service presents a complexity of environments that can expose a design or material weakness that can lead to failure. Clinical outcome of orthopaedic devices rely on the implant to achieve early, reliable and robust fixation to the host. Clearly, what happens at the device-coating interface during manufacturing and implantation, the bone-implant and after surgical implantation, play an important role in the success and/or failure of the device and can dictate clinical success or failure.

Understanding substrate-coating interactions in the lab and bone – implant interactions through pre-clinical animal models allows us to better understand and design materials and devices to assist surgeons in improving clinical outcomes. The in vivo responses at the bone-implant interface were studied using our established large animal pre-clinical bone-implant interface model. Our animal model has nearly two decades of history evaluating materials, coating and devices used for cementless arthroplasty fixation and more recently interbody spinal fusion devices.

Methods
Traditional Ti alloy metal implants, calcium phosphate coated Ti alloy as well as Ti alloy implants prepared from additive manufacturing process where evaluated in vivo in cortical and cancellous implantation sites versus time. All implants were 6 x 25 mm. The mechanical and local biological reactions at the bone-implant interface were examined. The coating-substrate interface was also carefully examined following mechanical testing to examine for evidence of damage, resorption or failure.

Results
Direct bone ongrowth as well as ingrowth was observed at 4 weeks which improved with time at 12 weeks for HA coated Titanium, Titanium and 3D printed implants in our vivo pre-clinical animal studies. The additive manufactured, 3D printed, devices to support new bone ingrowth into the porous domains remain superior to other technology. The interface between the implant and the coating and the bone can be controlled. The current studies demonstrate a firm understanding at the manufacturing and in vivo level for devices aimed at improving clinical outcomes in arthroplasty. Additive manufacturing technology is an exciting frontier in the development of new fixation systems for uncemented arthroplasty.

HOW TO MANAGE HIGH DEMANDING PATIENTS

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Total Hip Replacement is one of the most successful surgeries in medicine, which offers reliable relief of pain and considerable improvement of joint functionality. Although most hip replacements are performed in patients between 60 and 80 years of age, older or younger age is not a contraindication.
Beyond age and gender, patient population also differs for habits, lifestyle and therefore for expectations after surgery. In few words, different patients have different needs.

Among patients who undergo total hip replacement, a specific category of people can be identified: the so-called high demanding patients. What "high demanding" stands for?

In my personal experience I mainly treat young and very active patients, from 40 up to 70 years old with marked inclination to sport and fitness. These subjects require particular care and attention, in order to make the new hip compatible with their lifestyle. In fact the average age of my patients is 52 years and they are extremely active: professional dancers, free ride skiers, bikers, etc.

In the treatment of this population, the surgical technique plays of course a crucial role. The anterior approach is the only technique which follows a path both intermuscular and internervous and therefore reduces the risk of the damage, resulting in shorter rehabilitation and faster return to daily activities.
Moreover, a correct implant selection based on surgeon's experience is a key factor when facing high demanding patients.
On the acetabular side, I usually prefer ceramic or cross-linked polyethylene liners, paying attention to keep a reduced cup anteversion to minimize the risk of anterior

dislocation. Since I operate all my patients with the AMIS technique, posterior luxation is not an issue and therefore I limit the use of double mobility cups.
On the femoral side, there are different solutions depending both on bone quality and patient anatomy and the surgeon will select the proper fixation option (cementless or cemented) accordingly.
Depending on the femoral stem selection, it is extremely important to make the patient aware of the rehabilitation protocol that may vary according to the component (Quadra, MiniMAX, AMIStem).

In my own experience I implant the AMIStem since 7 years. I evaluated radiologically and clinically my first 140 cases at 5 years follow up. Results indicate that the AMIStem-H implanted using the AMIS technique provides a safe and reliable solution for cementless total hip arthroplasty.

Especially when treating very active patients, the proximal fixation of the femoral stem is crucial and could be enhanced with proximal highly porous coatings that favor both primary fixation and osteointegration.
For this reason since 2013 I have been adopting an AMIStem with a double proximal coating of highly porous plasma spray titanium and HA applied in the proximal 2/3 of the stem. Early clinical and radiological results are well promising for the future.
The evolution of the proximal coating aims to increase the implant performance, enhancing the component fixation and being therefore a specific solution for high demanding patients.

In conclusion, surgical approach, proper implant selection and surgeon experience are the tools to exploit to address at best high demanding patients. For this kind of patients, implant selection is crucial especially on the femoral side, for which stems with proximal porous coating represent a high performing solution.

MASTERLOC: GEOMETRY, FRICTION AND REPRODUCIBILITY

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Tapered stems have a long history and demonstrated longevity. In spite of this, problems have been shown with the fit of some designs in a wide variety of patients. Cooper et al have shown that distal fixation of a proximally coated tapered stem may predispose to failure of osteointegration. A number of different strategies have been employed by different companies to shorten implants and reduce distal to proximal mismatch in the larger sizes. Some of these have fared well in early outcomes, while others have had problems with thigh pain. The Masterloc Stem represents an intelligent and conservative evolution in the traditional tapered stem, including mild (4-6mm) shortening with respect to traditional stems, a distal to proximal ratio that better reflects anatomy, a gentle trochanteric relief, and extension of the porous surface to the level of the bottom of the lessor trochanter, representing 50% of the length in most stems. The Mectagrip is an advanced titanium coating with an open interconnected porosity of 30-60% porosity and a pore size of 50-100 microns, reflecting a greater frictional resistance or "stickiness". The broach to implant relationship was engineered to have the implant within 1-2 mm of the position of the broach, which has been achieved in 75% of cases thus far.

CURRENT INDICATIONS FOR CEMENTED STEM IN PRIMARY AND REVISION TOTAL HIP REPLACEMENT

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During the last 10 years, the use of cemented stems has dramatically decreased and uncemented stems are now seen as the gold standard all over the world.
However, in my daily practice I still use cemented stems in some indications where I am convinced that they are safer and more reliable than uncemented stem.
In Primary THR the stem fixation choice is depending on the bone quality, the femoral bone shape, the patient's age and the original disease of the hip. The bone quality is a critical issue. When it is poor, for example in case of severe osteoporosis, the use of a cemented stem is safer because the implantation is easy and non traumatic and the fixation is immediately achieved, decreasing the risk of postoperative fracture.
The worst femoral shapes for the uncemented fixation are the stovepipe and the champagne-fluted appearances. In the first case the cylindrical shape of the medullary canal is not suitable for the usual primary fixation of uncemented stems. In the Champagne-fluted femur, the metaphysis is large and the distal canal narrow exposing the uncemented stem to a solely distal fixation responsible for pain and stress shielding. In these cases cement provides a customized fitting of the stem fixation with the bone morphology and makes the fixation stable and durable. Old patients very often have both problems, poor bone quality and inadequate femoral shape. For them cemented fixation is in any case safer. The original disease of the hip might be responsible for deformities and/or modifications of the bone quality leading then to the choice of a cemented femoral component. For instance, distorted femurs as seen in posttraumatic cases

or severe hip dysplasia are in my opinion easier and safer to implant with a cemented stem. Also, rheumatoid arthritis often responsible for secondary osteopenia is a good indication for a cemented stem.
In revisions the key factor that influences the choice of a cemented fixation is the will of the surgeon to reconstruct the bone loss with a graft. In this situation a cemented fixation is mandatory to have an immediate and stable fixation to achieve a good fusion and remodeling of the graft. The other advantage of this technique is that it can be used with a stem of regular length, which is not possible with an uncemented stem because its fixation will be found distally under the bone loss of the proximal femur.
Both fixations have advantages and drawbacks. For a long time the two techniques were opposed and surgeons thought that they needed to choose one or the other. Today I am convinced that there is a right place for both of them, the only difficulty is to propose the most appropriate technique to each patient.

Anterior approach R-evolution

Session 4 - Hip Day

THE AMIS R-EVOLUTION

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The anterior approach is the only technique which follows a path both intermuscular and internervous and therefore reduces the risk of the damage to periarticular structures. The development of a standardized and simplified surgical technique for the anterior approach, with specific instrumentation and a personalized education program - the AMIS approach - strives to further respect the periarticular structures, in particular the capsule, usually released to efficiently expose the femur. In fact, a reduced capsular release potentially results in less bleeding and better hip functionality.
In order to reduce the learning curve and maximize the procedure outcomes, education plays a crucial role. Hence a dedicated education program has been developed to help surgeons facing the anterior approach. This program includes the teaching of the AMIS approach not only for primary, but also for revision and difficult cases.
In my experience, during the last 10 years, I conducted about 200 learning centers on the AMIS technique.
A proper use of the AMIS specific instrumentation is the key to optimize the surgical technique.

As part of this specific instrumentation, the AMIS Mobile Leg Positioner and AMIS self-retaining retractors allow for a stable and reproducible leg positioning, while the Judet type broach handle eases the femoral preparation, avoiding the impingement on the patient's skin. These instruments can efficiently help to achieve an adequate femoral exposure avoiding the excessive use of big retractors, and especially allow a very limited and selective capsular release.

For most anterior approach techniques (especially without leg positioner) it is common practice to release not only the pubofemoral and ischiofemoral ligaments but also the obturator internus and piriformis, in order to get an adequate exposure of the femur. A good knowledge of the hip capsule's anatomy in association with the use of the AMIS approach will render the femoral exposure (in fact, the whole surgery) much easier and reproducible, thanks to its specific instrumentation.
For those surgeons already expert with the technique, it is also possible to change the orientation of the surgical incision, turning it of about 90°. In this way the scar will be positioned on the junctional region between the abdomen and thigh, providing a cosmetic advantage to the patient. I adopt this incision in about 15-20% of my cases.

Currently I perform all my cases (both primary and revision, straightforward or complicated) with the AMIS approach, being a versatile technique that can be easily extended to treat every case.
In a consecutive series of 51 patients who underwent revision THA through the AMIS approach, 16% were revisions of resurfacing procedures, 41% were only acetabular revisions, 2% only femur and 41% needed both acetabular and femoral revisions. If only a simple acetabular revision is needed (liner exchange, cup revision, or revision of failed resurfacing), the exposure is no different from that used during primary arthroplasty, so the recovery and rehabilitation should be similar to those of a patient who has undergone primary anterior approach arthroplasty. If the case is more complex, different techniques and extensions can be used to address it, like the Levine approach (proximal extension), or the Zarack-Nissek approach (distal extension).
In this consecutive series no dislocations were observed and the average WOMAC at the last visit was around 83 points. We registered 9.8% of complications with a mean follow-up of 55 months. This means that the AMIS approach is a very effective technique to perform revision THA, offering advantages over other techniques.

Regarding capsular release, some of the primary THRs I performed through the AMIS approach didn't even need any release. In my last 100 AMIS cases, that happened in 15% of the cases, and in 83% of them I only released the capsular ligaments, no muscles were involved. I should add that I never touch the piriformis muscle.

In conclusion, the AMIS approach is a very effective and versatile technique. To further minimize the damage to periarticular structures, I personally try to minimize the capsular release as much as possible. This can be achieved with proper education and the usage of specific instruments.

REVISION THROUGH AMIS: HOW THE RIGHT INSTRUMENTS MAKE IT POSSIBLE

A. Gächter
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AMIS is a proven and versatile surgical technique, which can be used both for primary and revision surgeries. Revision through AMIS is feasible, but requires dedicated instruments, techniques and a proper education.
In order to revise the acetabulum and to remove an acetabular shell with minimal bone loss, a dedicated instrumentation system is required. The surgeon needs an offset handle with an easy and handy mechanism in order to avoid the impingement of soft tissues and useful modular blade set. According to the outer and inner cup diameter, usually short stiff blades are necessary to cut around the cup rim where one density is higher or long thin blades to cut in a deeper position.
A The use of specific sets of handles, blades and a slap hammer result in an effortless explantation of the stem, typical for a femoral stage. It should allow the implementation of all kinds of approaches, it simplifies the AMIS technique and also the hoop stress release technique, when required.
Focusing on the revision of cemented implants, the surgeon has to fragment and remove residual parts of cement after prosthesis explantation, and this would be really facilitated by the use of chisels, osteotomes, gauges, hooks and drills. Keep in mind, that we can get a solid fixation between old and new cement. Well-fixed cement has not to be removed completely (except infection). In case of very difficult stem revision (long stem etc.) a V-shaped inside-out trochanteric osteotomy is recommended. Since the tension band on the lateral side is intact, a osteosynthesis of the greater trochanter is not necessary.
According to literature regarding revision (Malchau/ Herberts 1979-1996) with the following causes and percentages: aseptic loosening (72.3%), dislocation (4.2%), primary infection (7.2%), late infection (1%) and technical mistakes (3.9%), in 80% of these cases revision through AMIS should be possible.
Revision through AMIS results in a gentle and less invasive surgery and allows a series of advantages for the patients and the administration including less intensive care, less blood loss and less dislocation. We can underline that the greater trochanter stays intact and the transfemoral approach is not necessary with AMIS. The few limitations are related to the long and very structured stems, or to chronic infection.
In conclusion, for an easy and successful revision, the availability and support of specific instruments and training are essential. Dedicated and curved instruments are helpful for the surgeons and safe for the patients.

M-VIZION: EXPAND YOUR HORIZONS WITH MODULARITY

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The volume of revision surgery will continue to increase as total hip replacements are being done in younger patients, our elderly are living longer and are a growing population and infections continue to be an issue.
Unfortunately, reimbursement does not commensurate with the level of difficulty for revision total hip replacement.
A system that is technically reproducible, cost effective and able to accommodate the anatomic variations associated with revision total hip replacement is necessary to address these issues.
Just as the level of expectations have increased for patients having a primary total hip, the same is said for those undergoing a revision.

M-Vizion addresses the challenges associated with revision of the femoral component. The modularity allows for fixation of the diaphysis and proximal femur independently. Anteversion can be optimized for any given situation. And M-Vizion is the first femoral revision stem designed to be utilized regardless of the surgical approach. It is the only system specifically optimized for the AMIS approach. The technique is reproducible and can be performed in a timely fashion with potentially decreased soft tissue damage and increased stability. This will allow patients the greatest chance to return to a high level of function and optimize their outcome.

MPACT SYSTEM: PRIMARY TO REVISION AND EVERYTHING IN BETWEEN

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Introduction

Total hip arthroplasty (THA) is one of the most commonly performed and successful orthopedic operations in improving a patient's quality of life. Orthopedic surgeons are continually striving to improve all aspects of care relating to this procedure whether in improvements in implant technology, instrument improvement, or the technique involved in performing the procedure.

Multiple studies have shown excellent survival of uncemented THA. Furthermore, numerous other studies have shown excellent survivorship for hemispherical press-fit cups, especially with the introduction of highly

crosslinked polyethylene. However, some studies have shown differences in cup revision rates with different coatings. For example, cups that are beaded and hydroxyapatite-coated have been shown to have a higher revision rate than cups that are either wire mesh or highly-porous.

During the last decades, new titanium porous coatings have been introduced to improve osseointegration for uncemented sockets. A high friction and scratch-fit feel secure the initial fixation and a high porosity ensures bone ingrowth, thus providing secondary stability. With a higher porosity relative to standard coatings, for any given percentage filling, a greater volume of bone is present within the porous surface, thus giving a proportionate increase in interface strength. Multiple authors have documented excellent initial fixation and subsequent osseointegration with these highly-porous implants. One disadvantage of using highly porous implants is the presence of a "dome gap" due to incomplete seating at the time of implantation. Fortunately, most authors report these resolve within 1-2 years post-implantation.

The Mpact acetabular family is a modular hemispherical press-fit acetabular shell with an external Titanium porous coating called Ti-Growth (Medacta commercial name: MectaGrip). Primary stability is enhanced by the high friction coefficient of the porous surface, which is between μ=1.08 and μ=1.11. The Mpact system includes Primary, Revision (Multi-hole, Rim hole options), and Double-Mobility Implants.

Methods and Results

The present study aims to evaluate both clinically and radiographically the performance of the Mpact cup in the treatment of patients with hip joint disease after undergoing a primary total hip replacement. 163 Primary THA's were performed in 147 patients from May, 2011 to August, 2013. There were 56 Male and 91 Female patients with an average BMI of 27.5 (20.1-41.6). Osteoarthritis represented 88.3%, while other diagnoses (AVN, Trauma) represented 11.7%.

There were no cup-related intraoperative complications. However, 2 femur fractures requiring fixation occurred in the series. Cup implantation averaged 45.2° (range 28° - 56°).

Post-operative complications included 1 dislocation and 5 infections. Radiolucencies were found in 32 (19.6%) of hips at six-weeks post-operatively. By one year, 19 of these had resolved completely. Only 3 had remained the same. No patient with radiolucency was revised for aseptic or fibrous loosening. Survivorship was 98.8%. Only 1 implant failed in the study due to failure of osseointegration. This failure occurred in a patient with colon cancer who underwent pelvic radiation.

Conclusion

In conclusion, the Mpact acetabular system is safe, effective, and achieves high osseointegration for THA.

INSTABILITY AFTER REPLACEMENT OF THE PROXIMAL FEMUR WITH MEGAPROSTHESIS - CAN A DOUBLE MOBILITY CEMENTED ACETABULAR COMPONENT REDUCE THE DISLOCATION RATE?

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Soft tissue problems and instability are common complications of proximal femur replacements following tumor resection and account for about 30% of failures in this region. The reason is in most cases an insufficiency of the abductor muscles due to an extended resection of soft tissue or failure of the musculoligamentous re-attachment at the prosthesis. Double mobility liners are one possible solution in order to achieve reduced dislocation rates. To date, the degree of evidence is limited especially for the use of double mobility liners in proximal femoral replacements, whereas only one study has been published, to our knowledge. The latter, however, as well as our own preliminary results (comparison of 72 patients with fixed vs. double mobility liners) emphasize, that there is a marked decrease of dislocations in proximal femoral replacements when using double mobility liners. Therefore, we have the opinion, that double mobility liners should be used routinely in proximal femoral replacements and especially in patients with high dislocation risk (e.g. following tumor resection).

Round Table Discussion
Avoiding and managing complications in THR

Session 5 - Hip Day

AVOIDING AND MANAGING COMPLICATIONS IN THR

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Total hip replacement normally provides an excellent outcome and a happy patient. However, anyone undertaking hip replacement, regularly, knows that complications do occur. Our round table group will discuss ten complications of hip replacement surgery. These are Deep Vein Thrombosis & Pulmonary Embolus, Infection, Dislocation, Leg Length Inequality, Neurovascular Injury, Peri-Prosthetic Fractures, Failed Osseointegration, Heterotopic Bone Formation, Squeaking and Aseptic Loosening.

The group will consider the following questions:
Does early mobilization reduce the incidence and severity of thromboembolic complications?
Does the anterior approach allow earlier mobilization?
Is the incidence of thromboembolic disease reduced with anterior approach hip replacement?
Is the rate of superficial and deep wound infection affected by surgical approach?
How do we decide when lucent lines are innocent and when lucent lines mean failed osseointegration or implant loosening?
What investigations can help this decision making process?
What to do in cases of component loosening?
Is there anything that can be done to delay aseptic loosening and does tis mean lifestyle changes.

The expert panel members will share their top tips on to avoid peri-prosthetic fractures and what post-operative weight bearing protocol is most appropriate for anterior approach hip replacement patients and how to avoid joint squeaking.

Finally, expert panel members will speak on the role of anterior hip replacement in strategies to reduce the risk of joint dislocation after total hip replacement & hemiarthroplasty; to minimize the risk of leg length inequality, neurovascular injury and heterotopic bone formation.

IN COMPARISON TO POSTEROLATERAL APPROACH, DOES THE ANTERIOR APPROACH REDUCE THE DISLOCATION RATE AFTER BIPOLAR HEMIARTHROPLASTY FOR NECK FRACTURE?

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Background
Bipolar hemiarthroplasty for femoral neck fractures performed by posterolateral approach (PL) is a well-recognized procedure which is yet associated to a high rate of dislocation (7-14%). The anterior approach (AMIS = Anterior Minimally Invasive Surgery) for hip arthroplasty is a minimally invasive procedure which theoretically ensures a low dislocation rate. This study aims to evaluate retrospectively if the AMIS approach in bipolar hemiarthroplasty for femoral neck fractures is effectively associated to a better stability without an unacceptable complications rate.

Patients and Methods
All patients operated by bipolar hemiarthroplasty for neck fracture either by PL (N=106) or AMIS (N=46), since the introduction in our hospital of AMIS for hip arthroplasty, have retrospectively been reviewed with at least a 6 months follow-up. Posterior approaches were classically performed in the lateral position with a tendino-capsular repair at the end of the procedure. Anterior approaches were performed in the supine position with a leg positioner. The choice of the approach was related to the surgeon's practice. Dislocation rate and other complications were investigated.

Results
PL and AMIS groups were comparable for age (82y ;80y), gender (M/F: 1/2), BMI (25;24). The ASA score repartition differed slightly among the two groups: PL group had ASA I: 3,8%, II: 34,9, III: 56,6, IV : 3,8 and AMIS group had ASA I: 0%, II: 32,6, III: 56,5, IV : 8,7. Seven patients in the PL group suffered at least one dislocation (6,6%); among those 4 hips were revised. No dislocation was observed in the AMIS group. Two per-operative proximal femoral fractures occurred in the PL group against 1 in the AMIS group. Deep infections with revision in two stage procedure was observed in 2 patients in the PL group and 1 in the AMIS group.

Conclusion
Our findings indicate that the anterior approach on an orthopaedic table is a safe technique applicable to bipolar hemiarthroplasty for fracture in an unselected population.

In this specific indication, the dislocation rate (< 1%) is low in comparison to that observed by the posterior approach in our study (6,6%) or generally in the literature (6-20%). This can be a major advantage for AMIS in this often debilitated population, and even more so if a faster recovery is confirmed by further studies.

HOW TO ASSESS LEG LENGTH THROUGH ANTERIOR APPROACH

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Think of leg length as the skeletal length of the lower extremity. Measurement of leg length is thereby the distance from a pelvic transverse plane to the plantar aspect of the foot when the long axis of the lower extremity is placed perpendicular to this transverse plane. Supine or standing plane x-rays or a supine CT scan are methods of measuring leg length by this definition. For the large majority of cases we may assume that the proximal-distal level of the acetabular roof as well as the teardrop and the proximal femoral landmarks are symmetrical enough between both hips to allow for accurate comparison of leg lengths before and after THA surgery.
Leg length is therefore a quantitative measurement of bony dimensions and not what the patient feels. It is not an adequate measurement of leg length to feel bony landmarks such as the iliac crest, malleoli or assess the patient by standing on blocks, or by intraoperative checks of soft tissue tension. The x-ray gives a real picture of the bone from which accurate quantitative and/or comparative assessment can be made.

There remains however, the actual goal of surgery which is for the patient to be happy with the result. It is desirable that the patient feels, following the surgery, that his leg lengths are equal, however in a minority of cases the patient will be happiest with unequal length legs (defining leg length as above). In the great majority of cases however, if x-ray views using the image intensifier at surgery confirm symmetrical leg length and offset, the patient will feel equal and be happy. I rely on superimposition of hip images as the most accurate check. I find that an AP Pelvis with horizontal lines drawn is less accurate. Comparative assessment of leg length and offset demands that the pelvis is level and both hips are in the same position regarding rotation and abduction. I use "software guided imaging" to enhance accuracy of cup position, leg length and offset. Prior to anterior THA surgery the patient will often feel that he has unequal leg length. First ask if this sensation is acquired, "10 years ago, before your hip arthritis did you feel your leg length was equal?". Most often the answer is yes and in that case, restoring radiographic symmetry at Anterior THA surgery is the solution. Most commonly the patient will feel that their leg is short and feel that it is shorter than it actually is. Typically the leg will shorten only a few millimeters with cartilage degeneration however the patient may sense 1 or 2 cm shortening because of the acquired Trendelenburg gait. In some cases the patient will feel the arthritic hip extremity is too long. This is typically because of an abduction contracture caused by impingement of osteophytes on the inferior femoral head and acetabulum. Again restoration of accurate hip anatomy, confirmed by x-ray will make the too long leg sensation go away as hip mobility is restored and the patient can level their pelvis.

Hips that have an acquired shortening such as from wear of the head or a mal united femoral neck fracture should be restored to their pre disease length. Hips that have shortening from childhood (CDH, perthes, etc) should not have complete length correction or the patient will feel too long. If the patient has unequal leg length from a previous opposite THA and that leg was made too long it is typically unwise to lengthen the Anterior THA side by an equal amount or the patient often feels too long on the Anterior THA side. If the patient has a shortening of the extremity ipsilateral to the hip you operate from another cause such as tibial shaft fracture, it is unwise to attempt complete correction of length with the THA because this will detrimentally alter the hip biomechanics.
I have frequently heard surgeons tell their patients that their leg length was made correct at the time of surgery however the patient senses unequal leg length because of spine induced pelvic obliquity or a hip abduction contracture. If a patient however, is still complaining at 6 months after surgery about leg length discrepancy, it is my impression that the patient is almost always correct and the surgeon is wrong.

LIMB-LENGTH DISCREPANCY AFTER THA WITH ANTERIOR APPROACH: COMPARISON OF EUMETRIA RESTORATION WITH AND WITHOUT AMIS MOBILE LEG POSITIONER

S. Lustig
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Introduction
Significant limb length discrepancy (LLD) is reported when patients experience shortening > 10mm or lengthening > 6mm after THA. We asked the question of the comparison of eumetria restoration with and without AMIS Mobile leg positioner.

Material and methods
We retrospectively analysed postoperative LLD about a series of 200 consecutive THA performed using anterior approach without leg positioner, using Williamson and Reckling method. We compare our results with literature data and suggest a combination of 3 peroperative controls in order to improve these findings (neck length, specific landmarks around the knee, +/- XRays templating). A pilot study has been performed.

Results
According to the literature regarding LLD and Mobile leg Positioner, mean LLD is 1mm to 7mm and 0% to 2% patients are reported with LLD > 10mm. Many studies found accurate leg length but several cases of surgical revisions for LLD have been described. Our personal experience with 200 consecutive THA without specific leg positioner reported : mean LLD 2mm (+/-3.1), 82 .6% with LLD < 5mm, 2% with LLD > 10mm. No revision has been performed for LLD. Our pilot study with AMIS mobile leg positioner using the combination of 3 peroperative checks suggests this protocol could help to control LLD and allow the surgeon to achieve appropriate Limb Length control.

Conclusion
Less than 2% significant LLD are reported after THA with anterior approach, but outliers still occur, with or without mobile leg positioner. Using a combination of peroperative checks (neck length, landmarks located around the knee +/- XRays) could significantly modify this statement for both techniques.

HETEROTOPIC OSSIFICATION & NEUROVASCULAR STRUCTURE DAMAGE AFTER TOTAL HIP REPLACEMENT

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Introduction
Heterotopic ossification (HO) is universally considered as an indirect sign of soft tissues damage during hip surgery. The accurate mechanism underlying the process is unknown, one theory suggests that it may be the result of the ostheoprogenitor cells' displacement from the femoral stem during its reaming and broaching. Another theory states that ostheoprogenitor cells may originate mainly from soft tissues and not from the bone. The incidence of HO using traditional approaches varies from 28% to 61%. Recent studies demonstrated there is lesser chance to develop clinically significant HO on anterior approach (AA) for THR; although scientific literature found a significant difference between the THR with AA performed on a regular OR table vs performed on a mobile leg positioner extension table. Neurological and vascular complications following hip arthroplasty are uncommon, their impact can vary from transient and slight to permanent and devastating. The proximity of nervous and vascular structures make any hip surgery highly dangerous. Direct or indirect injuries of these structures may occur during surgical exposures and/or subsequent procedures. Thus, complete consciousness of the anatomy of the pelvis and proximal femur is necessary. Peripheral nerve injuries can involve either nervous structure in the proximity of the hip joint or on distant sites. Sciatic nerve injury is the most common injury following THR. Femoral nerve damage is less common and is associated with AA, even if its diagnosis is often delayed the prognosis is slightly better then with sciatic nerve injuries. The superior gluteal nerve injury can happen during direct lateral approach (DLA) surgeries. Obturator nerve damage is the least common and with less functional consequences. Vascular injuries are less common but are associated with life threatening consequences. Vascular lesions mechanism are many, they include vessels occlusion often associated with pre-existing peripheral vascular disease. Direct vascular damage can occur during screw fixation of the acetabular components, cages or structural grafts. It is mandatory to avoid screw fixation on the acetabular anterior quadrant. All acetabular and femoral defects should be bone grafted to avoid unintentional cement migration.

Objectives
We wanted to compare literature data to that relating to the 537 THR performed at the Orthopaedic Institute G. Pini from April 2014 to June 2015.

Material and methods
In our series 330 patients were female and 207 were male; the patients average age was 68,8 and the average BMI was 30,4. Direct lateral approach was used on 344 patients (64%), on 193 patients (36%) the anterior approach was used. Of the patients undergoing THR with AA, 161 cases (83%) were performed using the regular OR table, in 32 cases (17%) a mobile leg positioner extension table was used. An anatomical stem was implanted in 333 patients (62%), while a straight stem was implanted in 204 cases (38%).

Results
At the 6 months follow-up clinical and radiological check, HO was detected in 107 patients (20%). Basing on Brooker's HO classification, grade I was found in 49 cases (45,5); grade II in 44 cases (40,9%); grade III in 12 patients (4,6%); grade IV in 2 hips (2,3%). We found HO in 29 cases (27%) with anatomical stem and 78 cases (72,5%) with straight stem. We found HO in 72 DLA cases (67%) and 35 AA cases (33%). In the 32 cases in which the mobile leg positioner extension table was used we found HO in 11 patients (33%); in the 161 hips treated with the regular OR table HO were found in 24 patients (67%). In our series we found that neurological damage had 1,3% (7 cases) incidence. The AA group of patients reported paraesthesia of the femoral lateral cutaneous nerve territory in 12 cases, with symptoms resolutions within 4-6 months in 4 patients and within 1 year in 8 patients. We found non significant difference in relation to the table used to perform the THR with AA. Eventually no immediate or delayed vascular injuries were found in our series.

Conclusion
Our results show that patients who underwent anterior approach THR with an anatomical stem, were significantly less likely to develop HO (Brooker's grade III and IV) when compared to those patients whose THR was performed with direct lateral approach and a straight stem. The same consideration can be applied to the cases where we used the mobile leg positioner extension table.

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Hip Preservation Day - 22 April 2016

Preserving Hip Surgery I - Indications & technical pearls

Session 1 - Hip Preservation Day

ARE THERE STILL INDICATIONS FOR SURGICAL HIP DISLOCATION?

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The technique of surgical hip dislocation (SHD) as introduced by Prof. Reinhold Ganz has improved the understanding of the mechanical development of osteoarthritis of the hip. For example the femoro acetabular impingement (FAI).
While the concept of FAI is now accepted worldwide, the treatment with SHD has not achieved the same acceptance. The Hip arthroscopy has overtaken the SHD to treat FAI and is now " the golden standard ". Reasons are the association to severe trauma (as a traumatic hip dislocation), the difficult blood supply of the femoral head and the necessity of trochanteric osteotomy giving the restrictions of postop treatment.
Although the technique and instruments of hip arthroscopy have improved, there are still intra and extra articular pathologies which can't be addressed by hip scope. For example post perthes disease with typically high riding greater trochanter (GT) and therefore extra articular impingement. In case of moderate or severe SCFE, pathology of proximal femur, femoral head- or neck fracture.
On the other hand a synovial chondromatosis with adherent loose bodies, PVNS and a mostly posterior situated cam deformity can be more accurately treated by surgical hip dislocation.

Conclusion
The most intra articular hip pathologies can be addressed by hip scope alone but are depending on clinical skills of the surgeon. Extra articular pathologies and severe intra articular deformity can often be addressed only by SHD.

TRANSITION FROM OPEN TO ARTHROSCOPIC SURGERY

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Introduction
Arthroscopy of the hip is technically demanding, particularly for open hip surgeons. This lecture presents technical tips on how to ease the transition from open to arthroscopic surgery.

Arthroscopy of the hip is technically demanding, particularly for surgeons that are used to open hip surgery. Consequently, technical difficulties, due to the anatomy, the location and the significant reduction of the intra-operative space/lumen, means that arthroscopic surgery of the hip joint has long been considered unsuitable.
However, the possible advantages related to the use of an arthroscopic procedure mainly include the avoidance of large incisions (less invasive technique), reduction in associated risks (fewer complications) and better post-operative outcomes (reduced recovery time and pain after surgery).As a result, it has been reported in literature that arthroscopic surgery results in significant improvements in the way patients resume normal activity.
A solution other than arthroscopic and open treatments could be represented by the mini-open approach (mini-Hueter) that: is less invasive than hip dislocation, more effective for most cases (i.e. acetabuloplasty with or without reinsertion, bump trimming), not as "difficult" as hip arthroscopy (due to the good knowledge of the Heuter approach/access), allows avoidance of any tendon or muscular section and does not require any special investment.
This technique is almost comparable with a classical arthroscopic technique but with some disadvantages, such as: difficult visualization in case of bleeding, less functionality of arthroscopic tools and impossibility to correctly see some structures like fovea, teres ligament and the top of the femoral head.
Overstated advantages of the arthroscopic surgery could lead to a move from open (even if mini-invasive) surgery to the arthroscopic techniques.
However the choice of the approach is strictly related to the kind of surgery and the skills of the surgeon. Several years are required to obtain good practice with a new

technique and to achieve the same results in terms of operative time, confidence in the surgeon's unit and post-operative results with respect to the traditional approach. These difficulties highlight the mini-Hueter approach as a possible gradual transition, in some specific cases where the overstated disadvantages are acceptable.
In particular, the mini-Hueter approach represents a good solution for mosaicplasty of the femoral head and for femoral osteotomy, showing comparable and acceptable results. With reference to the periacetabular osteotomy (PAO), the post-operative follow-up is easier than the classic procedure: no muscular lesion are caused and the incision is smaller (5 cm lesion). Moreover, when necessary, the approach has been successfully applied in the treatment of the possible associated femoral acetabular impingement (FAI), an abnormal contact between the anterior acetabular rim and the femoral neck.
In conclusion, the mini Hueter approach represents a good and interesting option for surgeons who do fewer hip arthroscopy and want to make the transition from open to arthroscopic surgery easier. Moreover, it also increases what you can do with a regular arthroscopic procedure and leads to several advantages over the hip dislocation technique.

CENTRAL COMPARTMENT 1ST VS PERIPHERAL COMPARTMENT 1ST - PROS & CONS

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Patients may be placed in a supine or lateral position for hip arthroscopy. In addition to these options are the Central Compartment 1st (CC1st) and Peripheral Compartment 1st (PC1st) approaches.

Hip arthroscopy can be technically challenging and the majority of surgeons adopt the techniques that they learnt from their teachers.

The strongest argument in favour of CC1st is that most hip pathology – labral tears, bearing surface articular cartilage damage, cotyloid fossa rim osteophyte formation, partial or complete tears of the ligamentum teres, ligamentum teres impingement and intra-articular loose bodies cannot be assessed until the central compartment is visualized.

Those who advocate CC1st need to achieve sufficient joint distraction for introduction of the arthroscope and instrumentation. Irrespective of patient position, radiological confirmation of joint surface separation is necessary and traction must be applied during patient set-up. Guide-wire positioning dictates the route of trochar insertion and until the arthroscope is inserted the surgeon cannot guarantee that labral perforation or articular cartilage damage has been avoided.

In contrast, the PC1st surgeon is able to access the central compartment under arthroscopic vision and is better able to ensure that iatrogenic damage is avoided. However, transfer from peripheral to central compartment necessitates application of traction per-operatively and patient repositioning may be more difficult if articular surface separation is inadequate.

Some advocates of PC1st argue that the most important step in the treatment of cam-type, femoro-acetabular impingement is to remove the cam deformity and to re-contour the femoral head-neck junction. A subset of these surgeons also argue that once the impinging bone has been removed, the cause of intra-articular damage has been addressed and the need for surgery to associated labral or acetabular articular cartilage damage is questionable.

A number of PC1st hip arthroscopists access the peripheral compartment without an image intensifier. While this does avoid radiation exposure to patient, surgeon and theatre staff, it may be a limited benefit as intra-operative screening can be necessary for the surgeon to assess acetabular rim recession or femoral re-contouring.

On rare occasions the surgeon may not have the option of choosing the sequence for Central and Peripheral compartment access. In cases of acetabular over coverage, osteophytic acetabular rim formation and deep set femoral heads, it may be impossible to achieve sufficient joint space separation to allow central compartment access and the surgeon is obliged to resect acetabular rim bone, from the peripheral compartment, before central compartment access can be achieved.

In recent years there has been increasing attention to pathology caused by hip instability. PC1st techniques either require incision of the capsule from outside or expansion of the peripheral compartment by resection of the zona orbicularis. When these steps are taken in patients with underlying hip instability, particular care must be taken to ensure that capsular integrity is restored at the end of the procedure.

FAI - OPEN VS. ARTHROSCOPIC

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In the English language literature, Impingement Surgery was first described by Smith Petersen in 1936, although the term "Femoroacetabular Impingement" (FAI) was not widely used until around 2001. Interestingly, Smith Petersen used his version of the Hueter approach to access the hip joint.
Impingement surgery developed far more rapidly after the work of Ganz, et al, in the 1990s, but continued to be performed as an open operation, using Safe Surgical Dislocation. It was only around 2002 that this surgery started to be performed arthroscopically.
Most FAI surgery is now performed arthroscopically. This technique has the advantages of fewer complications; shorter hospital stay; more rapid recovery and return to work and activities; it allows vision of the "intact" hip with all ligaments present; and it has greater patient acceptance due to its perceived minimally invasive nature.
However, it is very important to note that arthroscopic surgery and open surgery have equivalent longer term outcomes, and arthroscopic surgery does have significant limitations.
Some areas of the hip are difficult to access arthroscopically. This is particularly the case with the posterior, and postern-inferior parts of the femoral head and neck, and these areas may be better treated with open surgical techniques.
Surgery to correct pelvic deformity, such as acetabular dysplasia, and proximal femoral deformities, such as excessive femoral neck anteversion, also require open surgical techniques.
Some surgeries, such as femoral head osteochondral grafts, require a larger arthrotomy simply to insert the grafts.
Safe Surgical Dislocation has the added advantages that it allows global visualisation of the femoral head and acetabulum; it allows the use of templates to more accurately assess correction of cam lesions; and it is probably more easily learned by new surgeons.
Arthroscopic and open techniques to correct FAI should be regarded as complementary, and in any given patient the appropriate choice of technique made by the surgeon will be in part dependent on that surgeon's level of experience and skill in the use of each technique.

LABRAL SURGERY - REMOVE, REPAIR & RECONSTRUCT

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Initially thought to be a vestigial structure with no function, basic science studies confirm that the labrum does have many functions. The labrum serves as a joint seal that allows for joint lubrication, cartilage nutrition, as well as helping provide joint stability, assists in load sharing, and likely functions for joint proprioception. Labral tears may cause pain, result in microinstability of the joint, increase friction within the joint, increase cartilage consolidation and increase strain within the articular cartilage, and thus, may result in accelerated degeneration of the joint. However, the labrum is frequently torn, and may be a source of hip pain and dysfunction.
Partial labrectomy may relieve pain and eliminate mechanical symptoms in patients, however, the outcomes are markedly better when (1) there is no chondral damage to the articular surfaces and (2) associated bony pathology is addressed concomitantly. Based on basic science data, one can infer that removal of as little labrum as possible would be beneficial, as the remaining labral tissue still can function. With regard to strain in the labrum, the more that is removed, the more labral function may be lost. Although debridement of labral tears will lead to pain relief, some feel that labral tears should be repaired to maintain the chondroprotective function of the labrum. Interestingly, it has been shown that the labrum can regrow in some patients after a partial labral resection. The function and quality of this tissue has yet to be studied.
While clinical data pertaining to labral repair is sparse, and not of the highest scientific quality, basic science and clinical data would suggest that labral repairs can heal and improve clinical outcomes. Particularly, labral chondral separation type tears would likely be the best scenario to repair the labrum, as the blood supply from the acetabulum would provide the healing potential. On the other hand, intra-substance tears likely have poor ability to heal with repair. When the labrum is torn and irreparable, labral reconstruction has also advocated. Different tissues have been used for labral reconstruction, including autograft and allograft iliotibial band, hamstring tendon, and other allograft tissues. Case series and some basic science data do support the use of labral reconstruction as an alternative for the irreparable labral tear.
In the last few years, the evidence has been growing that confirms the acetabular labrum has clear clinical function, is important in hip function and health, and surgery for labral tears is indicated. With new clinical appropriate outcomes scores prospective studies are now being carried out to determine the true value and efficacy of these hip arthroscopy surgeries. These studies will allow for a better understanding for the indications for labral repair and reconstruction, as well as to help manage patient expectations.

Preserving Hip Surgery II - Complex & controversial

Session 2 - Hip Preservation Day

OSTEOARTHRITIS - WHEN TO PRESERVE WHEN TO REPLACE

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Hip preservation surgery can be an effective technique for managing many abnormalities of the hip including various forms of femoroacetabular impingement (FAI). However the degree to which to which hip preservation may be helpful in the presence of osteoarthritis (OA) remains uncertain and controversial.

As articular cartilage erosion progresses the opportunity for successful hip preservation becomes more challenging. The literature clearly shows us that when degenerative changes reaches an advanced stage, hip preservation is largely ineffective, and the indication for hip replacement in this setting is clear. And conversely in the very early stages of degenerative cartilage erosion in a patient with a correctable deformity, hip preservation is a reasonable option.

However, the decision becomes much more difficult when the degree of articular cartilage loss is mild to moderate. The question as to preserve or replace in these "in between" patients remains a difficult question to answer. A careful and thorough analysis of patient characteristics, history and physical exam clues , and tedious review of diagnostic imaging studies serve as the foundation for making the best decision in these challenging patients.

The evaluation starts with obtaining a full spectrum of information about the patient including age, sex, family history of OA, accurate staging of the severity of OA and a thorough understanding of the hip deformity. Good quality radiographs serve as the cornerstone of evaluating the current condition of the hip. Several OA classification systems exist but the Tonnis Classification system seems to be most widely accepted in the current orthopaedic literature. Domb et al recently found that patients with Tonnis grade >1 who underwent hip arthroscopy were associated with lower hip functional scores and higher pain scales and were more likely to go on to early THR or resurfacing. Other recent studies by Larsen, Philippon and others have corroborated these findings and further recommended that patient outcomes were better if at least 2mm of joint space remained or a minimum of 50% joint space remained compared to the other hip. These studies based only on radiographic parameters are certainly important, however, MRI studies can also provide important information about the condition of the joint and help further clarify the degree of OA. Patients with well preserved joint spaces can have significant articular cartilage erosions with underlying subchondral pathology. Subchondral edema and subchondral cystic changes are negative prognostic factors for hip preservation surgery, even when the joint space remains stable on plain radiographs. Other more sophisticated imaging studies such as cartilage mapping (T2 mapping and dGEMRIC) can also be helpful in quantifying articular cartilage volume and is become increasingly used in the clinical setting.

Hip replacement in young patients is becoming more acceptable and certainly remains a highly effective and legitimate solution for many patients with OA. However we know that at least one revision procedure will be necessary in their lifetime of a young patient undergoing THR, particularly in highly active individuals.
Additionally a recent study reported at the 2016 AAOS meeting that 40% of young patients (<55yo) admitted to ongoing soreness in the operative hip without evidence of malposition, loosening or infection.

While the surgeon may be tempted to aggressively treat the moderate OA patients with a hip preserving procedure, we must also be aware of the consequences of a failed surgery, even following a minimally invasive procedure such as arthroscopy. These patients are subjected to the following possible consequences including a protracted recovery time (several months), increased scarring of the anterolateral capsule, heterotopic ossification, and muscle atrophy. Early conversion to THR can be made more difficult if these types of issues arise following an unsuccessful hip preservation surgery.

While the question of when to preserve and when to replace remains controversial, it is important we continue to establish criteria to help us make the best decisions for this challenging patient population. Based on the current literature, favorable prognostic variables favoring hip preservation at this time include the following: preserved and stable joint space based on recent imaging studies, mechanical complaints, large correctable hip deformity,

short duration of symptoms, moderate functional and pain scores, and younger age. Patient factors favoring hip replacement include the following: Age >60, subchondral pathology, osteopenia, acetabular dysplasia, loss of joint space, central weight bearing cartilage loss, night pain, obesity and high pain scores and low functional scores.

HIP INSTABILITY - DIAGNOSIS & TREATMENT

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The spectrum of hip instability can range from subluxation to frank dislocation that leads to symptoms of pain and joint damage. Whilst the diagnosis of frank dislocation is obvious, the diagnosis of hip instability is more subtle and difficult to determine. Normally the hip has a deep acetabulum and strong capsulolabral complex that can withstand high joint reaction forces during activity. Most commonly traumatic hip dislocation involves a high energy injury with direct impact on the knee combined with hip flexion, adduction and internal rotation. Low energy hip dislocation has been reported to occur following hip arthroscopy for femeroacetabular impingement (FAI) and or in the presence of connective tissue disease such as Ehlers-Danlos syndrome, Marfan syndrome or Down syndrome. Micro-instability of the hip is often seen in patients with bony FAI. FAI is a clinical syndrome associated with structural abnormalities of the hip causing abnormal contact stresses in the hip that can lead to pain, dysfunction, premature osteoarthritis and hip instability. During activity that involves increased flexion and internal rotation, this may cause intrusion of the cam lesion into the hip, creating abnormal anterior contact between the cam lesion and the anterior acetabulum, which could result in a distraction force resulting levering of the femoral head posteriorly. The most common intra-articular findings comprise anterior labral injury, synovitis, chondral injury to the femoral head with loose bodies, and ligamentum teres avulsion. The ligamentum teres has been reported to be capable of withstanding tensile loads similar to that of the anterior cruciate ligament. Patients with early subluxation of the hip may become dependent on the secondary restraint that is potentially provided by the ligamentum teres. Rupture of the ligamentum may thus cause symptomatic hip instability during athletic activities. Developmental dysplasia of the hip also causes micro-instability of the hip. DDH represents a spectrum of hip pathology ranging from mild hip dysplasia to severe bony deformity resulting in hip subluxation and dislocation. Typical anatomic changes in DDH include a misshapen femoral head, a shallow acetabulum with loss of anterolateral coverage, increased acetabular lateral tilt and excessive anteversion of the acetabulum and proximal femur. The combination of these bony abnormalities can result in anterior hip instability and early degenerative changes. The diagnosis of hip instability is based on the patient history, clinical examination, radiological assessment and evaluation under anesthesia. The surgical management of hip instability should consider addressing underlying causes and associated intra-articular damage. Bony treatment should comprise correcting the underlying bone deformity in the form of osteotomy (acetabular and or femoral) and or ostectomy (cam and or pincer). Any underlying soft tissue pathology should be treated with capsulorrhaphy or plication of the capsuloligamentous structures, labral repair or reconstruction of the labrum, and ligamentum teres debridement or reconstruction.

DDH - ARTHROSCOPY: ROLE & TIMING

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The major goals of treatment in residual acetabular dysplasia (DDH) are to reduce pain and improve function and longevity of the native hip. By its nature, osteotomy is the only treatment to achieve these goals by normalization of hip biomechanics.

There are, however, circumstances where reorientation osteotomy of the acetabulum may not be indicated or chosen as the sole treatment. This discussion includes the timing of osteotomy and additional open or arthroscopic surgical interventions:

Significant DDH without evidence of Cam-FAI, unstable tears of the labrum or teres ligament and advanced secondary degenerative changes (Toennis 2-3). When diagnostic workup shows typical, activity related pain, a CE angle of less than 20°, a sourcil angle of more than 8°, typical MRI changes such as hypertrophy and degenerative changes of the acetabular labrum and early to moderate cartilage changes of the anterolateral rim, and absence of pathologic conditions of the proximal femur such as signs of femoroacetabular Cam impingement, acetabular reorientation osteotomy without additional access to the hip joint is indicated.

Significant DDH with evidence of Cam-FAI or unstable tears of the acetabular labrum or teres ligament. If there is radiologic evidence of Cam-FAI or unstable tears of the labrum or teres ligament, the hip joint needs to be accessed in addition to the osteotomy. This concomitant pathology may be one of the most important factors for unfavorable results of osteotomies in the past. After the

increase of acetabular coverage, a pre-existing, even mild Cam deformity of the head-neck-junction likely becomes more relevant. Symptoms caused by unstable tears of the labrum and teres ligament likely persist after osteotomy.

The Cam deformity can be addressed by open exposure during the osteotomy. This has however several disadvantages including not only the morbidity and risks of an open joint exposure but also the inability of access and treatment of concomitant labral, cartilage and ligamentous pathology within the central compartment. In consequence, where such pathology is seen, the author prefers an arthroscopic intervention before staged reorientation osteotomy is indicated. By arthroscopy both the Cam deformity and the collateral damage at the acetabular rim and teres ligament can be addressed, thus the joint prepared for the osteotomy and, last but not least, the indication for the osteotomy confirmed or withdrawn.

Borderline DDH. At CE angles between 20° and 25°, DDH is borderline and direct indications for osteotomy are questionable. There are additional signs such as the width, shape and pathologic changes of the labrum and cartilage changes at the anterolateral acetabular rim that need to be assessed to search for the correct diagnosis and adequate treatment. However, the decision whether to indicate a reorientation osteotomy is still difficult. In this situation arthroscopy is indicated to check for the typical intra-articular collateral damage of DDH in order to support the staged osteotomy with the option to treat potential intra-articular pathology.

Significant DDH with questionable cartilage status, status post surgical interventions alio loco or other risks of unfavorable results. Frequently, patients with DDH show up late, with more advanced cartilage degeneration, a questionable intra-articular status after surgical interventions alio loco or at ages where osteotomies may not be indicated any more. Here, arthroscopy may be indicated to prove whether osteotomy is still indicated with the option to treat intra-articular pathologies.

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Spine Day - 22/23 April 2016

Welcome

Session 1 - Spine Day I

PROSPECTIVE OUTCOMES IN SPINAL SURGERY: OUTCOMES OF MINIMALLY INVASIVE AND TECHNOLOGICAL IMPROVEMENTS

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Spinal surgical techniques for the decompression of spinal stenosis, stabilization of spondylolisthesis, and the management of adult degenerative deformity have recently been well adopted by surgeons worldwide for the treatment of these common pathologies. Within the modern analytic of evidence based medicine, their value / cost in terms of provide a quality of life year has been recently established in the literature for each of these problems. The cost of a 1 year QALY and QALY lifetime are respectively: Lumbar Stenosis $13,129 / $3,436 USD; Lumbar Spondylolisthesis $33, 457 / $ 8758 USD, and Adult Scoliosis $120,351 / $31505 USD. . Most medical economists set a $100,000 or less threshold for any medical procedure to be considered cost effective within the confines of the United States healthcare system.

By comparison, the costs for a Total Hip and Total Knee Arthroplasty are $21,702 / $5682 USD and $28595 / $6489 USD respectively. Minimally invasive surgical (MIS) techniques in their modern evolution over the last 20 years has led to measurable improvements in length of stay, cost, complications, infections and second reoperation rates in several class II and III prospective comparative series. Advances in less invasive spinal decompression (MED/MEDL) , percutaneous instrumentation(MSI-PSF) , inter body fusion (MIS-PLIF,MIS-TLIF), lateral DLIF corrective techniques, mini open corpectomies / vertebral body resections (MIS-ECDTF / DLCF) and anterior ALL release have all evolved in a stepwise fusion.

When used in combination, these recently evolved MIS spinal techniques have also been shown, in our experience, to positively impact the medical cost effectives of these procedures by an average of 15-18% (MIS Lumbar stenosis: $10,980 / $2874 (-16%); MIS Spondylolisthesis Fusion $28,534 (-15%)/ $7463; and Adult Scoliosis $98345 / 25834 (-18%). As such, less invasive treatment of spinal stenosis and spondylolisthesis compare extremely favorably with total hip and knee arthroplasties which are generally acknowledged as good, cost effective procedures for the population. However, additional advancements with less invasive techniques are still needed to further reduce the cost of Adult Scoliosis / Deformity treatment as the QALY of MIS Scoliosis treatment ($98345) continues to be unacceptably high.

Patient matched screw guidance technology (Part I)

Session 2 - Spine Day 1

PEDICLE SCREW PLACEMENT ACCURACY WITH PATIENT-MATCHED TARGETING GUIDES: A CADAVERIC STUDY AND FIRST CLINICAL EXPERIENCES

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Introduction
During the last years, the need for a safe method to improve pedicle screw placement in spine surgery has become more urgent. A safe and correct placement can have many important consequences, both clinical (development of new symptoms) and medico-legal. The estimated screw misplacement rate varies in the literature in a range from 6 to 31% with the free-hand technique and from 15 to 72% with the fluoroscopic guided technique, the two most widespread techniques. A recent developed technology is based on the use of tubular guides realized with a 3D printer. This new technology is being developed, and only a few patients have been treated, so it is too early to express a definitive judgment.

Methods
We report our preliminary experience with 3D printed tubular guides MySpine (Medacta International SA, Castel San Pietro, CH), a patient-matched pedicle targeting guide, in clinical practice, based on the study published by Prof. Lamartina about their efficacy in screw placement on cadaveric spine specimens. We describe the results of this study comparing them with our preliminary experience.

Results
In the study, of 46 inserted screws eligible for assessment, 91.3 % were fully inside the pedicle. There were no cases of Grade B (2-4 mm) or C (>4 mm) pedicle perforation. The mean deviation between the planned and actual screw position at the midpoint of the pedicle was 0.70 mm, the mean horizontal deviation was 0.60 mm and the mean vertical deviation was 0.77 mm. The mean angular deviation in the sagittal plane was 1.74°, versus 1.32° in the transverse plane. The mean deviation in screw depth was 1.55 mm. On all measures, the accuracy of screw placement was within the predefined criteria. Our limited experience seems to confirm this data in terms of accuracy of screws positioning and screws dimension and length.

Conclusions
This technique seems to offer some advantages when compared to the aforementioned standard techniques, in terms of accuracy of the screw placement. This reduces the post-operative morbidity and shortens the length of hospital stay. Furthermore reduces the exposure to ionizing radiations, both for the patient and for the staff. The increased precision in screw placement can permit the reduction of medicolegal issues through the reduction of the complications related to their misplacement. The expense of the system is higher than a surgical intervention performed with a standard technique due to the expense for the 3D print of the tubular guides and of the vertebral model. In conclusion, tubular guides seem to be a valid alternative to a standard technique for a safe screw placement, with its own characteristics and its own intrinsic limits.

A PILOT STUDY TO PROVE FEASIBILITY, ACCURACY, AND IDENTIFY OPERATIVE CHALLENGES

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Summary of Background Data
Spine surgery carries the potential risk of injury to neurovascular structures causing major complications. Especially in severe thoracolumbar deformities the correct placement of pedicle screws is challenging. Several techniques with varying accuracy have been described. Even though CT-based navigation seems to show a higher precision rate (89-100% of correct screw positioning), its use is limited to high-volume centers due to influencing factors such as high costs and lack of trained personnel. Patient specific drill / positioning guides with preplanned trajectory have been developed as a promising solution in spinal surgery for precise screw insertion.

Methods
In four patients with severe scoliosis navigational templates and models of all vertebrae to be instrumented were manufactured using a CT based 3D model of the thoracic and lumbar spine. The guides were designed differently for thoracic and lumbar segments according to the individual anatomy to achieve an optimal coupling to the surface of the patient´s spine, to maximize

the stability of the device itself, and to increase user friendliness for the complete screw positioning process. Intraoperative challenges and opportunities for device and process improvements regarding the handling of the guides during the surgery were recorded. Postoperatively, the intrapedicular screw positions were evaluated vs. the pre-operative plan and evaluated for cortical violation based on CT scans.

Results
A total of 76 pedicle screws were implanted (56 thoracic, 20 lumbar). 2 screws (2.6%) were assessed to be misplaced intraoperatively and repositioned. 84% of the pedicle screws were completely intrapedicular, 96.1% within less than 2mm cortical breech. CT scans did not demonstrate medial pedicle violation, or misplaced screw contact to neurovascular structures. No screw related clinical complaints were reported postoperatively.

Discussion
Template-based pedicle screw positioning is a promising navigation with easy intraoperative handling and accurate screw positioning. Compared to CT-based navigation it seems to achieve a better feasibility by eliminating restricting factors such as the need for trained personnel. Moreover a large benefit concerning patient effective radiation dose could be shown. In comparison to navigated surgery the mean radiation dosage of 1.1 mSv is significantly lower. It is even minor to reported average annual background radiation in the US of 3.1 mSV. Despite this advantages further improvements in instruments should be sought to ease intraoperative use.

Conclusions
The "MySpine" system is a reliable custom-made positioning guide which enables a precise and safe positioning of pedicle screws in patients with severe thoracolumbar scoliosis.

MYSPINE SURGICAL TECHNIQUE - DESCRIPTION OF TECHNIQUE, CHALLENGES & RISKS

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Insertion of pedicle screws requires accurate anatomical localization of the pedicles, followed by placement of the pedicle screws. The proximity of the nerve roots and thecal sac to the pedicles leaves little room for technical error. It is not surprising that nerve root injury occurs in as many as 15% of operations.
Intraoperative radiography and C-arm fluoroscopy have been used to define anatomical orientation in 2 dimensions before a screw is placed. Routine use of intraoperative imaging CT scan to provide 3-dimensional images is not available in all spine centers and currently is not the standard of care. In an effort to reduce the incidence of nerve injuries, experienced spine surgeons have used Intraoperative neurophysiological monitoring (IONM) in addition to intraoperative fluoroscopy to detect nerve root and cauda equina injury.
Myspine® is a new technique based on 3-D printed tubular guides specifically tailored and produced on the basis of a low-dose CT scan with a precise patient matched technology.
Here the developing process, the web planner concept and the surgical technique is described.
Based on preliminary results, the technique has shown to be accurate although further studies in a large randomized, prospective, multicenter trial are warranted.

MY OVERALL IMPRESSIONS AS A NEWEST USER OF MYSPINE GUIDES

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The goal of this presentation is more to give our early impressions about this new technology, rather than make a scientific paper.
We report our very early experience using My spine technology for pedicular screws insertion.
The estimated screw misplacement rate in the literature varies on a very wide range from 6 up to 70% using a free hand technique or a fluoroscopic guided technique.
The need for a more accurate surgical technique is mandatory in order to reach the most accurate and safe pedicle screw placement, for clinical and medico-legal reasons.
We currently use a free hand screw insertion technique, helped by the Pediguard (bone impedance guided technology) combined with the fluoroscopic guided technique, which is less suitable for upper thoracic levels.
Our interest in the 3D printed guides, realized from the data provided by the preoperative CT scan, was mainly motivated on our concern about upper and mid-thoracic pedicular screw insertion, as we don't have neuronavigation.
Regarding this matter the cadaver lab training organised by Medacta is extremely useful and very well set up by Claudio Lamartina and his team. This training provided an invaluable guidance and it is probably enough to start the in vivo experience.
I started my personal My spine experience with lumbar screws to assess the feasibility and accuracy of the system, and that was a mistake.
Obviously the guides for the lumbar area are larger than those for thoracic vertebrae, and need a large soft tissue exposure.

That is the critical point of the technique in my opinion, and that might discourage the early user to continue the experience, as a free hand technique or the fluoroscopic guided technique is much less time consuming for lumbar levels.
In addition there is anyway a need to use the C-arm at the start of the procedure in order to check the right level of positioning.
By contrast, this technique is highly performing for mid thoracic and upper levels , especially in deformation cases. The accuracy of screw placement at these critical levels is very high , less than 0,5 mm and 5°.
We think that MySpine technology is a very good alternative for thoracic screw implantation in long constructs for those users who don't have a navigation system.
The limitation is the average delivery time (20 days) for the guides , that means that the system is only available for elective surgery and not for emergencies.
We believe that the technique could be improved by reducing the size guides ,focusing their design on a larger plane surface contact with the lamina, the facet and /or the transverse process, without the need for three separate contact points.
That could be helpful to manage patients who have undergone previous surgeries or for mini-open procedures
using a half guide, but obviously this evolution has to be validated in terms of accuracy.
Reducing the time delivery for the guides could be also another future improvement.
Taking this even further, one could imagine the surgeon printing his own 3D guides in the OR!
Beyond these considerations, we think that the 3D printing process allows an accurate plan of the operation. As the 3D posterior arch model of the vertebrae are provided with the screw guides, this will lead to a surgeon's psychological preparation and decision making especially before a challenging operation.

Patient matched screw guidance technology (Part 2)

Session 2 - Spine Day 1

RADIATION SAFETY IN ORTHOPAEDICS AND NEUROSURGERY: DOES THE RADIATION DOSE MATTER?

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Abstract
The use of X rays in the investigation and surgical management of spinal conditions is essential. The development of minimally invasive surgical techniques and intra-operative navigation systems has seen an increase in radiation exposure to both patients and surgical teams. The recent literature has been reviewed to quantify the range of exposures and the potential health consequences.

Methods
A Medline search was performed, using the key words: surgery, spine, scoliosis, radiation, occupational exposure, occupational safety and fluoroscopy. Prospective studies were selected for review. Papers included open and minimally invasive instrumented procedures where members of the surgical team wore radiation dose monitors. In some instances, patient dose was also recorded.

Results
There was a wide range of radiation exposures recorded. Similar cases in different centres had markedly different radiation doses recorded between the different surgical teams. In many papers, important factors such as C arm orientation, patient size, fluoroscopy times and distance of the surgeon from the radiation source were not specified.
In most cases, radiation exposure to the patient and surgical team was not of a level that would be of concern. However, there were some papers that reported doses that could lead to a surgeon exposure of greater than 50mSv per year.

Discussion
The average annual environmental exposure to ionising radiation is 3mSv. The recommended annual occupational exposure in the US and EU is 50mSv (15mSv to the eye). Higher levels of exposure are associated with the development of some conditions, such as cataracts and an increased incidence of thyroid and other cancers.
Radiation exposure in the operating theatre should be minimised. The principle recommendation is ALARA – As Low As Reasonably Achievable. Measures such as lead protection, maximising distance from the radiation source, proper C arm orientation and minimising screening times will reduce dose. In addition, alternatives to prolonged screening with C arm and O arms should be considered.
Formal training in radiation safety is not universal in orthopaedic and neurosurgical specialties. In Australia, radiation safety is a mandatory part of orthopaedic training and was instituted as a consequence of a cluster of thyroid cancers in orthopaedic surgeons.

Conclusion
The effects of ionising radiation on health may be cumulative and delayed. The recent literature indicates a wide variation in radiation exposure for similar procedures, suggesting differences in the intra-operative usage of fluoroscopy.
It is likely that the usage of X ray guidance in spinal surgery will increase in the future. The associated risks can be reduced with proper understanding of the principles of radiation safety. Training in this area is recommended.

RADIATION RESULTS IN SPINE USING MYSPINE GUIDES VS FREEHAND AND CT SUPPORTED SURGERIES

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Introduction
MySpine (Medacta) is a new thoraco/lumbar Pedicle Screw (PS) technology, based on customised guides for each single patient. The guides are made for each single vertebra and are directly derived from a low-dose preoperative CT scan. This technology allows a more accurate placement of the PS together with a significant reduction in the intraoperative Radiation Dose (RD) to the patients and to the surgeons.
In our paper we compared this new RD technique with recent literature in spinal surgery.

Materials and Methods
A review of PubMed papers published from January to August 2015 about RD in spinal surgery was carried out. Papers based on cadavers or phantoms were excluded.
We measured the preoperative CT RD absorbed by patients treated in our Institution with the MySpine system. RD data is given as Dose Length Product (DLP) in mGy-cm. Total DLP was divided for each vertebra studied, so that the relative RD for each couple of screws was obtained.

Results
6 patients were considered for this study. From a maximum of 15 vertebrae (from T2 to L4, 30 total screws

placed) to a minimum of 4 vertebrae (from T12 to L3, 8 screws placed) were treated with pedicle screws. For the longest instrumentation a DLP of 226 mGy-cm was measured. This value divided for the 15 vertebrae treated results in 15 mGy-cm per couple of screws placed. This was the lowest dose measured in our series, the highest being relative to the shorter instrumentation (4 vertebrae) where 30 mGy-cm RD was measured.

Our data were compared with a prospective study based on 38 patients [Spine (Phila Pa 1976). 2006 Aug 1;31(17):2024-2027]. In this paper the spinal surgery was performed with CT and C-arm guidance and the RD was measured. Mean RD for each couple of screws placed was 432 mGy-cm when CT was used and 664 mGy-cm with C-arm, (the RD ranged from 822 to 114 mGy-cm for CT guided screw placement and from 1083 to 333 mGy-cm for C-arm guided screw placement).
If the lowest mean value is considered (CT-guide, 432 mGy-cm) the RD for each couple of screws was 216 mGy-cm, 7 times higher than the highest of our preoperative RD values (30 mGy-cm).

Conclusions
Low-dose preop CT used to produce MySpine (Medacta) thoraco/lumbar (PS) placing guides allows RD reduction both for the patient and for the surgeon in spinal surgery, particularly if no X-ray controls are intraoperatively necessary.

APPLICATIONS OF MYSPINE IN DEGENERATIVE PATHOLOGIES: FIRST CLINICAL EXPERIENCES IN MYSPINE

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A synopsis of the initial procedures utilizing the MySpine pedicle screw placement system in the United States is reviewed. The US market emphasizes cost containment. The additional cost of the MySpine guides needed to be justified to the hospital system prior to implementation. This was successfully accomplished by emphasizing reduced radiation exposure to patient and operative personnel, shorter operative times, more accurate screw placement, as well as comparison to the costs of other image guidance alternatives available in the US market. The majority of the cases were performed on patients with adult degenerative deformity, as opposed to pediatric deformity. Sample radiographs are presented of cases performed utilizing the MySpine system comparing standard radiographic parameters pre operatively and post operatively, including Cobb angle, lordosis, and pelvic incidence. All US cases involved instrumentation of both the thoracic and lumbar spine. All cases utilized the original cranial guides. All cases utilized M.U.S.T. Medacta unconstrained screw technology. The operative experience is reviewed, highlighting technical nuances of the guides. This includes pre operative planning utilizing the MySpine surgical planning report and the interactive 3D planning system, intraoperative set up, order of levels instrumented, guide anchoring techniques, starting point initiation, and experience with previously operated levels.

A PROSPECTIVE RANDOMIZED CLINICAL SURVEY ON ACCURACY OF PEDICLE SCREWS POSITIONING WITH MYSPINE VS FREEHAND TECHNIQUE

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Introduction
Surgical techniques involving pedicle screws implantation have become more common in the treatment of spinal disorders, in particular in deformities. Screw misplacement represents the main complication and can occur in 30% of cases. MySpine is a custom-made navigation system based on preoperative low dose CT scans. The aim of the system is to increase the accuracy of pedicle screw implantation, decreasing the related complications rate. A randomized controlled trial is in place to verify the suitability and the accuracy of the new navigation system compared to the traditional freehand pedicle screw placing technique.

Materials and methods
Patients were enrolled and randomized in two groups. The first (MySpine Group) implies a preoperative CT scan for guide manufacturing and a postoperative CT scan to evaluate the position of the screws. The second group (Free Hand Group) receives just a postoperative CT scan for the evaluation of screw placement. A low-dose CT scan protocol is used in each step when needed. 207 screws were calculated to be placed in both groups, in order to gain significant statistical power.

Results
So far, the placing of pedicle screws using the custom-made guide-masks has shown more accuracy and a decreased violation of pedicle cortex compared to the freehand technique. No relevant complications have been observed in either group to date.

Conclusions
The custom-made navigation system seems to be more accurate compared to the free-hand technique for pedicle screw implantation in patients affected by spinal deformities. When the study will be completed, we will be able to verify if this system has similar efficacy and accuracy to those systems already available using, however, high-dose ionizing radiations.

M.I.S. techniques, indications: current practice and future

Session 3 - Spine Day 1

MIS TLIF VERSUS LLIF: WHICH ONE IS BETTER?

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Background
Minimally invasive transforaminal lumbar interbody fusion (MI TLIF) allows for direct decompression of the neural structures. Lateral lumbar interbody fusion (LLIF) provides indirect decompression, but offers a larger fusion surface and better correction of focal deformity. The surgical indications for these two procedures often overlap, but their outcomes have not been compared.

Surgical technique
MI TLIF: The TLIF was performed on the more symptomatic side. Two 2.5cm skin incisions were placed about 5cm off midline and a minimally invasive self-retaining retractor was centered on the L4 pars interarticularis. Using the high-speed drill, the medial (L4) facet and then the tip of the lateral (L5) facet were resected. After removal of the yellow ligament, the annulotomy was placed just lateral to the dural sac. A generous discectomy with adequate endplate preparation was followed by graft and cage insertion. The ipsilateral pedicles were cannulated under direct visualization and K-wires were inserted in the created paths. The retractor was then removed and the pedicle screws/rods were placed in a percutaneous fashion bilaterally. LLIF (shallow-docking technique): The 2.5cm skin incision was centered on the L4-5 disc projection (on lateral X-ray), typically just above the iliac crest. The lateral abdominal wall muscles were bluntly dissected and the retroperitoneal fat was finger-swept anteriorly. A shallow retractor was placed on top of the psoas muscle, which was dissected under direct visualization, with great care to protect the genitofemoral nerve. A deeper retractor was placed to maintain exposure of the lateral aspect of the L4-5 disc, and then a standard discectomy, endplate preparation, and cage insertion were performed. Bilateral percutaneous pedicle screws/rods were then inserted.

Methods
We retrospectively reviewed our outcomes in 50 consecutive patients, fulfilling the Fritzell criteria for lumbar fusion at L4-5, who were treated by either MI TLIF (n=25) or LLIF (n=25). Grafting was performed with bone marrow aspirate concentrate mixed with demineralized bone matrix. Perioperative parameters, as well as the VAS, ODI, and the fusion rates at 3-months, 6-months, and 1 year, were analyzed.

Results
The mean operative time, estimated blood loss, and length of hospital stay for the MI TLIF versus LLIF were: 200 and 260 min, 100 and 80 ml, and 2.3 and 2.1 days, respectively. The mean ODI decreased from 68 to 20 in the MI TLIF group and from 69 to 21 in the LLIF group. The fusion rate was 100% in the LLIF group. There were 2 patients in the MI TLIF group who did not exhibit bone bridging at 1 year postoperatively, but they were asymptomatic and there was no screw loosening, so no revision surgery was deemed necessary. There was one dural tear in the MI TLIF group that did not result in a CSF leak and did not require any postoperative treatment. There were 5 patients in the LLIF group with thigh paresthesias at 3-months, which resolved by 6-months.

Conclusions
MI TLIF and LLIF appear to provide similar long-term results, but they have distinct risks and benefits.

THE NEW TECHNIQUE OF PEDICLE SCREW INSERTION METHOD ON MIS-TLIF

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Recently, minimally invasive operations such as endoscopy-guided ones have been popular not only in orthopedics but also in other areas of surgery. Some orthopedicians try to perform only decompression and avoid fixation as much as possible to achieve minimum invasion. Practically speaking, however, it is difficult to treat every spinal disease only by decompression and those who need fixation are not uncommon.
New operation instruments and procedures for fixation have been developed to achieve minimum invasion, and early rehabilitation and shorter hospitalization have become possible. However, there are several important

factors to progress minimally invasive surgery of lumbar body fixation (MIS-TLIF). (1) Long-term outcomes of MIS-TLIF should be the same or better than those of conventional methods. (2) It is necessary to clarify to what and how less invasive MIS-TLIF is, that is, the method should be less invasive for patients as a whole. (3) MIS-TLIF must be safe as conventional methods. (4) MIS-TLIF should be less invasive even for the orthopedicians and co-medicals as conventional methods, that is, the method should not be a burden for doctors, which would be essential for MIS-TLIF to spread among orthopedicians.
We have performed MIS-TLIF using a tubular retractor and Sextant system for almost 6 years. This method has been recognized as a feasible and efficacious one because of small skin incision, operative hemorrhage less than half than conventional method, early rehabilitation, and shorter hospitalization. However, there are no reports demonstrating that the MIS-TLIF satisfies the above conditions. In this paper, we are going to report what merits and what demerits exist in MIS-TLIF using Sextant, Viper and Mantis devices from our experience treating about 300 patients. We will also introduce our recent new approach of percutaneous screw insertion to solve the problem that MIS-TLIF requires more radiation exposure than conventional methods for operators. At present, intra-operative anteroposterior and lateral imagings are necessary for the insertion of screws from the small skin incision using a Sextant, Viper or Mantis device. In open TLIF, on the other hand, after taking a lateral image to confirm the position for operation, most orthopedicians insert screws confirming the orientation by hands without radiological image guide. Thus we have developed a new system to insert screws percutaneously without radiological imaging. A new device with a hole to let the guide wire through in an oar and probe is used. We are going to report this new approach in detail, although the number of cases is still not many.

MIS VS CONVENTIONAL OPEN TLIF - INDICATIONS AND LIMITATIONS

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Today's advances in minimally invasive surgery (MIS) have been proposed as beneficial alternative to conventional open surgery (COS) in adult spinal deformity. Although modern implant designs and features have extended the scope of applying MIS techniques to the lumbar spine, its limited capability to sufficiently correct lumbar lordosis, yet unknown long-term efficacy and increased rates of perioperative complications compared to COS remain an issue of debate. Moreover, the quality of current comparative evidence is low and most retrospective analyses may assume an inherent bias. However, the evident minimization of exposure-related morbidity, blood loss and length of hospital stay strongly argue for an MIS approach in the carefully selected patient.
With regard to our multi-institutional experience and the recent literature, this presentation shall focus on preoperative decision making, technical pitfalls and complication management in cases indicating a transforaminal lumbar interbody fusion (TLIF) procedure. In conclusion, MIS demands a well-rehearsed OR environment to equally benefit younger and older adult patients with degenerative conditions of the lumbar spine. In obese patients with a unilateral radiculopathy, the MIS approach proves to be advantageous, particularly in the L5/S1 segment. However, in cases where multilevel decompression and spondylodesis or correction of severe olisthetic, scoliotic or kyphotic deformity is required, COS techniques should be preferred.

ADJUSTED BILATERAL MINI-OPEN LUMBAR FUSION: TECHNICAL ASPECTS AND CONSIDERATIONS

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Abstract
Minimally invasive spine surgery (MISS) has proven to be a valuable technique for degenerative and trauma spine surgery. In comparison with classic open spine surgery, MISS has proven to result in less blood loss, less need for postoperative analgesia, shorter hospital stay and faster rehabilitation. The long term outcomes for MISS seem to be at least similar to open spine surgery, although little high quality literature support is available.

This presentation focusses on a single surgeon experience using MISS for degenerative disc disease necessitating lumbar fusion. The objectives for MISS in these indications are the same as for open spine surgery: achieve neural decompression where needed, achieve primary stability of the level to be fused (by inserting pedicle screws and/or intervertebral cages), achieve secondary and lasting stability when bony fusion is accomplished;

However, long term outcomes show that the incidence of delayed union or non-union in minimal invasive lumbar fusion is similar to the incidence in open lumbar fusion; the principles used to achieve bony fusion are the same for minimal invasive lumbar fusion as for open lumbar fusion; however, since minimal invasive lumbar fusion is technically very demanding, this may not only lead

to longer surgery times but also to a lesser commitment to achieve the necessary secondary stability in terms of bony fusion.

The proposed technique for minimal invasive lumbar fusion tries to offer a number of solutions/ recommendations from a technical point of view, to increase the chance of achieving bony fusion; the following principles are recommended:

1. use bilateral access to the disc space to be able to clean out the disc space and prepare the endplates more thoroughly; also to be able to insert two cages to increase the surface for bony fusion and get symmetrical load on the endplates;

2. only perform neural decompression when needed;

3. use iliac crest bone graft; not only has literature shown that autologous bone graft is superior to allograft or bone substitutes, also, the iliac crest can easily be reached through one of the paravertebral incisions, when performing a L4/5 or L5/S1 minimal invasive lumbar fusion;

4. not only aim for intervertebral fusion, but also for fusion of the facet joints; when gaining access to the disc space, try to limit the opening in the facet joint to the necessary height and width of the cage to be inserted; in this way, a lot of (decorticated) bony facet joint will stay intact and can become a matrix for bony fusion; this can be stimulated by putting extra bone graft in the bony defect of the facet joint;

5. put extra load on the cages by patient positioning and by using compression tools before torque is applied;

In conclusion, minimal invasive lumbar fusion is technically demanding and has a steep learning curve; a number of advantages over open lumbar spine fusion are generally accepted and supported by literature; however, to be able to better achieve the necessary primary and in particular the secondary objectives (bony fusion), a number of technical considerations are proposed.

Spine surgery: preservation & restoration strategies

Session 4 - Spine Day I

SURGERY FOR ADULT SPINAL DEFORMITY: OPTIMAL SAGITTAL ALIGNMENT AND SHOULD WE ADJUST SAGITTAL ALIGNMENT GOALS BY AGE?

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Objective of this study : to know how much sagittal deformity can be tolerated in the elderly population and optimal sagittal alignment we should aim for with surgical treatment.
Subjects
- 656 out of 756 volunteers: Male 263, Female 393 :Average age: 73

Results
1: We collected the 656 volunteers data, which was Male 263, Female 393 :Average age: 73. From this data we concluded the following. 1: Sagittal spinal malalignment is highly associated with health related QOL deterioration. 2: Threshold of sagittal spinal malalignment is associated with over ODI 40% were PI-LL 20°: PT 24°: SVA 91mm. 3: Sagittal malalignment may progress by aging
Results 2: In our clinical experience, we know the difference between younger ASD and elderly deformity patients. In elderly patients, caution is always required for general health, bone quality is often poor or fragile. We can stop at L4 or L5 in younger ASD, but we should go down to the pelvis in elderly deformity patients due to high rate of DJK problems. When we correct the deformity and fuse the spine and pelvis, we should target the perfect sagittal alignment without compensatory mechanisms required. If the deformity remained, it will get worse year by year. We established the formula how much lumbar lordosis is required using the data of healthy volunteers and surgical cases. We are using this formula to make good lumbar lordosis especially in the lower lumbar area. ideal LL =0.45PI + 31.8 (60% LL in L4-S)

Conclusion
• Older volunteers showed worse sagittal alignment associated with worse health related QOL.
• Worse sagittal alignment requires more compensatory mechanisms including thoracic lordosis, lumbar retrolisthesis, pelvic retroversion, and knee flexion.
• Surgical goal of the correction of elderly deformity is still the perfect sagittal alignment regardless of age.

LUMBO-SACRAL MALALIGNMENT: HOW TO RECOGNIZE IT AND HOW TO PLAN THE SURGERY

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Introduction
Adult deformity in the sagittal plane has become a widely recognized clinical entity and has been identified to result in significant pain and disability, and burden of disease. Lumbar fusion surgery is a common surgical procedure for the management of degenerative and spinal deformities. Not adequate restoration of the lumbar lordosis during surgery may result in mechanical low back pain, sagittal imbalance and adjacent disc degeneration. Pelvic incidence (PI) as an anatomical parameter is the key factor to assess global Lumbo-sacral alignment. The purpose of this work is to review the current concepts in order to recognize clinical significant Lumbo-sacral malalignment and how to plan lumbar fusion surgery in order to restore adequate lordosis.

Methods
Literature review of the most relevant publications about spino-pelvic parameters, clinical outcome related with spino-pelvic alignment and surgical solution for lumbar fusion surgery.

Results
Biomechanical studies have shown a strong correlation between PI and lumbar lordosis, which it has become a paramount method for spino-pelvic assessment of pathologies. Normal distribution of the lumbar lordosis (2/3 of the lordosis is given by the L4-S1 segment and 85% by the L3-S1 segment) achieves a normal lumbo-sacral alignment. Technical tips during surgery involve patient position, surgical approach, release manoeuvres, type of implant and the surgical strategy (Hyperlordotic cage Vs Osteotomy).

Conclusion
A combination of techniques or implants should make a custom made surgery for patients, but, in order to plan the right surgical strategy it's compulsory to undergo a methodical assessment of the different parameters to determine the theoretical lordosis and therefore the amount of lordosis to restore. Afterwards our restoring

lordosis strategy will match the patient's needs. At the end, not one but several strategies may be used to achieve a lumbar fusion surgery in a proper lordotic position, which implies a patient into a spinal ergonomic, painless and balanced posture.

ANTERIOR SCOLIOSIS SURGERY FOR SHORT SEGMENT CORRECTION

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Anterior surgery for the correction of thoracolumbar scoliosis (Lenke types 5 & 6) was developed by Dwyer and improved by Zielke. The development of solid rods and improved understanding of the pathoanatomy of scoliosis has further refined the technique. It allows good correction of deformity with fewer levels fused compared with posterior procedures. The surgical technique is demonstrated with personal examples of the strengths and weaknesses of this approach.

REVISION STRATEGIES IN ADULT DEFORMITY PATIENTS

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As technologies as well as techniques continue to advance the strategies to approach a revision adult deformity patient have gotten more complex. It involves a comprehensive approach that can reach other specialties outside of the deformity surgeon.
The patient's pain must first be investigated. Axial pain, radicular complaints as well as muscle fatigue are all common complaints that patients present with. When approaching a possible revision surgery for deformity it is important to have a thorough surgical as well as medical history. Relative or absolute contraindications such as severe osteoporosis, cardiac compromise and necessary anticoagulation may exist. These can be overcome through medical optimization, anti-resorptive medication, and IVC filters. A spine program with an involved intensivist and internist are important for both preoperative and postoperative care.
Radiographic work up is the next step in formulating a surgical plan. 36 inch Postero-anterior and lateral radiographs are used to determine overall sagittal and coronal balance, proximal junctional kyphosis and adjacent level disease. Achieving sagittal balance has been found to correlate with patient satisfaction and pain relief. Computed Tomography (CT) is used to investigate instrumentation position as well as fusion status both posterolaterally as well as in interbody device. Axial pain typically caused by pseduoarthrosis or positive sagittal balance or combination of both. CT myelogram is ideal to evaluate persistent radiculopathy despite prior laminectomy or fusion with instrumentation. If the patient's issues appear to be adjacent level disease, then Magnetic Resonance Imaging (MRI) is imaging of choice to evaluate the remaining discogenic pathology.
Once all the preoperative information is obtained, the goal of sagittal and coronal balance, fusion, as well as nerve root decompression is combined. The surgical approach is dictated by the comfort level of the surgeon. A deformity spine surgeon must be able to approach the spine posteriorly, anteriorly or laterally. As techniques have evolved, an all posterior approach can achieve most of the goals previously mentioned without the added morbidity of multiple approaches. Posterior techniques range from positioning to pedicle subtraction osteotomies. Revision posterior approach can present challenges in regards to muscle and skin coverage. A plastic surgeon should be included in the surgical team for revision surgeries. Anesthesia also plays a critical role in blood loss management including anti-fibrinolytics, and blood pressure control. Neuro-monitoring team must be consistent and familiar with anesthesiologist to avoid false positives or negatives. This is crucial during the deformity correction maneuver.
Staging the surgery is dependent on the surgeons pace and the condition of the patient. Optimizing the patient between stages involves the intensivist with blood and blood products as well as nutrition management. These goals are similar even if the surgery is done in one stage. Revision deformity spinal surgery is the most challenging situation a spinal surgeon will face with a high complication rate and exhausting work. Medically optimization as well as multispecialty involvement helps reduce complications. Appropriate preoperative planning is key to streamline surgical goals, and preparing for complications.

DEGENERATIVE SCOLIOSIS & SAGITTAL PROFILE CORRECTIONS WITHOUT PSO

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Introduction

While PSO became a standard procedure to correct the sagittal alignment especially in revision cases it has its disadvantages in correcting coronal deformities. Furthermore complications and adjacent level fractures are common.

In a number of cases it will be shown when and how the coronal as well as the sagittal profile can be corrected with lordotic cages and when PSOs are still needed.

Methods
All patients with adult degenerative scoliosis received bending and traction films. If at least some intersegmental movement was detected an intervertebral restoration was aspired.
After placement of pedicle screws from T10 to L5 or down to the Ilium, all facet joints were removed similar to Ponte osteotomies. Then the discs were cut out from the concave side and a lordotic posterior or oblique cage placed. Usually this led to a satisfying coronal and sagittal correction. Afterwards the rods are dropped in without force and final correction is done by posterior compression.

Discussion
This technique has several advantages compared to PSOs.
• a more harmonic lordosis;
• less stress on the screws as most of the correction is done before inserting the rod;
• thus hardware failure and adjacent level fractures are less likely.
Disadvantages are, that the exact amount of correction is hard to predict and that 3-5 cages are more expensive and time consuming than a single PSO.
If full restoration of the sagittal balance could not be achieved, coronal correction was done by oblique cages and a PSO can be added on top of this.

SAGITTAL BALANCE CORRECTION: A COMPREHENSIVE SURGICAL APPROACH USING EOS

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Purpose
EOS 2D/3D imaging system takes simultaneous orthogonal images while the patient is standing and can be used to perform 3D reconstruction. The purpose of this communication is to present the state of the art for the EOS imaging technique, to report the most recent advances in the technique. A recent development consists of a 3D software that is able to simulate the surgical corrections that will help to achieve an optimal correction of sagittal unbalance. Our preliminary experience is here presented.

Methods
The current review was based on a thorough literature search as well as personal experience gained from using the EOS system since 2014 and a 3D planning software since 2016.

Results
EOS imaging can be proposed as a diagnostic tool in relation with sagittal balance disorders, to perform 3D reconstruction, and to determine various relationships among adjacent segments (cervical spine, pelvis, and lower limbs). A new EOS 3D surgical planner software simulates, by visualizing the impact of implants introduction or different osteotomy procedures, the extent of sagittal balance modifications that can be obtained.

Conclusions
The major advantages of EOS are the low dose of radiation (50-80 % less than conventional X-rays) that the patient receives and the possibility of obtaining a 3D reconstruction of the bones. The EOS imaging technique has proven to be a useful diagnostic tool in spine and lower limb diseases. EOS coupled to 3D planner software, enables the surgeon to predict the results and define the best surgical strategy that would help to restore sagittal balance.

Discussion
As a concept with the data of the 3D planner, the existing MySpine patient matched 3D printing technology could be used to produce rod templates in the short term to help bend the rods intra operatively to the ideal curve as well as pre-determine the ideal screw positioning possibly even in combination with PSO requirements. This could result in patient-matched pre-bent implantable rods plus customized screw positioning guides combined with implant kits that are fully determined personally by the surgeon and customized to the patient.

Requirements on intervertebral fusion devices

Session 5 - Spine Day I

OSTEOPOROTIC PATIENTS IN SPINE SURGERY

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Osteoporotic patients in spine surgery are a very problematic group with an arising number. Depending on the fracture-type, the neurological status, the number of involved vertebras aswell the localization (thoracic, thoracolumbar, lumbar, lumbosacral) the type of surgery, once the indication for a surgical procedure is detected, is different. Minimally invasive techniques like vertebro or kyphoplasties and vertebral body stenting techniques are helpful procedures, differential indications can be made with the various types of cement now available.
In case of neurological symptoms and signs of instability, instrumentation/fusion and decompression is mandatory. Instrumentation in patients with weak bone quality is difficult and has a high revision rate, due to screw loosening and loss of correction.
The presentation will show the typical treatment-algorhythm, based on a new classification-system for osteoporotic fractures from the german-expert team for osteoporotic fractures DGOU/spine-section.
Tips and tricks will be shown about increasing stability for vertebral body replacements.
Important seems to be also the treatment of the systemic disease itself to reduce the number of adjacent and new fractures due to ongoing osteoporosis.

TITANIUM COATED INTERBODY DEVICES

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Introduction
The external forces imposed to any medical device from manufacturing, sterilisation, implantation, and functional in life service presents a complexity of environments that can expose a design or material weakness that can lead to failure. Clinical outcome of many spinal and orthopaedic devices rely on the implant to achieve early, reliable and robust fixation to the host. Clearly, what happens at the device-coating interface during manufacturing and implantation and the bone-implant and after surgical implantation play an important role in the success and/or failure of the device and can dictate clinical success or failure.

Understanding substrate-coating interactions in the lab and bone – implant interactions through pre-clinical animal models allows us to better understand and design materials and devices to assist surgeons in improving clinical outcomes. The current work first examined the coatings in the laboratory. The in vivo responses at the bone-implant interface were further studied using our established large animal pre-clinical bone-implant interface model. Our animal model has nearly two decades of history evaluating materials, coating and devices used for cementless arthroplasty fixation and more recently interbody spinal fusion devices.

Methods
The laboratory based studies examined the bioactivity of Titanium coated PEEK interbody device (Mecta C) compared to a standard PEEK Optima device. The titanium coated devices were examined to assess the coating quality and thickness at the optical and electron microscopy level. We also tested the hypothesis if the titanium coating was bioactive. Bioactivity is a property of a material whereby exposure to a buffer that simulates the body fluids results in the formation of a calcium phosphate interface. The presence of calcium phosphate species at the interface is known to improve the local biology at the bone-implant interface.

PEEK and Titanium coated PEEK implants (6 x 25 mm) were evaluated in vivo in cortical and cancellous implantation sites versus time. The mechanical and local biological reactions at the bone-implant interface were examined. The coating-substrate interface was also carefully examined following mechanical testing to examine for evidence of damage or failure.

Results
The titanium coating on the Mecta C interbody device provides a titanium interface to the host bone on all surfaces of the implant. This is in contrast to other devices that have titanium coating at the interface with the endplates. The results of the bioactivity study demonstrated the titanium coating to support the formation of a calcium phosphate layer on the surface of the titanium. This is the first time this has been shown for titanium coated interbody devices.

The in vivo pre-clinical animal studies on Titanium coated PEEK compared to PEEK alone demonstrated

direct bone ongrowth to the surface of the titanium coated devices at the 4 week time point with a significant improvement with time. Shear strength increased as the bone matured on the titanium coating while PEEK alone demonstrated a non-reactive fibrous tissue layer. No titanium delamination was noted in this study.

The interface between the implant and the coating and the coating and the bone can be controlled. The current studies demonstrate a firm understanding at the manufacturing and in vivo level for devices aimed at improving clinical outcomes in the spine.

MIST SURGICAL C-SHAPED CAGE IMPLANTATION TECHNIQUE

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Introduction
We have performed a thousand MIS-PLIF/TLIF cases for lumbar spinal canal stenosis (LSCS) since 2005. We decompress both sides of the lamina in hemi incision and put one cage for one disc space. Before we used a bullet type cage. Now we can use a new type of C-shaped cage that is able to control position with a small retractor. One big merit is to get lordosis of lumbar spine better than before. We will report acquisition of lordosis after MIS-PLIF in new series.

Material and method
The object is one level MIS-PLIF for LSCS. We analyzed two groups. The bullet group consisted of 14 cases from 2012 to 2014. The C-shaped group consisted of 15 cases from 2014. There was no significant difference in both groups about age, sex, and fixed level. The operation used the same method, decompressed by one side approach and inserted local bone and a cage between the vertebral bodies and fixed it in PPS on both sides. I analyzed the operative time, blood loss, and lumbar lordosis before and after operation, the bone union rate in six months, rotation movement and subsidence of cage in both groups.

Result
The operative time and blood loss did not have any significant difference,115.1 minutes, 136cc for the bullet group and 125.7 minutes 146.4cc for the C-shaped group.. The lumbar lordosis angle before and after the operation was 14.5 to 17.3 degree for the bullet group and 13.4 to 19.6 degree for the C-shaped group. The C-shaped group was able to significantly increase lordosis ($P<0.001$). The bone union rate in six months did not have any significant difference in 66.7% of the bullet group, C-shaped group 64.2%. The rotation movement of the cage is as for three in the C-shaped group. Subsidence is three cages in the bullet group and one in the C-shaped group.

Conclusion
The operation time and blood loss of our method in MIS-PLIF were reasonable. It was reported in MIS-PLIF that lumbar lordosis was not good enough, but latest controllable C-shaped type cage is available for the easy acquisition of lumbar lordosis.

TRANSFORAMINAL LUMBAR INTERBODY FUSION IN PEEK OBLIQUE CAGES WITH AND WITHOUT TITANIUM COATING: RESULTS FROM A RANDOMIZED CLINICAL TRIAL

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Purpose
The primary aim of this study was to compare fusion rates after instrumented transforaminal lumbar interbody fusion (TLIF) using either titanium-coated polyetheretherketone (TiPEEK) or common PEEK cages. Secondary aims were to assess postoperative radiographic and clinical differences between these groups.

Methods
We conducted a randomized controlled trial in 40 patients scheduled to undergo instrumented spinal fusion with insertion of the implants in the lumbar levels L2-L5. Fusion rates were assessed by computed tomography at 3 months and functional radiography at 12 months. Disc height of the treated and adjacent levels was assessed immediately postoperatively, and at 6 and 12 months. Oswestry Disability Index, EuroQoL-5D, and back and leg pain were determined preoperatively, and at 3, 6, and 12 months postoperatively.

Results
At the final follow up, 1 patient in each group was lost to follow-up. Two patients each in the PEEK and TiPEEK groups were revised for pseudarthrosis ($p = 1.00$). Complete or partial fusion rate at 3 months was 91.7% in both groups. Overall, no significant differences were found in radiographic or clinical outcomes.

Conclusion
Favorable results were observed with both PEEK and TiPEEK cages for single- or two-level instrumented spinal fusion in the lumbar levels L2-L5. Identical high fusion rates were observed as early as 3 months postoperatively in both groups. The titanium coating appears to have no negative effects on outcome and safety in the short term. A positive trend was observed in partial fusion rate and restored disc height in fused segments.

SPINE CORRECTION WITH LATERAL INTERBODY DEVICES

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Objective
To determine the outcomes of different lateral minimally invasive approaches to the lumbar spine.

Background
A wide range of conditions including spinal deformities, tumors, infection, spine trauma and degenerative spine disease can result in spine instability. These conditions are associated with disability, back pain and decreased quality of life.
Spondylolisthesis is a common cause of surgery in patients with lower back pain. Degenerative lumbar scoliosis is one of the big drivers of disability in the elderly patient population. Although lateral fusion and pedicle screw fixation are a relatively common treatment method for the treatment of spondylolisthesis and degenerative lumbar scoliosis, controversy exists about the efficiency of different methods. Each surgical approach carries a particular risk profile, including potential vascular, visceral and sexual dysfunction, paraspinal denervation, dural tear and neural injury risks.
Minimally invasive approaches like XLIF (extreme lateral interbody fusion) and DLIF (direct lateral interbody fusion) have several advantages such as the increased stability, indirect decompression and they avoid dissection and retraction of muscles, bones, nerves and ligaments. We will present our experiences of lateral fusion techniques in the treatment of spondylolisthesis, degenerative lumbar scoliosis and revision surgeries.

Conclusion
XLIF and DLIF are not only effective for indirect decompression and deformity correction but also show satisfactory mechanical stability and fusion rate with low complication rate. In cases of revision the lateral fusion techniques are favoured due to less soft tissue injury.

A RETROSPECTIVE ANALYSIS OF PATIENTS TREATED WITH TIPEEK CAGES IN THE CERVICAL AND LUMBAR SPINE

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AZ Monica Deurne, Deurne, BE

The ideal intervertebral cage provides load bearing support, promotes fusion and facilitates fusion assessment.
PEEK has a good elastic modulus and is radio opaque but does not interact with bone. Titanium cages on the other hand have high stiffness and limited radio opacity but are biocompatible and do interact with bone.
In this presentation our results will be presented in using titanium coated PEEK cages. Theoretically, these cages should combine the advantages of both materials.
We evaluated 92 cervical TiPeek cages and 144 Lumbar TiPeek cages. We were particularly interested whether or not there was subsidence (support), whether or not there was fusion (biocompatibility) and what was the best way to evaluate fusion (fusion assessment). Clinical evaluation and radiological investigations were performed on all patients.
The results that will be presented show that TiPEEk cages are safe to use. No adverse effects were seen directly related to the implant. Using them, both in the lumbar and cervical spine provided us with a high fusion rate which can be assessed with flexion extension X-rays and/or CT scan. Whether or not there is bone ingrowth on the titanium coating itself cannot be proven, although there are suggestive radiological findings.

Challenges, complications and solutions in the treatment of spine pathologies

Session 6 - Spine Day 2

POLYAXIAL SCREWS IN TRAUMA AND HIGH GRADE SPONDYLOLISTHESIS: ARE THEY USEFUL?

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The use of pedicle screws has been a fundamental change in the treatment of spinal pathologies.
Posterior transpedicular pedicle screw fixation is widely used for obtaining internal fixation for management of the unstable spine mainly caused by trauma or spondylolisthesis.
Many variations of screws are proposed but two fundamental treatment philosophies: monoaxial or polyaxial screws.
The biomechanical properties of monoaxial pedicle screws have been widely reported
Polyaxial pedicle screws are a common method of fixation to facilitate spinal fusion while monoaxial screws are less favored due to the difficulty of rod insertion with fixed heads.
Short-segment posterior spinal instrumentation using pedicle screws remains the standard method for the treatment of thoracic and lumbar fractures, with acceptable results.
Short-segment stabilization with monoaxial screws has been beneficial in the management of thoracolumbar spinal fractures for better correction of kyphotic deformity, greater initial stability and indirect decompression of the spinal canal.
In fact, short monoaxial pedicle screw in short construct exhibited more stability in flexion and extension than the polyaxial pedicle screw.
The loss of reduction and instrumentation failure associated with this technique is well known and these failures have been attributed to poor bone quality, inadequate anterior column support, and insufficient points of fixation. An excellent surgical technique, using uniaxial long screws properly positioned can reduce the risk of failure.
Reduction of lumbar spondylolisthesis has been performed via a variety of techniques including Harrington rod distraction and posterior reduction by instrumented segments.
Poliaxial screws for the treatment of spondylolisthesis is designed to be more versatile. This system is adjustable to connect the rod and secure the head to the pedicle screw.
Top-tightening polyaxial pedicle screw system was used for reduction and fixation by using precontoured rods. The screws were properly tightened but not locked for retaining screw head movement and under fluoroscopic control, lever reduction maneuver incorporating segmental distraction and posterior translation forces was performed.
After positioning the cage for interbody fusion, a compression maneuver was done in order to restore better segmental lordosis and good sagittal balance.
In conclusion, we think that poliaxial screws are very useful to treat spondylolisthesis patients while monoaxial screws lead to a better short segment stabilization for fracture management.

ROLE OF WEEKLY ADMINISTERED TERIPARATIDE IN BONY UNION ENHANCEMENT AFTER POSTERIOR OR TRANSFORAMINAL LUMBAR INTERBODY FUSION FOR OSTEOPOROSIS-ASSOCIATED LUMBAR DEGENERATIVE DISORDERS

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Background
Posterior or transforaminal lumbar interbody fusion (PLIF or TLIF) is usually performed to treat lumbar degenerative diseases; however, pseudoarthrosis can be experienced in some cases. A multicenter, prospective, randomized, study was performed to examine the role of once-weekly teriparatide, which is an agent commonly prescribed for osteoporosis in Japan, on patients from a single-level lumber interbody fusion.

Methods
The patients were females over the age of 50 years with osteoporosis and lumbar degenerative disease for whom surgery was indicated for single-level PLIF or TLIF. Patients were randomized to receive either once-weekly teriparatide, starting week one for six months postoperatively (teriparatide group), or no teriparatide (control group). After one week, patients received 1.2 g/day calcium l-aspartate, wore a lumbar soft corset for three months, and did physical training. Radiological evaluations were performed using dynamic x-ray and three-dimensional computed tomography in a blind

fashion. Clinical and neurological symptoms were evaluated using the Japanese Orthopaedic Association Back Pain Evaluation Questionnaire (JOA-BPEQ) and the Oswestry Disability Index (ODI). Serum concentrations of P1NP and TRACP-5b were measured and femoral neck bone mineral density was assessed.

Results
Seventy-five patients were randomized, nine patients discontinued, and sixty-six patients received treatment. Bone fusion was significantly increased in the teriparatide group compared with the control group six months postoperatively. Postoperatively, JOA-BPEQ and ODI were significantly improved in both groups. In the teriparatide group, P1NP increased and TRACP-5b decreased, both significantly.

Conclusions
Weekly administered teriparatide accelerated bone union enhancement at the PLIF or TLIF. Weekly teriparatide increased bone formation and decreased bone resorption as the result of bone metabolism markers. Combining lumbar interbody fusion with teriparatide therapy may be an appropriatetreatment for lumbar degenerative disease in elderly patients.

SURGERY IN PATIENTS WITH SPINAL METASTASES

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Surgical management of spinal metastasis gained an increasing importance over the last decade. The spine is the most frequent location for skeletal metastases which occur in up to 40% of patients with cancer. The thoracic spine is mostly affected, followed by the lumbar and cervical areas. Advances in imaging and instrumentation have allowed improvements in the techniques of excision of the tumour and spinal stabilisation. Despite this, the treatment of spinal metastases remains largely palliative and most of the time stabilization is of greater importance than decompression. Surgical decision-making is complex, with clear indications being spinal instability, neural compression secondary to retro-pulsed bone, deformity, intractable pain and failure of radiotherapy. Even if the patient satisfies one or more of these indications, the nature and objective of surgery must be determined by the ability of the patient to tolerate the procedure and, more importantly, by their estimated life expectancy. Minimally-invasive techniques, namely percutaneous cement augmentation, stereotactic radiosurgery and radiofrequency ablation have challenged the conventional management of metastatic spinal disease. These less invasive procedures afford palliation, have a lower morbidity than conventional surgical operations and may alter our decision-making in the future. This talk will give you an overview of the variety of options currently available for the treatment of metastatic disease of the spine.

SI JOINT ARTHROPATHY - DIAGNOSTIC CHALLENGES, A NEW PROVOCATIVE TEST, AND TREATMENT OPTIONS

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Background
The sacroiliac joint (SIJ) is a frequently underestimated cause of lower back (LBP). A simple clinical test of sufficient validity would be desirable. The aim of this study was to evaluate the diagnostic value of a new PSIS distraction test for the clinical detection of SIJ arthropathy and to compare it to several commonly used clinical tests.

Methods
Consecutive patients, where a SU pathology had been confirmed by an SIJ infiltration were enrolled (case group, 61 SIJs in 46 patients). Before infiltration, patients were tested for pain with PSIS distraction by a punctual force on the PSIS in medial-to-lateral direction (PSIS distraction test), pain with pelvic compression, pelvic distraction, Gaenslen test, Thigh Thrust, and Faber (or Patrick's) test. In addition, these clinical tests were applied to both SIJs of a population of individuals without history of LBP (control group, 64 SIJs in 32 patients).

Results
Within the investigated cohort, the PSIS distraction test showed a sensitivity of 100% and a specificity of 89% for SIJ pathology. The accuracy of the test was 94%, the positive predictive value (PPV) was 90% and the negative predictive value (NPV) was 100%. Pelvic compression, pelvic distraction, Gaenslen test, Thigh Thrust, and Faber test were associated with a good specificity (> 90%) but a poor sensitivity (< 35%).

Conclusions
Within our population of patients with confirmed SIJ arthropathy the PSIS distraction test was found to be of high sensitivity, specificity and accuracy. In contrast, common clinical tests showed a poor sensitivity. The PSIS distraction test seems to be an easy-to-perform and clinically valuable test for SIJ arthropathy.

ADJACENT LEVEL FRACTURES IN LONGER CONSTRUCTS

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Introduction
Adjacent level fractures are a common problem especially after multisegmental spondylodesis. Such fractures, their prevention and treatment are great challenges in Spinal surgery.

Methods
Actual definitions of junctional disorders are presented to focus clearly on the fractures as mentioned in the title. By understanding different types of failure, reasons for junctional deformities become obvious that can be avoided by improvement of surgical techniques .
Common trends in prevention of PJK are presented, their theoretical background but also their failure, illustrated by the authors own experiences in this field.
Finally, keypoints concerning patient- and surgery-related risks and possible improvements are summarized to avoid failure, or at least lower their fequency in daily practise.

Conclusion
Junctional disorders, particularly adjacent level fractures are a growing problem in patients getting older and receiving longer constructs for de novo deformities. Understanding of biomechanics of the spine and the knowledge of the sagittal profile may help prevent some of the reasons for failure. Still, current research has not found a definitive solution for this issue.

CUSTOM SEGMENTAL SPINE TREATMENT STRATEGIES

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The degeneration of the segments in the cervical and lumbar spinal column with its different anatomical components is a process that is not only depending on the age of the individual but also on genetic and mechanical factors. If conservative therapy finally fails, surgical options are the only treatment options left. The development of various surgical techniques and implant designs over the last decades offer various strategies that are ideally suited for the corresponding pathology. There are different stages ranging from simple microdiscectomy to a final fusion which are also mirroring the amount of risks associated and potential collateral damages with these surgical interventions. The logic behind this step algorithm is that there is always a next treatment level left as a reserve if the initially performed treatment level should clinically fail. If no structural biomechanical instabilities and only nerve related pain issues are the problem minimally invasive or microscopic disc surgeries are performed.Where severe back pain or neck pain conditions are the issue, an additional instrumentation is necessary as usually biomechanical deterioration needs to be compensated. If a disc is severly degenerated and is the source of pain a total disc replacement is an option. In cases of a stenosis a decompression with a posterior dynamic stabilizing interspineous device may be sufficient to compensate for the removed bone material whereas a more severe condition a posterior dynamic stabilization system using pedicle screw systems can be used. It always depends on the nature of the pathological structural condition and, in order to maintain or restore motion, a 360° solution is possible as a hybrid construct using an artificial disc with an anterior implantation in combination with posterior dynamic pedicle systems. If all that fails or if the structural pathology requires a stable fixation of the segment as in a spondylolisthesis the final step in this algorhytm - the fusion may be considered as the initial option. However, these motion preserving implants may fail mechanically although the reported numbers compared to numbers of these devices used worldwide is low. One reason for low complication rates can be the strict adherence to inclusion and exclusion criteria and missing long term follow up. So any of these devices can be used to support a failed implant even if it is only biomechanical stabilization at a later stage of degeneration before having to use the final fusion. So in the present situation the availability of numerous different technical systems - motion preserving or not - allow a flexible response to address these various pathologies.

THE INFECTED SPINE - OPERATIVE SOLUTIONS

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The incidence of spondylodiscitis has been increasing over the last decade. Mainly geriatric patients are affected. The demographic change and risk factors for spondylodiscitis are of high importance.
Whereas early detected and mild courses can be successfully treated conservatively, spondylodiscitis going along with relevant vertebral destruction leading to instability, malalignment, spinal canal stenosis, and neurologic deficits needs to be treated operatively.

Several surgical strategies have been described in the literature. Instrumentation only, both, open or minimally invasive; anterior debridement, fusion and stabilization; dorsal debridement, stabilization and fusion or combined procedures are recommended in the literature. Additional antibiotic therapy over a prolonged time is widely accepted as standard.
Stabilization of the anterior column with cages in case of large anterior defects as well as in case of subsequent deformity is proven as a safe procedure after radical debridement, fusion and additional instrumentation.
Consequently we recommend spinal stabilization, radical debridement, secure fusion, and supportive antibiotic therapy in order to gain infectious healing in correct alignment.
Considering, mainly, the geriatric patient population with reduced bone quality, titanium coated implants with tensile modulus comparable to osseous tissue are of particular interest. Additionally, implants with large foot prints to ensure optimal force transmission are essential.
In accordance to literature we have seen promising results after a surgical approach including radical debridement, dorsal stabilization and fusion in correct alignment in combination with test appropriate antibiotics.

Anterior approaches and surgical solutions

Session 7 - Spine Day 2

SPINE CORRECTION WITH THE HELP OF ANTERIOR INTERBODY DEVICES

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Anterior surgery has been used as either an adjunct or primary method for treating spinal deformities.[1-3] The use of an anterior interbody device can increase focal lordosis. Further, anterior release with a cage can be a powerful tool, improving coronal and sagittal alignment.

In our practice, anterior discectomy and the use of interbody devices has been utilized: 1) to improve focal lordosis in patients with sagittal plane deformity, 2) with discectomy and annular release to maximize coronal and rotational correction, and 3) in combination with posterior fixation as a treatment for lumbar spondylolisthesis.

Studies regarding anterior surgery for degenerative conditions have shown improved focal lordosis and foraminal height. In evaluating these cases at our institute, we have found similar results. When comparing patients with 1- or 2- level spinal fusions, patients with anterior interbody fusions had increased focal lordosis when compared to transforaminal or posterior lumbar interbody fusions (TLIF/PLIF). This is comparable to other studies.[4,5]

The use of anterior surgery has been documented in adult deformity; however, there are a limited number of studies comparing interbody techniques. The literature supports the use of posterior only techniques, but more recent studies suggest anterior surgery may yield improvements in coronal and sagittal parameters.[6-8] One possible benefit of anterior surgery is the release of anterior soft tissues. This can assist in the correction of rotation, coronal plane, and sagittal plane deformity. Further, with the addition of interbody devices, construct stability may improve. In our biomechanical evaluation of surgical techniques, 360° fusions decreased strain on the construct compared to posterior only models. Other biomechanical and clinical studies have shown mixed results.

With several techniques available for interbody fusion, it is important to choose the procedure best fit for the surgeon and the patient. While lateral approaches (with hyper-lordotic cages and anterior release) and posterior approaches to interbody fusion and deformity correction have gained popularity, the use of anterior surgery can be a powerful adjunct in adult deformity surgery. Surgeon experience, availability of an access surgeon (or ability to perform the anterior approach), and patient specific factors must be evaluated. In our practice, anterior interbody fusion allows for significant deformity correction and is our primary method of interbody in adult deformity surgery.

1. Bradford DS, Tay BK, Hu SS. Adult scoliosis: surgical indications, operative management, complications, and outcomes. Spine (Phila Pa 1976). 1999;24(24):2617-2629.
2. Byrd JA, 3rd, Scoles PV, Winter RB, Bradford DS, Lonstein JE, Moe JH. Adult idiopathic scoliosis treated by anterior and posterior spinal fusion. J Bone Joint Surg Am. 1987;69(6):843-850.
3. Dick J, Boachie-Adjei O, Wilson M. One-stage versus two-stage anterior and posterior spinal reconstruction in adults. Comparison of outcomes including nutritional status, complications rates, hospital costs, and other factors. Spine (Phila Pa 1976). 1992;17(8 Suppl):S310-316.
4. Hsieh PC, Koski TR, O'Shaughnessy BA, et al. Anterior lumbar interbody fusion in comparison with transforaminal lumbar interbody fusion: implications for the restoration of foraminal height, local disc angle, lumbar lordosis, and sagittal balance. J Neurosurg Spine. 2007;7(4):379-386.
5. Jiang SD, Chen JW, Jiang LS. Which procedure is better for lumbar interbody fusion: anterior lumbar interbody fusion or transforaminal lumbar interbody fusion? Arch Orthop Trauma Surg. 2012;132(9):1259-1266.
6. Crandall DG, Revella J. Transforaminal lumbar interbody fusion versus anterior lumbar interbody fusion as an adjunct to posterior instrumented correction of degenerative lumbar scoliosis: three year clinical and radiographic outcomes. Spine (Phila Pa 1976). 2009;34(20):2126-2133.
7. Dorward IG, Lenke LG, Bridwell KH, et al. Transforaminal versus anterior lumbar interbody fusion in long deformity constructs: a matched cohort analysis. Spine (Phila Pa 1976). 2013;38(12):E755-762.
8. Ni J, Zheng Y, Liu N, et al. Radiological evaluation of anterior lumbar fusion using PEEK cages with adjacent vertebral autograft in spinal deformity long fusion surgeries. Eur Spine J. 2015;24(4):791-799.

ANTERIOR/LATERAL APPROACHES FOR SAGITTAL PLANE CORRECTION WITH LORDOTIC GRAFTING AND PLATE FIXATION

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Aims and Objectives

The lateral retroperitoneal approach has become a widely employed technique for lumbar spinal fusion in the surgical treatment of both degenerative spinal disease and spinal

deformity. The approach is inherently powerful in correcting coronal deformity but limitations exist in the ability to correct the loss of lumbar lordosis due to the anatomical constraints and the lordotic design of standard interbody cages. Recently, hyperlordotic cages with angulation of up to 30° have been designed to overcome these limitations in an attempt to provide more significant focal correction similar to that achieved with three column osteotomies which historically provide 25 to 40° of correction. These grafts require supplemental plate and screw fixation when used in combination with surgical resection of the anterior longitudinal ligament (ALL) due to the iatrogenic focal instability created by sacrificing this structure. Early experience suggests that obtaining the full extent of correction built into the graft requires a supplemental posterior facet release or Smith-Peterson osteotomy with cantilever compression of posterior instrumentation. The goal of our study was to determine if a circumferential approach, combining lateral transpsoas surgery with sectioning of the ALL, hyperlordotic cage placement with lateral plating, and open posterior SPO could provide the full extent of correction inherent to the lordotic angulation of the graft.

Methods

A retrospective radiographic review of prospectively collected data from 22 patients was performed. A total of 23 hyperlordotic grafts with plate fixation were inserted as a means of correcting sagittal deformity in a series of revision cases with fixed sagittal imbalance and chronic back and/or radicular leg pain.

The mean patient age was 58.6 years-old with 8 Males and 14 Females. 20 degree hyperlordotic cage used at 4 levels and 30 degree hyperlordotic cage used in 19 levels. The goal was to evaluate mean segmental correction, not global correction of sagittal balance as other osteotomy techniques were used in many cases where significant correction was needed.

Results

The mean segmental correction obtained for levels fused with a 20° cage was 22.6°. The mean segmental correction for levels fused with a 30° cage was 24°.

Discussion/Conclusions

Segmental lordotic correction of 20 to 30 degrees can be obtained during lateral transposas approaches with full or partial sectioning of the ALL and placement of hyperlordotics cages with supplemental SPO. Under correction can occur with graft subsidence that can occur due to oversizing the graft and poor bone quality. Additional lordosis beyond the degree inherent to the cage change can occur with SPO if the graft is partially unloaded after posterior compression. This approach provides a degree of correction similar to traditional three column osteotomies without the potential benefits of decreased blood loss and is an attractive option for treatment of fixed sagittal imbalance in patients without previous anterior column fusion.

Cervical spine pathology

Session 8 - Spine Day 2

PEDIATRIC AND SYNDROMIC CERVICAL DEFORMITIES

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Cervical deformities in children may have many underlying causes. They may occur in the form of congenital deformity (e.g. due to a cervical hemivertebra), or arise due to cervical instability or they can be associated to various syndromes as we can see in patients with skeletal dysplasia conditions. Post traumatic, postinflammatory, iatrogenic pathogenesis is also possible. These conditions are very heterogeneous and the treatment has to be tailored accordingly. Congenital conditions are present at birth and can be relatively easily diagnosed. However, the likely progression of a deformity is often difficult to predict. In skeletal dysplasia conditions, the bony morphology keeps on changing throughout life. Diagnosis is often difficult due to the large and ever increasing number of recognized syndromes. Cervical instability might cause irreversible spinal cord damage if not recognized or treated appropriately. The choice of the best treatment (surgical versus follow up visits/conservative treatment) can be challenging. In this talk, illustrative cases will be presented along with highlighting the main aspects and possible pitfalls during the treatment of children with cervical deformity.

DEVELOPMENT OF A NEW TECHNIQUE FOR CERVICAL PEDICLE SCREW AND MAGERL SCREW INSERTION USING A 3-DIMENSIONAL IMAGE GUIDE

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Introduction
Cervical pedicle screw fixation and Magerl screw fixation provide good correction of cervical alignment, rigid fixation and a high fusion rate. However, malpositioning of the screws is not a rare occurrence and the insertion of screws has a potential risk of neurovascular injury. Thus, it is necessary to determine a safe insertion procedure for these screws. To avoid complications during cervical pedicle screw and Magerl screw insertion, the authors developed a new technique which is a mold shaped to fit the lamina.

Materials and Methods
Preoperative CT scan images of 1 mm slice thickness were obtained of the whole surgical area. The CT data was imported into a computer navigation system. We developed a 3D full-scale model of the patient's spine using a rapid prototyping technique from the CT data. Molds of the left and right sides at each vertebra were also constructed. One hole (2.0 mm in diameter and 2.0 cm in length) was made in each mold for the insertion of a screw guide. We performed a simulated surgery using the bone model and the mold before operation in all patients. The mold was firmly attached to the surface of the lamina and the guide wire (K wire of 1.42 mm in diameter) was inserted using the intraoperative image of lateral vertebra. The proper insertion point, direction and length of the guide were also confirmed both with the model bone and the image intensifier in the operative field. Then, drilling using a cannulated drill and tapping using a cannulated tapping device were carried out. Twenty consecutive patients who underwent posterior spinal fusion surgery using this technique since 2009 are included. The screw positions in the sagittal and axial planes were evaluated by postoperative CT to check for malpositioning.

Results
The screw insertion was done in the same manner as the simulated surgery. With the aid of this guide the cervical pedicle screws and Magerl screws could be easily inserted even at the level where the pedicle seemed to be very thin and sclerotic on the CT image. Postoperative CT showed that there were no critical breaches of the screws.

Discussion
The present method employing the device using a 3D image guide appears to be easy and safe to use. The technique may improve the safety of cervical pedicle screw and Magerl screw insertion even in difficult cases with narrow sclerotic pedicles. Based on this study, we concluded that this procedure can provide a safe insertion of cervical pedicle screws and Magerl screws for critical cases.

DIFFERENT SURGICAL OPTIONS FOR CERVICAL SPINE INDICATIONS

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Introduction
There are a number of diagnoses in the cervical spine that require surgical considerations. This commonly includes cervical radiculopathy and myelopathy. Other indications include deformity, trauma, or chronic axial neck pain. Multiple treatment options have evolved providing surgeons with different techniques to treat the same surgical condition. Advantages and disadvantages of each technique exist, and it is up to the surgeon to determine the best option for their patient.

Cervical Indications
For this discussion we will present the most common operative cervical conditions, including cervical myelopathy, cervical radiculopathy, cervical deformity, and odontoid fractures.

Techniques
Cervical operative techniques, review of surgical indications, and outcomes for multiple techniques will be presented. Advantages and disadvantages and pitfalls of each will also be discussed.

Anterior cervical discectomy and fusion, anterior cervical corpectomy and fusion, cervical laminectomy, cervical laminoplasty, cervical foraminotomy, cervical disc arthroplasty, and stand alone fusion devices will be discussed. Various treatment options for odontoid fractures will also be presented.

Discussion
Advantages and disadvantages and pitfalls of each technique will be discussed. Relevant data regarding long term outcomes of these surgical procedures will be presented.

Conclusions
Conclusions regarding techniques and best practices will be presented. Illustrative case studies will also be used.

HOW TO REDUCE DYSPHAGIA AFTER ANTERIOR CERVICAL SPINE SURGERY?

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Oropharyngeal dysphagia is a frequent postoperative complication after anterior cervical spine surgery. The reported incidence varies widely in the literature, direct postoperatively up to 79%, after 3 months up to 50%, and after one year up to 35%. Direct or indirect instrumental evaluations in patients who develop dysphagia show significant alterations in swallow biomechanics. However, as dysphagia is a subjective sensation, patient reported instruments (questionnaires) appear to be more accurate and clinically relevant.

The causes for dysphagia after anterior cervical spine surgery are multifactorial, involving neuronal, muscular and mucosal structures. The pressure induced by the medial retractor blade on the esophageal wall seems to be one of the causes due to the induction of edema, inflammation and finally fibrosis, as well as due to a reduction of esophageal wall perfusion. The endotracheal tube cuff pressure seems also to be associated with postoperative dysphagia. Further causes and risk factors are prolonged operative time, the use of bone morphogenetic proteins (BMP), the design and thickness of an additional anterior plate, surgery of more than two levels, revision surgery, female gender and an old age.

Therefore, several measures can be used to reduce dysphagia after anterior cervical spine surgery:
• Preoperative traction exercises, starting 4 days before the surgery, can decrease dysphagia in multilevel fusions.
• The surgical approach should be done via a gentle blunt dissection of the structures of the anterior neck, avoiding unnecessary manipulation.
• Prolonged operative time should be avoided, i.e. in complex cases senior surgeons would probably have less dysphagia after surgery than junior surgeons.
• BMP should generally not be used in the anterior cervical spine.
• The endotracheal tube cuff pressure should be monitored and reduced to ≤ 25 mmHg after placement of the retractors.
• The use of small static retractors, repositioned for each level and with intermittent relaxation, or of dynamic retractors, is recommended.
• Using an anchored spacer implant instead of plating may decrease postoperative dysphagia.
• In case of plating, a low-profile and small cervical plate should be chosen.
• Postoperative short-term steroid treatment, as well as local prevertebral steroid application, both appearing to decrease postoperative dysphagia without relevant adverse effects, can be considered especially in patients with a high risk of developing dysphagia.

ADJACENT LEVEL DEGENERATION AFTER SINGLE LEVEL CERVICAL FUSION - A STUDY OF MORE THAN 600 PATIENTS

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Introduction
There is some evidence in literature that ventral fusion in the cervical spine is followed by symptomatic adjacent level disease. In response to this data we followed up our patients undergoing single level arthrodesis to identify how many developed new clinical symptoms and how many needed additional surgery.

Patients and methods
Patients undergoing single level ventral arthrodesis were analyzed retrospectively. The indication for initial surgery was degeneration with nerve root or spinal cord compression. In all patients a titanium spacer was inserted. For clinical evaluation Odom´s criteria and the CSRS Outcome Questionnaire (German version) were used.

Results
During a 10-year period 724 patients were operated. 14 patients died for reasons unrelated to the cervical spine surgery, and 144 patients could not be located for follow up. The remaining 566 patients (78%) completed the questionnaire. The mean time of follow up was 6.8 years after surgery. An excellent and good outcome was observed in 81% of the patients, a fair in 13% and a poor in 6% of the cases. Logistic regression analysis found no correlation between axial neck pain and age, level of surgery, and the time interval to completing the questionnaire, respectively. An increased risk for adjacent disc disease was detected at the level C5/6 and C6/7.
Out of these 566 patients, 15 had second surgery for adjacent level disease. Kaplan-Meier analysis showed an incidence of 2% within the first 5 years and a 5% incidence at 10 years.

Conclusion
The incidence of surgery for adjacent level disease is lower than that reported in literature. The lower incidence in our study could have been influenced by patient selection with only single-level index surgery or by the surgeon's decision regarding the indication for the first and the second operation.

REVISION STRATEGIES IN CERVICAL SPINE SURGERY

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In the past 10 years we have seen a rapid evolution of surgical techniques and implants for the purpose of performing revision surgery in the cervical spine.
I have been performing simple and complex revision surgery with increasing frequency in the past decade, which is a similar trend in the North Texas region.
When possible, most surgeons prefer the anterior approach for de novo and revision procedures in the cervical spine; however it is extremely important for the complex spine surgeon to master posterior approaches as well as less used approaches to the cranio cervical junction.
Spine hardware companies have developed newer implants that have facilitated some revision procedures. For example, the stand alone anterior cervical interbody graft with zero profile plate is very useful in adjacent cervical disc disease. Using the above mentioned devices there is no need any more to remove previously placed anterior cervical hardware.
In my personal experience, complex cervical spine revisions are technically demanding procedures that often require a combination of anterior and posterior approaches within a well planned strategy. The presence of cervical spinal cord mandates a more precise and careful surgical technique compared to the lumbar spine. Emerging techniques such as intraoperative CT scan and navigation are going to further improve the surgical techniques used for cervical spine revision procedures with improved outcomes.

Pros & cons surgical approaches

Session 9 - Spine Day 2

OUTPATIENT MIS FOR LATERAL LUMBAR FUSION WITH ANALYSIS OF BOTH COST AND PATIENT OUTCOMES

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Summary of background data
Outpatient and ambulatory surgery centers (ASCs) are regularly utilized for procedures with low risk profiles and minimal need for extended postoperative observation. Recent advancements in minimally-disruptive approaches for lumbar interbody fusion have shown that early postoperative discharge is possible and reproducible.

Objective
The object of this work was to examine patient and surgical predictors of early postoperative discharge and test the predictive model against two clinical series of outpatient minimally invasive lumbar fusion patients.

Methods
Two analyses were undertaken, an examination of patient characteristics to determine predictors of early (<24 hours) postoperative discharge and then clinical examinations of patients treated with lumbar fusion at an ambulatory surgery center. For the predictive arm of the study, 1,033 patients treated with minimally invasive (MIS) lateral interbody fusion (XLIF) were grouped according to length of postoperative hospitalization with 45 patients discharged <8 hours (ambulatory), 828 discharged between 8 and 23 hours (outpatient), and 160 discharged >23 hours following surgery (inpatients). Demographic data between the groups were compared to determine any patient characteristics common to patients with different postoperative discharge results. For the clinical studies, 54 consecutive XLIF and 18 consecutive MIS posterior fusion patients were treated at an ASC with demographic, treatment, and complication data collected.

Results
From the predictive study, the strongest baseline predictors of early postoperative discharge (e.g., ambulatory or outpatient) were diagnoses of degenerative conditions compared to more advanced (deformity) disease, age, baseline hemoglobin levels, and body mass index (BMI). The most predictive treatment variables that predicted early postoperative discharge were number of levels treated and postoperative hemoglobin levels, where fewer levels and higher postoperative hemoglobin predicted earlier discharge. No differences were seen between out- and inpatient discharges in terms of number of comorbidities or having had prior surgery.
In the clinical series, outpatient surgeries were performed in younger patients (50.6 years and 53.2 years), at relatively few levels (99% of cases were at one or two levels), for simple degenerative disease (degenerative spondylolisthesis and stenosis the most common primary indications). No intraoperative and few postoperative were seen in either XLIF or MIS posterior fusions performed in ambulatory settings with no emergent transfers to inpatient facilities.

Conclusions
Select patients, by health and indication, can safely be treated as outpatients with XLIF or other modern MIS approaches. Being younger, having elevated preoperative hemoglobin levels, fewer levels being treated, and single-incision interbody fusion and fixation may predict early postoperative discharge. With ASCs receiving 65% to 70% of inpatient reimbursement, this has the potential to substantially decrease payer and societal costs while providing patients with a safe surgery and ability to spend the early postoperative period recovering at home.

THEORIES AND CONCEPTS BEHIND STAND-ALONE ANTERIOR FUSIONS

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Historical Perspective
Anterior Fusions were first used to treat TB and Lumbar Spondylolisthesis in the early 1930's. As the technology advanced and the techniques were improved, anterior fusions began finding their way as a solution to collapsed disks, and degenerative disk disease around 1948. ALIF's, though being performed safely, were not yet ready to be stand-alone solutions for fusions. Femoral Ring Allograft (FRA) were reported in 1994 to have fusion rates as high as 96% with posterior instrumentation. Many iterations of cages followed such as threaded cages, cages combined with blocking screws, anterior plates, and different materials including Titanium and Polyetheretherketone (PEEK). Interbody Cage design, originally cylindrical, evolved into a box-shape design and has led to better matching of the endplate geometry.

Benefits

There lies a multitude of advances and benefits in anterior fusion. The Anterior approach in general lends itself to being inherently minimally invasive and serves as a reasonably low complication approach. The selected angle of the approach allows for ALIFs to facilitate a more complete discectomy and anterior decompression, when indicated. Due to the load bearing mechanics on the spinal column ranging from 400N while sitting to a maximum total of 10,000N in compression strength, 80% of the load bearing force is concentrated on the anterior column itself. The location of the anterior cage, and subsequent fusion, allows for optimal anterior column support during these extreme compression forces. The stability of the devices is largely dependent on the compressive forces, which are inversely related to the tension forces created by the remaining annulus.

Technology

The Anterior approach, can be relatively bloodless, provided the patient selection criteria, such as obesity is strictly adhered to. Because of the surrounding anatomy of the anterior column, Iliac artery and vein, Iliolumbar branches and other retroperitoneal structures, the potential for significant complications is real and requires a specific skill level from the surgeon.

With the advent of new technology, including biomechanically superior devices, safer approaches, instrumentation, better biologics as well as a better understanding of the biomechanical forces, great strides have been made in broadening the indications. Currently many new devices are seeking approval, after Dr. Christopher Cain successfully pioneered the stand alone device with fixation, showing that there was equal stiffness of the stand-alone device compared to 270- and 360- degree constructs, with the surface of the cage bearing the stress in flexion and the interlocking plate and screws bearing most of the stress in extension.

Future

The progression and advancements of anterior fusions have exponentially grown in the last 80 years. Developing different anterior approaches to benefit our patients is already on the way. The new frontier lies in finding materials and shape designs to be patient specific. A material that has a modulus of elasticity closer to bone, and can be modified to meet the patient specific needs, can potentially negate complications such as subsidence and migration. The possibilities are amazing. Imagine delivering local therapies such as contained radiation via a cage and local osteoporosis treatment through the cage, as well as absorbable cages. This will change the paradigm of treatment and will bring interesting options for our patients in the future.

1. Mercer W. Spondylolisthesis with a description of a new method of operative treatment and notes of ten cases. Edinburgh Med J 1936;43:545–572
2. Burns B. An operation for spondylolisthesis. Lancet 1933;224: 1233–1239
3. Ito H, Tsuchiya J, Asami G. A new radical operation for Pott's disease. J Bone Joint Surg Br 1934;16:499–515
4. Sasso, R. et al. Anterior Lumbar Interbody Fusion. resnick.cls May 25, 2008 13:53
5. Herkowitz H. et al. Rothman-Simeone The Spine, 6th Edition. Philadelphia; Elsevier Saunders 2011. print

THEORIES AND CONCEPTS BEHIND UNILATERAL FUSIONS

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Introduction

The quest for clinical improvement with successful lumbar spine fusion continues to be measured against patient morbidity and the rising financial costs associated with spine surgery. Minimally invasive instrumentation and fusion techniques have allowed many surgeons to obtain fusion rates similar to traditional procedures without the associated morbidity associated with open approaches. The benefits of this new technology have led some surgeons to push the boundaries of minimalist surgery and attempt spinal fusion with unilateral instrumentation as compared to bilateral instrumentation.

Methods

A critical review of recently published articles related to Unilateral Fusions was performed.

Results

The clearly defined benefits of the Unilateral Fusion technique include decreased surgical time, soft tissue damage, blood loss, and costs associated with surgery. Although less post-operative pain after 7 days has been reported in one study, there was no difference after 1 month. Length of stay comparisons between unilateral instrumented fusion vs. bilateral instrumentation was found to be similar. The reported clinical success was similar between the treatment groups. Complication rates were also found to be similar. There are conflicting reports on the results of the fusion rates with unilateral techniques. While several studies state unilateral instrumentation provides equal fusion rates as bilateral instrumentation, others clearly report higher nonunion rates with the unilateral technique. Biomechanical studies have shown less stability in unilateral pedicle screw constructs, specifically in rotation and lateral bending, which may theoretically increase the chance for implant loosening or failure. Decreased posterior instrumentation stress is observed with bilateral pedicle

screws. Cage migration was also a factor in one study that reported a 23% incidence with unilateral instrumentation vs. 11% with bilateral screws, leading the authors to conclude that unilateral pedicle screw techniques were not stable enough in some patients. Nevertheless, two meta-analyses of randomized clinical trials comparing unilateral vs. bilateral pedicle instrumentation for fusion have shown no significant difference with regard to pain, complications rates, and fusion rates.

Conclusion

Unilateral instrumented fusion appears to be a viable clinical option for lumbar disc disease in select patients. This technique has been reported to provide similar clinical results compared to the use of bilateral instrumentation. Controversy remains regarding biomechanical stability and fusion rate utilizing this technique. One of the key principles to consider with this technique is the use of an appropriate intervertebral fusion device. After proper preparation of the disc space for interbody fusion, the implant provides immediate anterior column stability. However, proper sizing of the height and footprint of the implant can enhance that stability. Finally, the positioning of the implant so that it crosses the axial midline is a critical step in the success of this unilateral fusion technique. If the interbody implant cannot obtain all of these technical guidelines, the surgeon should be prepared to complete the fusion with bilateral instrumentation.

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