European Knee Society

EKS Closed Meeting
Gleneagles
12-13 May 2022

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Welcome address

Dear Colleagues,

It is our pleasure to forward you this invitation to attend the European Knee Society closed meeting in the beautiful countryside of Scotland.

You will find enclosed the preliminary schedule of all events and accommodation information for the EKS closed meeting which will start on Wednesday, 11 May with a Welcome Dinner for those arriving in the afternoon.

The scientific session will start on Thursday, 12 May. In the afternoon you will be able to enjoy the many different activities available at the Gleneagles Hotel.
In the evening, we will have the '7 Year Anniversary Gala Dinner'.

On Friday, 13 May, the meeting will continue until approximately 13.00 hrs which will allow you to further enjoy the Gleneagles estate. Members wishing to extend their stay are able to do this as well (upon availability).

This closed meeting will be also an excellent occasion to socialise with your peers during the dinners and various activities, and many of you have already expressed their willingness to come with their partner, what we encourage you to do and register for them as well with all the details below.

We are looking forward seeing all of you in Scotland!

With our very best regards,

David Barrett EKS President	Anders Troelsen EKS General Secretary

Nick London and Phil Chapman-Sheath
Local Organisers

Wednesday, 11 May

Morning **Arrival of the EKS Members**

20.00 Welcome Dinner for Active and International Members

Thursday, 12 May

08.00 – 12.30 **EKS Meeting**

08.00 - 09.10 Session I: New Abstract Presentations
Moderator: Andrew Price and Emmanuel Thienpont

08.00 **UniQ-Study: Factors Influencing the usage of Medial Partial Knee Replacement**
Rutger van Geenen

08.09 **The excellent outcomes of fixed-bearing medial UKA are not compromised by patella-femoral arthritis, ACL deficiency or patient age – an EKS-supported study**
Nick London

08.18 **The “deep-MCL line”: A simple and reliable anatomical landmark to optimize the tibial cut in UKA**
Sebastien Parratte

08.27 **10-year Survival of cementless Oxford medial UKA using microplasty instrumentation - a report of 1000 cases with 5-year minimum follow-up using modern indications for surgery**
Andrew Price

08.36 **Effect of design parameters in FB & MB UKA biomechanics**
Bernardo Innocenti

08.45 **Superior survival of fully cemented fixation compared to hybrid fixation in a single design rotating hinge knee implant**
Gijs van Hellemondt

09.54 **Avoiding early femoral insufficiency fractures after primary total knee arthroplasty**
Friedrich Boettner

09.03 **Appearance and evolution of radiolucent lines in two different primary Total Knee Arthroplasty designs**
Emmanuel Thienpont

09.15 Summary of Delphi experience from Courmayeur
Moderator : Franco Benazzo

10.00 Coffee break

10.30 EKS Annual General Meeting (for International and Active Members only)

11.30 **Hot Debate : "Old Question – New Twist"**
Moderators : Sebastian Lustig and Phil Chapman-Sheath

What's new in Constraint ?: Anders Troelsen

Early Migration of Medial Congruent compared to Cruciate Retaining Total Knee Arthroplasty – Results from A Randomized Controlled Trial
Anders Troelsen

Panel Discussion and Q&A: Anders Troelsen, Gijs van Hellemondt, Andrew Toms, Michel Bonnin

12.30 Lunch

Free afternoon for activities (to be pre-booked)

19.00 Champagne Reception (Black Tie)

19.30 Celebratory Gala Dinner (Black Tie)

Friday, 13 May

08.45 **Open Delphi discussion forum and potential future EKS Delphi projects**
Moderator: Francesco Benazzo

10.00 – 11.00 Session II: New Abstract Presentations
Moderators : David Barrett and Chris Dodd

10.00 **An Artificial Intelligence based on a Convolution Neural Network allows Precise Analysis of Lower Limbs Alignment**
Jean-Noel Argenson

10.09 **Medial patellofemoral ligament reconstruction is an efficient procedure to treat patellar instability following total knee arthroplasty**
Cécile Batailler

10.18 **Clinical and cost-effectiveness of a new care pathway for patients with pain at three months after total knee replacement: the STAR randomised controlled trial**
Andrew Toms

10.27 **Does objective ligament laxity affect the clinical outcome of TKA?**
Stefano Campi

10.36 **The effects of adding tibia varus are more predictive than soft tissue releases to obtain Inter-compartmental balance in a varus deformed knee**
Martin Roche

10.45 **Long term survival of Trabecular Metal Cones (TMC) for TKA revisions with severe bony defects**
Siegfried Hofmann

11.00 Coffee Break

11.30 Hot Debate: Robotics – Is it worth it?
Moderators: Nick London and Martin Roche

Setting the scene : Which one should I buy and why? – *Jan Victor*

11.40 **The accuracy of kinematic alignment cuts using a low cost link-jig, an emerging technique**
William Jackson

11.45 **Malleoli and distal tibio-fibula joint landmarks provide reliable measures for intra-operative coronal alignment**
Andrew Porteous

11.50 **Alignment deviation between planned/performed bone resections and implant positioning in robotic-assisted TKA**
Fabio Catani

11.55 **A new robotically assisted technique can improve outcomes of Total Knee Arthroplasty comparing to an imageless navigation system**
Stefano Marco Paolo Rossi

12.00 **Functional Gait after inverse kinematic aligned Total Knee Arthroplasty resembles healthy controls - a comparative, blinded, Gait analysis of 45 subjects at 2 years postop**
Philip Winnock de Grave

12.05 **Remote patient monitoring with wearable sensors following robotic-assisted and conventional knee arthroplasty**
Paul Monk

12.10 **Debate:**
For - “I need a robot in my life” - *Sebastian Parratte*
Against - “I can manage without one” - *Andrew Porteous*

General Discussion – OPEN TO ALL DELEGATES

12.45 Lunch

Free afternoon, extended stay or departure of EKS Members

Hotel Accommodation

Active and International Members

Hotel Accommodation is offered to Active and International Members.

Gleneagles Hotel

Address: The Gleneagles Hotel
Auchterarder PH3 1NF
UK
Website: www.gleneagles.com/

Rate: £375.00 / night

This includes:

- Breakfast
- Use of the Club facilities (https://www.gleneagles.com/wellbeing/health-club/)

Check-in time: 15.00 hrs
Check-out time: 12.00 hrs

Parking: Free of charge

Social Events

Wednesday, 11 May

Active and International Members arriving in the afternoon are invited to attend the EKS Welcome Dinner.
This dinner is offered free of charge to EKS Active and International Members.
EKS Active and International Members are most welcome to register their partner for this dinner at a price of € 120,00. This must be paid to the EKS upon registration.

Thursday, 12 May

Active, International and Junior Members are invited to attend the EKS Gala Dinner on Thursday evening. The Gala Dinner consists of 5 courses and will be held at the Gleneagles Hotel.
This dinner is offered free of charge to EKS Active, International and Junior Members.
EKS Members can register their partner for this dinner at a rate of € 140,00. This must be paid to the EKS upon registration.

EKS Members are obliged to attend the Gala Dinner.

Please note that the dress code for the dinner is Black Tie.

Cancellation Policy
Dinners of partners can be cancelled until 1 April 2022. No refunds will be made after this date.

Accessibility

- **Edinburgh Airport**
  It is a 50-minute drive to the Gleneagles Hotel. Rent a car or book your private transport.

- **Glasgow Airport**
  It is a 1-hour drive to the Gleneagles Hotel. Rent a car or book your private transport.

- **Train**
  You can travel by train into Gleneagles Station *(2 hours from Edinburgh, 1,5h from Glasgow)*, a complimentary transfer service to the hotel is available from here. Please arrange in advance by calling 01764 694175.
  Train timetable: http://www.nationalrail.co.uk/

- **Private transport**
  The hotel offers a private chauffeur transfer service from both airports, to book, you must provide the hotel with your flight number and arrival time at least 24 hours in advance.
  Contact: concierge@gleneagles.com / +44 (0) 1764 694 175
  Rates: 1-4 guests, £160 one-way // 5-8 guests, £200 one-way

Booking Procedure and Cancellation Policy

Active and International Members

EKS Active and International Members are requested to book the room through the EKS registration form. Members booking their room through another platform (booking.com, hotel website,…) or booking another hotel will NOT be reimbursed.
We have obtained competitive rates and the hotels request a minimum number of booked rooms for our Meeting for which EKS takes the financial risk.

Availability
The hotel has a limited number of rooms and rooms are allocated on a first-come, first-served basis. We strongly advise to book your room as soon as possible.

Minimum stay
There is a minimum stay of 2 nights (12+13 May). If you wish to extend your stay before or after the proposed dates, you can contact the EKS Secretariat (Nele) by email on eks@medicongress.com or by telephone on +32 (0) 9 218 85 83.

How to book?
You can book your hotel and social events through the following link:
https://www.eiseverywhere.com/eksgleneagles

You will be asked to pay your social events for your partner by credit card or bank transfer within 30 days.
You will receive your confirmation within 3 working days by email.

What does EKS cover?
The EKS covers a total amount of **€ 1300,00**:

- 2 nights at a rate of €440,00 per night.
- 2 dinners for EKS Active and International Members on Wednesday and Thursday evening.
- Access to the scientific meeting
- 2 Coffee Breaks
- 2 Lunches

Please note:
A credit card will be asked upon registration to serve as a guarantee for your participation into the EKS Closed Meeting in Scotland. See cancellation policy on page 10 for more information.

Liability
The EKS cannot be held responsible if the hotel has no availability after 1 April 2022.

Insurance
Participants should organise their own health, travel and personal insurances.

Payment
Social events must be paid through the online registration form provided by the EKS within 30 days and before 1 April 2022.
Hotel accommodation must be booked through the online registration form, but a credit card number will be requested upon registration to serve as a guarantee for your participation and hotel booking. The cancellation policy is mentioned below.

Cancellation Policy
Cancellations are accepted until 1 April 2022. Cancellations received after this date will be charged in full. Cancellations must be done in writing to eks@medicongress.com and are valid upon confirmation by the Secretariat.
The cancellation fee is **€ 1 300,00** for the costs made by the EKS (hotel accommodation, dinners, meeting room rental, coffee breaks)
A credit card will be asked upon registration to serve as a guarantee for your participation into the EKS Closed Meeting in Scotland.

By registering to the EKS Closed Meeting in Scotland on 12-13 May, you agree to the above-mentioned procedure and policies.

Abstracts

Session I – Thursday 12 May

UniQ-Study: Factors Influencing the Usage of Medial Partial Knee Replacement
Stephan J. van Langeveld[1,a], Iris van Oost[1,a], Sander Spruijt[2], Stefan J.M. Breugem[3], Rutger C.I. van Geenen[1]
[1]Dept. of Orthopaedic Surgery, FORCE (Foundation for Orthopaedic Research Care and Education), Amphia Hospital, Breda; [2]Dept. of Orthopaedic Surgery, HagaZiekenhuis; [3]Dept. of Orthopaedic Surgery, Bergman Clinics, Naarden, The Netherlands
[a]Shared first authorship

Keywords: survey, usage, medial partial knee replacement

Background:
The medial partial knee replacement (PKR) revision rates decrease with increasing PKR usage with the minimal revision risk expected at a usage of 40-60%. When the correct indications are used, almost 50% of the patients requiring knee replacement are suitable for a PKR. However, national registries have reported a usage of PKR far below 50%. We aimed to assess and identify the various factors that could influence the usage of PKR.

Design and Methods:
We conducted a digital survey among practicing orthopaedic knee surgeons of the Dutch Orthopedic Society. The designed questions were classified into different domains: surgeon, patient selection and indications, and professional opinion.

Results:
116 respondents completed the questionnaire. The most striking finding in the surgeon's domain was that 40% of the respondents did not perform PKRs during their residency. In the domain of patient selection and indications, reported contraindications were a high BMI (67%), anterior cruciate reconstruction (31%), the presence of lateral osteophytes (21%), and chondrocalcinosis (21%). Only 51% of the respondents considered the absence of full thickness lesions medially and 62% the presence of joint space narrowing laterally to be true contraindications. According to the respondents, PKR outperforms TKR regarding all clinical parameters except survival (58% in favor of TKR). In the domain of professional opinion, respondents stated that the main barriers for PKR are insufficient experience (24%), revision rates (21%), and volume (17%), whereas 58% do not experience any barriers at all.

Conclusion:
This survey shows that a large proportion of the surgeons had little exposure to PKR during their residency. We also found considerable variations in (contra)indications for PKR. These factors may contribute to the underusage of PKR. More education and training in PKR could lead to increased experience and better patient selection among surgeons and consequently a higher usage of medial PKR.

The excellent outcomes of fixed-bearing medial UKA are not compromised by patello-femoral arthritis, ACL deficiency or patient age – an EKS-supported study

Nick London, Damian Bull, Ashim Mannan, Juned Ansari, Katy Mason, Emily London, David Duffy

Background:

Severe patello-femoral osteoarthritis (PFJOA), ACL deficiency and extremes of age have traditionally been seen as relative contra-indications to Partial Knee Arthroplasty. This study (part-supported by The European Knee Society) assessed clinical outcomes from a consecutive series of fixed-bearing medial PKA with broad selection criteria.

Methods:

We prospectively studied 240 consecutive, fixed-bearing PKA cases (Persona Partial Knee, Zimmer Biomet) with pre-operative, one and two-year assessment of clinical/functional outcomes.

Results:

Mean age at time of surgery was 65.8yrs (range 41-89), mean BMI 29.2 (range 20-47).
Grade III/IV osteoarthritis of the medial, central and lateral PFJ was observed in 100, 87 and 28 cases respectively. No statistically significant difference was demonstrated in post-operative OKS, EQ-5D, KOOS PS, UCLA & FJS between cases demonstrating no significant PFJOA vs those with grade III/IV PFJOA.
ACL deficiency was recorded in 22 knees (9%) with no significant difference in mean age (65.9yrs) nor BMI (29.9) compared to ACL-intact knees. Outcome scores for the ACL-deficient knees were higher at two years compared with ACL-intact. OKS 46.7 vs 44.5, KOOS 92.3 vs 83.1 ($p<0.04$), UCLA 7 vs 6, FJS 91.1 vs 79.3 ($p<0.04$).
Satisfaction rates and mean outcome scores were consistent across all age groups. Young patients (<50yrs) demonstrated a significantly larger improvement in their OKS (mean 20.5 pre-op to 44.8 at 2yrs, $p<0.05$). Patients aged 80 or over reported the highest FJS-12 (88.1), significantly greater than all other age groups ($p<0.02$). Patients in their 70s and 80s achieved only slightly lower UCLA activity (6.0 vs 6.8) than the youngest group.

Conclusions:

This study supports the use of isolated fixed-bearing PKA in patients with severe PFJOA, functionally stable ACL deficient knees and both younger and older patients. Such patients should be included in the selection criteria although severe lateral PFJOA remains a relative contraindication.

The "deep-MCL line": A simple and reliable anatomical landmark to optimize the tibial cut in UKA.

Sebastien Parratte[1,2], Jeremy Daxelet[2], Jean-Noel Argenson[2], Cecile Batailler[4]
[1]International Knee and Joint Centre, Abu Dhabi United Arab Emirates; [2]Institute for Locomotion, Aix-Marseille University, Marseille; [3]Dept. of Orthopaedic Surgery, Croix-Rousse Hospital, Lyon, France

Introduction:
Most of unicompartimental knee arthroplasty (UKA) systems used the tibial cut as a platform to determine the femoral cut and the optimal implant positioning in UKA. Using conventional or computer-assisted technologies, an acurate tibial cut remains a crucial step in UKA. Therefore, the aims of this study were: 1) to describe the surgical technique of the tibial cut in UKA using the tibial insertion of the fibers of the deep medial collateral ligament (MCL)) as a landmark for frontal and sagittal orientation and the thickness of resection; and 2) to assess the accuracy of the tibial cut with this surgical technique as measured on post-operative radiographs (MPTA, tibial slope, joint line height, HKA angle).

Materials and Methods:
After obtaining ethics review board approval, a consecutive series of patients who underwent a primary cemented morphometric fixed-bearing medial UKA by a single senior surgeon between 2019 and 2021 at a single institution were retrospectively reviewed. The indication for surgery was medial femorotibial osteoarthritis or femoral osteonecrosis. 50 met the criteria. The mean age at the time of surgery was 54.5 ±6.6 years [44-79]. Mean BMI was 32.7 ±3.7 kg/m2 [27-44]. 40% (n=20) were male patients, 48% (n=24) were operated on the left knee. The landmark used the line of insertion of the fibers of the deep-MCL around the anterior half of the medial tibial plateau called the "Deep MCL insertion line" to determine the orientation (in the coronal and sagittal planes) and the thickness of the tibial cut. The radiographic assessment was performed preoperatively and at 2 months using standardized radiographic measurements: HKA angle, mechanical Medial Distal Femoral Angle (mMDFA), Medial Proximal Tibial Angle (MPTA), tibial slope, the joint line height, the Cartier angle, the coronal axis and the thickness of the tibial cut. Restitution of joint line height was assessed using the two methods of Weber. The tibial resection was measured with the technique described by Negrin. Statistical analysis was performed using the XL STAT software (Version 2021.2.1, Addinsoft Inc., Paris, France).

Results:
The radiographic measurements showed very good to excellent intra-observer and inter-observer agreements (Table 1). The limb and implants alignments and the tibial positioning are reported in Table 2. The tibial insert was 8mm for 50% of the patients (n=25), 9mm for 48% (n=24) and 10mm for 2% (n=1).

Conclusion:
The use of the "Deep MCL insertion line" as specific anatomical landmark for the tibial cut during medial UKA can be considered as a simple and reliable landmark to help surgeons to optimize the accuracy and reproducibility of the frontal, sagittal position and the thickness of the tibial cut.

Table 1: Preoperative and postoperative radiographic measurements and outliers.

	Preoperative data N=50	Postoperative data N=50
HKA (°) **(mean ±SD) [Min; Max]**	173.5 ±3.6 [164.6 ;180]	176.5 ±3.1 [170 ;182]
mMDFA (°) **(mean ±SD) [Min; Max]**	91.2 ±2.2 [87 ;96]	92.2 ±2.3 [88 ;96]
MPTA (°) **(mean ±SD) [Min; Max]**	86.4 ±1.5 [83 ;89]	86.8 ±1.5 [84 ;90]
OUTLIERS MPTA< 85°	6 (12%)	1 (2%)
Slope (°) **(mean ±SD) [Min; Max]**	80.9 ±3.2 [74 ;87]	82.6 ±2.3 [78 ;87]
OUTLIERS Slope< 78°	7 (14%)	0
Cartier angle (°) **(mean ±SD) [Min; Max]**	2.6 ±2.8 [-3 ;7]	-
Joint line height (femoral cortex) (mm) **(mean ±SD) [Min; Max]**	-	0.9 ±1.1 [-1.7 ;4.5]
Joint line height (femoral diaphysis) (mm) **(mean ±SD) [Min; Max]**	-	0.8 ±1.1 [-1.7 ;4.5]
OUTLIERS Joint line height > 2mm	-	3 (6%)
Tibial resection height (mm) **(mean ±SD) [Min; Max]**	-	6.0 ±1.7 [1 ;9.5]
Tibial cut axis (°) **(mean ±SD) [Min; Max]**	-	87.7 ±1.6 [84 ;92]
OUTLIERS Tibial cut axis <85°	-	1 (2%)
OUTLIERS Tibial cut axis >90°	-	2 (4%)
Difference tibial cut and Cartier angle (°) **(mean in absolute value ±SD) [Min; Max]**	-	0.57 ±1.1 [-5 ;4]

HKA: Hip Knee Ankle angle; mMDFA: mechanical Medial Distal Femoral Angle; MPTA: Medial Proximal Tibial Angle; JLCA: Joint Line Convergence Angle; JLO: Joint Line Orientation; SD: Standard Deviation

10-year survival of cementless Oxford medial UKA using microplasty instrumentation *- a report of 1000 cases with 5-year minimum follow-up using modern indications for surgery*

Prof. Andrew Price, Mr. Will Jackson, Mr. Abtin Alvand, Mr. Nick Bottomley
Orthopaedic Centre, University of Oxford, UK

Background:
The recommended approach for using the Oxford knee is to treat patients with antero-medial OA in patients who meet modern indications for unicompartmental knee replacement. Implantation should employ 'Microplasty' instrumentation and cementless implants. We began routine use of this approach in 2012, Any revision surgery of these cases is independently recorded by the UK National Joint Registry. This is our first detailed report of the 10-year results with minimum 4-year follow-up in all cases.

Methods:
We used the UK National Joint Registry to review the status of first 1000 cases performed by 4 surgeons in Oxford. All cases presented with anteromedial OA, with a functioning anterior cruciate ligament and intact lateral compartment. Patello-femoral degenerative change was only used as a contra-indication if there was exposed bone on the lateral patellar facet. All patients had a minimum follow-up of 4 years (range of 4-10 years). There was no loss to follow-up and the status of each knee was established. Revision was defined as removal of at least one component and the 10-year implant survival was calculated using life-table analysis. In each case of revision, we established the indication for surgery and mechanism of failure.

Results:
During the study period 55% of all primary knee replacements performed as Oxford partial knee replacements. Of the 1000 cases 54% were male and 46% female, with an average age of 67.7 years. The average bearing size used was 4. There were 17 revisions with the following indications: 11 for progression of arthritis, 4 infection, 1 dislocation, and 1 for aseptic loosening. The mean time to failure in patients with lateral progression was 4.2 years. The calculated 10-year survival of the cohort was 98%, with 44 at risk in the 10th year. One patient presented with a periprosthetic fracture at 3 weeks post-operation that was successfully treated with buttress plate fixation.

Discussion:
This is the first detailed series recording the long-term outcome of the cementless medial Oxford knee implanted with the Microplasty technique. There was a low rate of failure in the cohort, with data collection validated through the UK NJR. The cementless fixation was reliable with only one revision due to aseptic loosening. Lateral progression the commonest cause of revision with an incidence of 1%. The study provides evidence that using the combination of evidence-based indications, well-designed precise instrumentation together with cementless fixation can provide excellent long-term survival for the Oxford knee used to treat anteromedial OA.

Effect of design parameters in FB & MB UKA biomechanics

Thomas Luyckx[1], Edoardo Bori[2], Sara Fiore[2], Virginia Altamore[2], Bernardo Innocenti[2]
[1]Dept. of Orthopedic Surgery, AZ Delta, Roeselare; [2]BEAMS Dept. (Bio Electro and Mechanical Systems), École Polytechnique de Bruxelles, Université Libre de Bruxelles, Bruxelles, Belgium.

Background:

Unicompartmental Knee Arthroplasty (UKA) is a valid and less invasive alternative to Total Knee Arthroplasty for well-selected patients presenting single-compartment knee degeneration.

Nowadays both Fixed and Mobile Bearing (FB&MB) UKAs are available on the market, and both designs demonstrated good clinical outcomes.

To evaluate the effect of different design parameters on UKA biomechanics, a sensitivity analysis was performed to evaluate if and how a variation in such factors might influence knee biomechanics.

Methods:

For both MB&FB UKA, five design parameters were considered: poly thickness, tibial component material, friction coefficient, antero-posterior slope, tibial bone cut thickness.

Two control models were defined based on the conventional features for MB&FB implants.

A total of 216 configurations were analyzed, considering different parameters combinations, both at 0° and 90° of flexion with a Finite Element Analysis based on previously validated models.

The results of the analysis were evaluated in terms of change of Von Mises stress in the polyethylene and in the tibial bone (considering four different regions of interest) and medial tibio-femoral contact area.

Results:

Among the analysed parameters, bearing thickness, tibial bone cut, and slope angle are the most sensible parameters for both implants.

The influence of these parameters are more relevant in the insert for FB UKA and in the bone for MB UKA.

Conclusions:

Any change in the design parameters induced a variation in terms of poly and bone stress in comparison with the control configuration. In details, FB designs led to lower bone stress variations, while MB design did similarly for the bearing.

Superior survival of fully cemented fixation compared to hybrid fixation in a single design rotating hinge knee implant

Gijs van Hellemondt[1], S.N. van Laarhoven[1], A.H.J. van Eerden[1], B.W Schreurs[2], A.B. Wymenga[1], P.J.C. Heesterbeek[1]
[1]Sint Maartenskliniek, Nijmegen; [2]Radboud University Medical Center, Nijmegen, The Netherlands

Background:
Clinical observations revealed higher rates of aseptic loosening for hybrid fixated rotating hinge knee implants compared to fully cemented ones. We hypothesize that the use of a fully cemented fixation technique had a higher survival rate for aseptic loosening compared to a hybrid fixation technique in a rotating hinge knee implant.

Methods:
All procedures of patients who were treated with the RT-PLUS® rotating hinge knee implant (Smith & Nephew, Memphis, USA) between 2010 and 2018 were included. Primary outcome was revision for aseptic loosening. Kaplan-Meier survivorship and Cox proportional hazard regression analysis were performed to calculate survival rates and hazard ratios.

Results:
A total of 275 hinge knee implants were placed in 269 patients (60 primary procedures, 215 revisions). Median follow-up was 7.3 ± 3.9 years. In total, 24 components (16 hybrid femur, 2 fully cemented femur, 6 hybrid tibia; all revision procedures) in 19 patients were revised for aseptic loosening. Kaplan-Meier survivorship analysis showed superior survival rates of fully cemented components (femur 97.1%; tibia 100%) compared to hybrid fixated components (femur 89.5%; tibia 95.9%) at the 10-year follow-up (Fig.1). Multivariate Cox hazard analysis showed a significantly higher risk of aseptic loosening for hybrid fixated components, a prior stemmed component and the femoral component.

Conclusion:
Fully cemented fixation showed superior survival rates for aseptic loosening compared to hybrid fixation in a single design rotating hinge knee implant. A prior stemmed component appears to be a risk factor for aseptic loosening and the femoral component seems to be more prone to loosening.

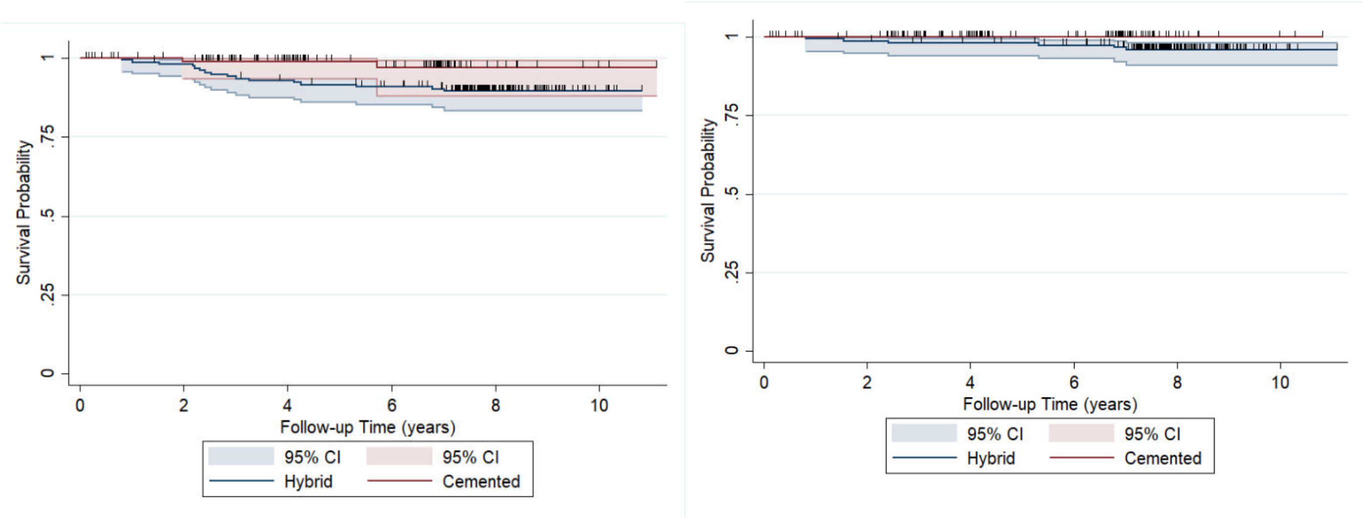


Figure 1: Kaplan-Meier survivorship curves for aseptic loosening of the femoral component (left) and tibial component (right)

Avoiding early femoral insufficiency fractures after primary total knee arthroplasty
Friedrich Boettner, T. David Tarity, William Xiang, Ioannis Gkiata, Paul Guirguis, Elizabeth B. Gausden, Brian P. Chalmers, Alberto V. Carli, Peter K. Sculco
Stavros Niarchos Complex Joint Reconstruction Center, Hospital for Special Surgery, New York, NY, 100USA

Introduction:
Periprosthetic femur fractures (PFF) following total knee arthroplasty (TKA) are devastating complications associated with functional impairment and considerable morbidity. Although trauma-related PFFs have been well studied, early atraumatic insufficiency periprosthetic fractures (IPFs) are slowly gaining attention. We present an evaluation of the largest IPF series to date, with specific attention towards preoperative patient variables, implant design and fracture characteristics.

Materials and Methods:
A retrospective study of all patients who underwent revision surgery for periprosthetic fracture within 6 months of primary TKA at a tertiary referral institution between 2007-2020 was performed. Patient demographics, preoperative radiographs, implant details, and fracture radiographs were reviewed. Alignment measurements and fracture characteristics were assessed by two independent reviewers.

Results:
Twenty-six early periprosthetic fractures were identified in our database; ten were excluded due to a history of acute trauma. All 16 cases that met criteria involved an implant with an intercondylar notch. The rate of IPF in primary TKA was 0.03%. Mean age was 79 years, mean BMI was 31 kg/m^2, and 94% (15/16) were female. Seven (47%) patients had a confirmed history of osteoporosis.
Mean time from index TKA to IPF was 4 weeks (range, 4 days–13 weeks). Overall, 12 of 16 (73%) had preoperative valgus deformities, and 11 patients (10 valgus, 1 varus) had severe preoperative deformities > 10 degrees. A characteristic radiographic appearance of femoral condylar impaction and collapse was noted in 12 of 16 cases (75%); 11 of these 12 fractures (92%) involved the unloaded compartment based on preoperative varus/valgus deformity.

Conclusion:
Patients who developed IPFs were most commonly elderly, obese females with osteoporosis and severe preoperative valgus deformities. The apparent mechanism of failure was overloading of previously unloaded osteopenic femoral condyle. In high-risk patients, the use of a cruciate-retaining femoral component or a femoral stem for a PS femur may be considered to help avoid this catastrophic complication.

Acknowledgements:
Support and Funding was received from the Stavros Niarchos Complex Joint Reconstruction Center, Hospital for Special Surgery

Appearance and evolution of radiolucent lines in two different primary Total Knee Arthroplasty Designs

Thienpont Emmanuel and Wautier Delphine
Cliniques universitaires Saint Luc, Brussels, Belgium

Background:
Aseptic loosening (AL) is the most common reason for revision. The aim of this study was to describe different types of radiolucent lines (RLL) and signs of aseptic loosening in two different primary knee designs.

Methods:
Persona (N=255, min 5 year FU) and Vanguard (N=774, min 7 year FU) total knee arthroplasty implants were compared retrospectively for the occurrence of RLLs and radiological signs of aseptic loosening. Both implant designs differ by their tibial base plate (size and shape) and keel design. Clinical, surgical and demographic data were compared, as well as the type and rate of RLLs, occurrence of aseptic loosening, pre- and post-operative HKA angles, amount of postoperative HKA correction and the presence of potential risk factors.

Results:
The tibial bone surface coverage of the Persona implant is more important. It presents with a shorter and more squared keel than Vanguard TKA.
The rate of RLLs was similar (21% vs 23%), despite of a significantly lower rate of radiological signs of macro-mobility of the tibial component with Persona vs Vanguard (2% vs 17%). The frequency of RLL was for the isolated RLL (64% vs 43%), combined RLL (25% vs 39%) and evolutive RLL (11% vs 18%) respectively. Survivorship of both designs was overall comparable (99.5% vs 98.8%).
Patients at risk are younger females with big deformities and medical co-morbidities leading to osteoporosis undergoing more important tibial cuts with smaller size trays.

Conclusion:
The asymmetric design of the Persona implant is more anatomic and offers a better coverage of the epiphyseal tibial surface. RLLs, as a sign of implant micro-mobility or bone modifications, are equally present in both designs. However, radiological signs of loosening or macro-mobility were less frequent in Persona, potentially because of better epiphyseal contact surface area and better metaphyseal zone fixation of the keel design.
Epiphyseal fixation might ask for metaphyseal support in patients with risk factors for poor epiphyseal bone quality and with higher constraint conditions.

Session I – Hot debate

Early migration of medial congruent compared to cruciate retaining Total Knee Arthroplasty – results from A randomized controlled trial.

Kristian Mortensen[1]; Lina Holm Ingelsrud[1]; Omar Muharemovic[1,2]; Kirill Gromov[1]; Anders Troelsen[1] (Presenting author)
[1]Clinical Orthopedic Research Hvidovre (CORH), Dept. of Orthopedic Surgery, Copenhagen University Hospital Hvidovre; [2]Dept. of Function and Imaging Diagnostics, Copenhagen University Hospital Hvidovre.

Background:
Medial Congruent (MC) kinematics in Total Knee Arthroplasty (TKA) aims to enhance knee function by mimicking the native knee, possibly altering force translations on the tibia compartment. Our primary aim was to compare early migration of a MC TKA to a well-established Cruciate Retaining (CR) TKA. Additionally, complications and patients' pain and function was compared 2 years post-surgery.

Methods:
In a double-blinded RCT, 60 patients (mean±SD age 69.2±8.2 years, 63% female) were allocated to a Persona Total Knee System with a MC or CR liner. Early tibial migration was measured by Maximal Total Point Motion (MTPM) with Radiostereometric Analysis 2 years post-surgery. Complications were registered. Pain and function was measured with Oxford Knee Score (OKS). Difference in MTPM was analyzed with the Mann-Whitney U-test. OKS was analyzed with an independent t-test and as the proportions achieving the Patient Acceptable Symptom State (PASS) (OKS >=30) and Minimal Important Change (MIC) (OKS improvement >=8).

Results:
Primary outcome was available for 52 patients (MC:27, CR:25). Median Tibia MTPM was **0.601** [IQR 0.391-0.969] mm for MC and **0.481** [IQR 0.316-0.779] mm for CR, **p=0.167.** No complications were registered in the MC group, one patient (CR-group) suffered a deep venous thrombosis and superficial infection. Mean 2-year OKS was **41.90** [95CI 39.86-43.93] for MC and **42.15** [95CI 40.57-43.73] for CR, **p=0.844**. One patient (MC-group) did not achieve the PASS, all CR-patients did. Mean OKS improvement was **18.69** [95CI 15.91–21.47] for MC and **19.22** [95CI 16.28–22.16] for CR, **p=0.788**. OKS improvement was smaller than the MIC for 3 patients with MC while all with CR improved more than the MIC.

Conclusion:
We found no significant difference in MTPM, complications or OKS between patients treated with MC and CR TKA. The MC variant provided similar safe fixation and complication-rate, however no advantage in self-reported function.

Session II – Friday 13 May

An artificial intelligence based on a convolution neural network allows precise analysis of lower limbs alignment

Jean-Noel Argenson, Florent Bernard de Villeneuve, Maxime Fabre-Aubrespy, Xavier Flecher, Sebastien Parratte, Matthieu Ollivier
Institute for Locomotion, Aix-Marseille University, Marseille, France

Background:
The objective of this study was to develop a numerical tool to automate the analysis of deformity from lower limb telemetry and assess its accuracy for preoperative planning of knee osteotomy. Our hypothesis was that artificial intelligence algorithm based on a convolution neural network would be able to determine mechanical and anatomical angles to within one degree.

Methods:
After institutional review board approval, 1175 anonym patient telemetries were selected from a database of more than ten thousand telemetries, with the following inclusion criteria: absence of obvious signs of congenital, degenerative, traumatic lesion or surgical material in the two lower limbs. Two trained surgeons identified on the telemetries eight landmarks for determination of the following four angles: Hip-Knee-Ankle Angle (HKA), Medial Proximal Tibial Angle (MPTA), Lateral Distal Femoral Angle (LDFA) and Joint line congruency Angle (JLCA). Angle difference of more than 1° between the two surgeons led to a new analysis to confirm the adopted measurements.
An algorithm based on a machine learning process from a convolution neural network was trained on our database to detect automatically the landmarks and determine the angles. Performance of the model was trained on the last hundred telemetries. The reliability of the algorithm was evaluated by calculating the intraclass correlation coefficient (ICC) of interobserver agreement. Accuracy was evaluated using the mean deviation in degree as well as the time needed to measure the angles.

Results:
The analysis time for obtaining 16 points and 8 angles per image was 48+/-12 seconds.
The ICC of algorithm was 0.97 95% CI (0.92-0.99) for HKA, 0.96 95% CI (0.93-0.98) for MPTA, 0.95 95% CI (0.94-1) for LDFA, 0.97 95% CI (0.93-0.99) for JLCA.
The average difference between the angles measured by the observers and the AI was 0.3° for HKA, 0.5° for MPTA, 0.5° for LDFA and 0.4° for JLCA.

Conclusion:
The algorithm showed high accuracy for automated angle measurement, allowing the estimation of limb frontal alignment to the nearest degree. The next version of this algorithm will include a proposal for corrections of femoral and tibial deformities by osteotomy, and a 3D analysis from CT scan data.

Medial patellofemoral ligament reconstruction is an efficient procedure to treat patellar instability following total knee arthroplasty

Cécile Batailler, Gaspard Fournier, Jobe Shatrov, Elvire Servien, Sébastien Lustig
Orthopaedic Surgery Dept., Croix-Rousse Hospital, Lyon, France

Introduction:
Patellofemoral (PF) instability following total knee arthroplasty (TKA) is a complex problem to treat, with scarce published data. This study aimed to describe outcomes of patients who had undergone medial patellofemoral ligament reconstruction (MPFLr) to treat PF instability following TKA.

Methods:
This monocentric retrospective cohort included all the patients treated by MPFLr for PF instability after TKA between 2015 and 2021, with a minimum 12-months follow-up. The exclusion criteria were implants malpositioning. MPFLr was performed using a quadriceps tendon autograft. The femoral fixation was performed with an interference screw and sometimes an additional suspensory fixation. Twenty-two patients were included. The mean BMI was 31.1kg/m^2±6, the mean age was 68yo±8. 76% were postero-stabilized implants, 24% were hinge implants. The average pre-operative femoral component rotation on CT was 0.1° external rotation [-3°;+3°]. At the last follow-up, the assessment included: Kujala score, international knee score (IKS) score, Caton-Deschamp index (CDI), patellar tilt and shift.

Results:
The mean follow-up was 38 months [12-72]. At the last follow-up, the mean Kujala score was 60.3 ±11, the mean IKS knee score was 77.7 ±13.2, the mean IKS function score was 75.3 ±23.3. There was one mechanical failure, which occurred after MPFLr with interference fixation. There were six complications (28.1%) post-operatively (2 infections, 1 tibial fracture, 1 patellar osteonecrosis, 1 tendinopathy of patellar tendon, 1 implant revision). All patients were improved clinically and radiographically after the surgery. Patients receiving a double femoral fixation had higher clinical and radiographic scores, but not significantly. MPFLr had a patella lowering effect (CDI: 0.97 preoperatively versus 0.74 post-operatively (p=0.069)).

Conclusion:
MPFLr was an efficient option to treat PF instability following TKA in appropriately selected patients. Suspensory fixation in addition to an interference screw showed superior functional outcomes than fixation with an interference screw only.

Clinical and cost-effectiveness of a new care pathway for patients with pain at three months after total knee replacement: The STAR randomised controlled trial

Wylde V., Howells N., Bertram W., Sanderson E., Noble S.M., Peters T.J., Beswick A.D., Blom A.W., Moore A.J., Bruce J., Walsh D.A., Eccleston C., Harris S., Garfield K., White S., **Toms A.D.,** Gooberman-Hill R.

Background:
Approximately 20% of people experience chronic pain after total knee replacement (TKR), but effective treatments are lacking. We evaluated a new intervention to optimise the treatment of chronic pain after TKR.

Methods:
We undertook a pragmatic, open-label, randomised trial in eight NHS hospitals in England and Wales. People with troublesome pain in their replaced knee at three months post-TKR were randomly assigned (2:1) to the Support and Treatment after Replacement (STAR) care pathway plus usual care, or usual care alone. The STAR intervention comprised an assessment appointment at three months post-operatively with an Extended Scope Practitioner, with subsequent telephone follow-up. The assessment aimed to identify underlying causes for chronic pain and enable onward referral for treatment. The co-primary outcomes were the Brief Pain Inventory (BPI) pain severity and interference scales at 12 months after randomisation (15 months post-operative), analysed on an 'as randomised' basis. Embedded qualitative interviews explored trial processes and intervention acceptability. The trial was registered on ISRCTN:92545361.

Findings:
Between 2016 and 2019, 363 participants were randomly assigned to the intervention plus usual care (n=242) or usual care alone (n=121). At 12 months, the difference in means between groups was -0·65 (95% CI -1·17, -0·13; p=0·014) for pain severity and -0·68 (95% CI -1·29, -0·08; p=0·026) for pain interference, both favouring better outcomes in the intervention arm. The intervention over a 12-month horizon from an NHS and PSS perspective was the cost-effective option, incremental net monetary benefit at £20,000 per quality adjusted life year NICE threshold, £1234 (95% CI £162, £2305). Only one adverse reaction of participant distress in the intervention group was reported. Qualitative findings showed that patients found the STAR pathway acceptable.

Conclusion:
STAR is a clinically and cost-effective intervention to improve pain outcomes over one year for patients with troublesome pain three months after TKR**.**

Does objective ligament laxity affect the clinical outcome of TKA?

S.Campi, V. Candela, A. Gambineri, U.G. Longo and R. Papalia
Università Campus Bio-Medico di Roma

Background:
Instability is one of the main causes of failure in total knee arthroplasty (TKA). However, the difference between “physiological” and “pathological” ligament laxity after TKA remains unclear.
We present the preliminary results of a study correlating the coronal laxity and clinical outcome after TKA.

Methods:
Fifty-one knees in 47 patients were evaluated at a minimum follow-up of 6 months. The coronal laxity was measured by a single operator with a goniometer after varus and valgus stress were applied with a standardized moment of 10 Kg at 0, 30, 60 and 90° of flexion. In addition, the antero-posterior laxity was assessed clinically at 90° of flexion. The correlation between the angular displacement and functional scores (Knee Society Score and Knee Injury and Osteoarthritis Score) was analyzed.

Results:
A negative correlation (p-value <0.05) was observed between medial laxity ≥5° at 30, 60 and 90° of flexion and the outcome measures. Lateral laxity did not correlate with the clinical outcome. At 30° of knee flexion, a total varus and valgus laxity ≥10° was related to poorer outcomes. The same amount of angular displacement did not influence the outcome in the other flexion angles.

Conclusion:
A valgus displacement ≥5° measured at 30, 60 and 90° of flexion correlated with inferior KSS and KOOS. In contrast, the same amount of displacement measured on the lateral compartment did not influence the clinical outcome after TKA.

The effects of adding Tibia Varus are more predictive than soft tissue releases to obtain inter-compartmental balance in a varus deformed knee

Introduction:

Improper soft-tissue balancing has been shown to lead to failures of primary total knee arthroplasty (TKA). Patients with excessive varus deformities can undergo soft tissue releases (STR) or bony resections of the medial proximal tibia (MPT) to achieve a balanced knee; however studies investigating these two modalities are limited. Therefore, the purpose of this study was to compare resection of MPT and STR in patients with a varus deformity. Specifically, we analyzed: 1) changes in compartmental pressures; relative to Tibial alignment and 2) changes in patient-reported outcome measurements (PROMs) between the two modalities.

Methods:

A retrospective query of our institution's knee registry was performed. The inclusion criteria consisted of all patients undergoing primary sensor-assisted TKA and requiring either STR or MPT resections with recorded intraoperative compartmental pressures, complete surgical data, completed pre-operative PROMs, and PROMs at the final office visit with a minimum 2-year follow-up. Patients undergoing robotic procedures, revisions, or having additional soft tissue releases besides STR or MPT resections were excluded. MPT resection was defined as patients having 1.5-2 mm of varus resected on the MPT; whereas STR was defined as having pie-crusting or releases of the medial collateral ligament. The query yielded 207 patients, with a mean follow-up of 3.57 years, who met the inclusion criteria requiring STR (n = 106) or MPT (n = 99) resection during their procedure. Outcomes analyzed included changes in compartmental pressures from initial readings to post-cementing at 10° extension, 45° mid-flexion, and 90° flexion, and changes in Short-Form 12 Physical Component Score (SF-12 PCS) and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scores. Changes in compartmental pressures were attained using the Orthosensor Verasense (Orthosensor, Dania Beach, FL) device. Categorial variables were assessed using Pearson's chi-square analyses; whereas continuous variables were compared using Welch's *t*-tests. A *p*-value less than 0.05 was considered statistically significant.

Results:

MPT resections demonstrated significantly greater reduction in pressures within the medial compartment through the entire range of motion, while engaging lateral compartment pressures. [10° extension (68.38lbs. to 25.08lbs. *vs.* 49.19lbs to 21.93lbs; $p<0.0001$), 45° mid-flexion (67.37lbs. to 23.67lbs. *vs.* 42.01lbs. to 27.48lbs.; $p<0.0001$), and 90° flexion (46.83lbs. to 19.21lbs. *vs.* 39.03lbs. to 24.17lbs.; $p<0.0001$)] compared to STR. MPT resection patients had significantly higher SF-12 PCS scores (69.31 *vs.* 64.33, $p<0.0001$) and lower total WOMAC (1.13 *vs.* 2.67, $p<0.0001$) scores at final follow-up.

Conclusion:

The study is the first to quantitatively use sensor data to compare two modalities to achieve a balanced knee through the entire range of motion. MPT demonstrated consistent achievement of balanced intercompartmental load distribution compared to STR for varus deformity. Additionally, the study demonstrated MPT resections to have a greater impact in reducing high medial compartmental pressures compared to STR. Furthermore, MPT resections led to lower total intraoperative time, and greater improvement in PROMs.

Degrees	Mean Medial Compartment Initial Pressures (lbs.)	Mean Medial Compartment Post-Cementing Pressures (lbs.)	Change in Pressure (lbs.)	*p*-value
10° Extension	68.38 ± 32.84	25.08 ± 9.80	43.26	<0.0001
45° Mid-Flexion	67.37 ± 29.44	23.67 ± 11.43	43.97	<0.0001
90° Flexion	46.83 ± 27.02	19.21 ± 10.37	27.61	<0.0001

Table 1. Changes in Medial Pressure Compartments After Adding 1.5° of Varus to the Proximal Tibia in Patients (n = 98) Undergoing Primary Total Knee Arthroplasty. lbs. = Pounds

Degrees	Mean Lateral Compartment Initial Pressures (lbs.)	Mean Lateral Compartment Post-Cementing Pressures (lbs.)	Change in Pressure (lbs.)	*p*-value
10° Extension	18.06 ± 18.31	17.26 ± 9.79	0.79	0.708
45° Mid-Flexion	13.54 ± 14.20	16.44 ± 9.28	2.90	0.074
90° Flexion	10.44 ± 9.24	13.28 ± 8.87	2.83	0.033

Table 2. Changes in Lateral Pressure Compartments After Adding 1.5° of Varus to the Proximal Tibia in Patients (n = 72; SOME) Undergoing Primary Total Knee Arthroplasty. lbs. = Pounds

Degrees	Mean Lateral Compartmental Initial Pressures (lbs.)	Mean Lateral Compartment Post-Cementing Pressures (lbs.)	Change in Pressure (lbs.)	*p*-value
10° Extension	0	16.38 ± 8.68	16.37	<0.0001
45° Mid-Flexion	0	13.68 ± 8.05	13.36	<0.0001
90° Flexion	0	8.69 ± 4.97	8.69	<0.0001

Table 3. Changes in Lateral Pressure Compartments After Adding 1.5° of Varus to the Proximal Tibia in Patients (n = 26; ZERO) Undergoing Primary Total Knee Arthroplasty. lbs. = Pounds

Degrees	Mean Lateral Compartment Initial Pressures (lbs.)	Mean Lateral Compartment Post-Cementing Pressures (lbs.)	Change in Pressure (lbs.)	*p*-value
10° Extension	13.53 ± 17.57	16.99 ± 9.36	3.38	0.061
45° Mid-Flexion	10.05 ± 13.59	15.57 ± 8.98	5.52	0.0003
90° Flexion	7.85 ± 9.06	11.94 ± 8.27	4.09	<0.0001

Table 4. Changes in Lateral Pressure Compartments After Adding 1.5° of Varus to the Proximal Tibia in Patients (n = 98) Undergoing Primary Total Knee Arthroplasty. lbs. = Pounds

Long term survival of Trabecular Metal Cones (TMC) for TKA revisions with severe bony defects

Eder-Halbedl M., Pietsch M., Djahani O., Hofmann S.
Orthopedic Hospital Murtat-Stolzalpe, Austria

Background:
During revision TKA with severe bony defects cones and sleeves are commonly used but long-term data are rare. Aim of this study is to present the 9 years survival analysis after implantation of TMC during revision TKA in a tertiary referral centre.

Methods:
80 consecutive patients (44 female, 36 male, average age 65,3 years) who underwent revision TKA surgery with 113 TMC (TMT©, Zimmer, USA) for tibia and/or femur were included in this retrospective study. The reasons for revision surgery were 64 (80 %) aseptic and 16 (20 %) septic failures. At the time of revision all knees showed large bony defects AORI Type 2a (18%), 2b (36%) and 3 (46%). Except of 2 all revision implants were fixed with cementless stems in hybrid technique. Peri- and post OP complications, Reoperations and Re-revisions as well as pre- and post OP clinical outcome (ROM, KSS, VAS, WOMAC) were documented. Any loosening or osteolysis of the TMC or revision implants were evaluated according to a modified Knee Society Radiographic Evaluation System.

Results:
After an average FU of 6.1 years (5-9) all implanted TMC (n=113) showed no radiographic signs of loosening or osteolysis and were clinical stable. There were 3 (4%) periop complications with wound healing problems and 11 (14%) post-operative complications including deep infections (n=3), periprosthetic fracture (n=2), aseptic loosening of components without TMC (n=2), instability (n=2) und one hinge dislocation (n=1). There were 5 reoperations (2 inlay change, 2 DAIR and 1 patella) and 8 re-revisions including one arthrodesis and 1 amputation. In 4 cases the well osteointegrated TMC had to be removed. The estimated 9-year Kaplan Meier survival rate for aseptic loosening was 95 %. All clinical parameters showed significant ($p < 0,001$) improvement from pre- to post OP.

Conclusions:
In this study TMC showed an excellent metaphyseal fixation combined with hybrid stems for severe bony defects during revision TKA. The stable fixation could also be confirmed after an average of 6 years FU with a 9 year survival rate of 95 % for aseptic loosening.

Session II – Robotic Session

The accuracy of kinematic alignment cuts using a low cost link-jig, an emerging technique

A. Memarzadeh[1], J Dixon[2], A Charalambous[3], A Alvand[4,5], A Price[4,5], W. Jackson[5]
[1]Post-CCT Knee Fellow, Nuffield Orthopaedic Centre, Oxford; [2]ST in Trauma and Orthopaedics, Oxford; [3]Post-CCT Knee Fellow, Oxford; [4]Professor of Orthopaedics, Oxford University; [5]Consultant Knee Surgeon, Nuffield Orthopaedic Centre.

Introduction:
Kinematic alignment (KA) confers a more ‘personalised approach’ to knee arthroplasty. The surgical technique is demanding and lack of reliable manual instrumentation is a barrier to the mass uptake of this technique. Robotic platforms are available and have been advocated for this technique, but add significant costs to the procedure. We present the results of unrestricted KA using a manual instrumented technique. The femur is ‘resurfaced’ using measured resection with the tibial cut made using a jig referenced from the femoral trial with the soft tissues appropriately tensioned.

Materials and Methods:
We performed a retrospective review of 55 consecutive patients following unrestricted KA arthroplasty. The mean age was 71 years (46-88). Primary outcome was the tibial re-cut rate, secondary outcome was restoration of alignment parameters compared to the contralateral knee (mLDFA, MPTA, HKA).

Results:
The total tibial re-cut rate was 20%, although only 5.4% were to change alignment in the coronal or sagittal planes. The remaining re-cuts were for an additional 2mm in the same plane.
The difference in mLDFA between the operated and contralateral knee was 0.7 degrees (SD 2.7). The MPTA difference was 0.1 degrees (SD 3.9).
The median post op HKA was 1.3 degrees varus (SD 2.3) with 14% of patients lying outside the traditional “safe zone”.

Conclusion:
The results show minimal tibial re-cuts for alignment change using the link-jig and confirms the soft tissue envelope can be utilised to make an optimum tibial cut. The planned 10mm space using this jig may not produce enough physiological laxity in the soft tissue envelope, and 1 in 5 cases required a deeper tibial cut.
KA can be reliably achieved using the link-jig device without the need for expensive technologies.

Malleoli and distal tibio-fibula joint landmarks provide reliable measures for intraoperative tibial coronal alignment

Andrew Porteous, N Blucher, J Fletcher[1] N Platt
Avon Orthopaedic Centre, North Bristol NHS Trust, Bristol, UK.

Introduction:
Controversy exists regarding the optimal tibial coronal alignment in TKA. Many believe navigation or robotics are required to set kinematic alignments or to ensure they remain within "safe" limits e.g maximum 5 degrees varus on the tibia.

Aim:
To radiographically analyse standardly used intra-operative landmarks around the ankle, to assess their value in the achieving kinematic alignment or setting safety boundaries.

Materials and Methods:
167 long leg alignment radiographs from 119 patients were analyses independently by two orthopaedic surgeons at two time points, eight weeks apart. Angles were measured between the long axis of the tibia (TB) and: 1) the lateral malleolus (TB-LM), 2) the lateral border of the talus (TB-LT) and 3) the medial aspect of the medial malleolus (TB-MM). Intra- and inter-rater reliability was assessed.

Results:
Mean age of patients was 71.6 years. The mean angles (95% CI) were: TB-LM 4.8° (4.7°-4.8°), TB-LT 2.6° (2.5° - 2.6°) and TB-MM 4.2° (4.1° - 4.2°). The 95% CI's for all landmarks were extremely tight, showing great consistency of theses angles despite the cohort size. Interrater reliability was good for TB-LM (ICC = 0.72) and TB-MM (ICC=0.67), and fair for TB-LT (ICC= 0.50). Intra-rater reliability was excellent for all measures (ICC >0.85).

Conclusion:
There are consistent angles between tibial alignment and ankle landmarks. Most navigation or robotic systems require the surgeon to identify the ankle malleoli. Using these landmarks with standard instrumentation and alignment checks would allow a surgeon to define safe limits e.g. maximum 4.8° tibial varus if aligned to the tip of the lateral malleolus or set a 2.5°varus cut without the need for added technology.

Alignment deviation between planned/performed bone resections and implant positioning in robotic-assisted TKA

Fabio Catani, F. Zambianchi, N. Matveitchouk.
University of Modena and Reggio-Emilia, Modena, Italy

Introduction:

CT-based robotic system for total knee arthroplasty (TKA) has showed improved accuracy compared with conventional. This study was designed to: (1) confirm the accuracy of the robotic system in achieving the preoperative planning; (2)establish the deviation of the final components from the planned alignment and positioning, by measuring the discrepancy between final implant alignment and the corresponding planned cut.

Methods:

Ninety-six robotic-arm assisted cementless TKA were prospectively assessed. Bone resections were performed according to intraoperative planning, using the haptically-controlled robotic-arm. Alignment in the coronal and sagittal plane and resection depth of the distal femoral and proximal tibial cuts were recorded with a navigation planar probe. After final components were impacted, the probe was positioned on each implant surface to determine its alignment and positioning.

Results:

The mean Δ between tibial planned/performed resections and planned/implanted component's positioning was on average 0.4mm (SD 0.6) and 0.9mm(SD 0.8) proud, respectively ($p<0.01$). The tibial cut showed significantly less flexion than planned ($p<0.05$), with 19.8% of ±1° outliers. In 41.7% of cases, the tibial component was impacted prouder of 1mm than planned. Relative to the femur, the mean Δ between planned/performed resections and planned/implanted component's positioning was on average 0.1mm (SD 0.8) and 0.2mm(SD 0.7), respectively, with the latter being significantly different from zero ($p<0.05$). In 24.0% of cases the femoral sagittal cut and femoral component alignment deviated more than ±1° from planned alignment.

Conclusions:

Overall, CT-based robotic system showed good accuracy in achieving the preoperative plan. Tibial and femoral bone resections in the sagittal plane are the less accurate compared to the coronal plane. Considerable deviations from preoperative planning in terms of alignment and positioning can occur in final components impaction even in cementless designs.

A new robotically assisted technique can improve outcomes of Total Knee Arthroplasty comparing to an imageless navigation system

Stefano Marco Paolo Rossi[1], Fabio Mancino[1,2,3], Rudy Sangaletti[1,4], Ludovico Lucenti[1], Flavio Terragnoli[4], Francesco Benazzo[1,4]
[1]Sezione di Chirurgia Protesica ad Indirizzo Robotico, Unità di Traumatologia dello Sport, Fondazione Poliambulanza, Brescia; [2]Unità di Ortopedia e Traumatologia; Dept. di Scienze dell'Invecchiamento, Neurologiche, Ortopediche e della Testa-Collo, Fondazione Policlinico Universitario Agostino Gemelli IRCCS, Roma; [3]Università Cattolica del Sacro Cuore, Roma; [4]U.O.C. Ortopedia e Traumatologia, Fondazione Poliambulanza, Brescia; [5]Università degli Studi di Pavia, Pavia, Italy

Corresponding Author:
Stefano Marco Paolo Rossi, Sezione di Chirurgia Protesica ad Indirizzo Robotico, Unità di Traumatologia dello Sport, Fondazione Poliambulanza, Brescia, Italy

Background:
Robotic assisted total knee arthroplasty (RTKA) has shown improved knee alignment and reduced radiographic outliers. However, there remains debate on functional outcomes and patient-reported outcomes (PROMs). This study compares the 1-year clinical outcomes of a new imageless robotically assisted technique (ROSA Knee System, Zimmer Biomet, Warsaw, IN) with an imageless navigated procedure (NTKA, iAssist Knee, Zimmer, Warsaw, IN).

Methods:
The study is a retrospective analysis of prospectively collected data that compared the functional outcomes and PROMs of 50 imageless RTKA with 47 imageless NTKA at 1-year follow-up. Baseline characteristics, intraoperative and postoperative information were collected including complications, revisions, Knee Society Score (KSS), Knee injury and Osteoarthritis Outcome Score (KOOS) score and Forgotten Joint Score (FJS). Radiographic analysis of preoperative and postoperative images evaluating hip-knee-ankle (HKA) angle was performed.

Results:
There was no difference regarding baseline characteristics between the groups. Mean operative time was significantly longer in the RTKA group (122 min vs. 97 min; $p<0.0001$). Significant differences were reported for the "Pain" (85 [RTKA] vs 79.1 [NTKA]; $p=0.0283$) subsection of the KOOS score. In addition, RTKA was associated with higher maximum range of motion (119.4° vs. 107.1°; $p<0.0001$) and better mean improvement of the arc of motion by 11.67° (23.02° vs. 11.36°; $p<0.0001$). No significant differences were noted for other subsections of KOOS, KSS, FJS, complications, or limb alignment at 1-year follow-up.

Conclusions:
Imageless RTKA was associated with longer surgical time, better pain perception and improved ROM at 12-months follow-up compared with NTKA. No significant differences were reported on other PROMs, complication rates and radiographic outcomes.

Level of evidence III

Keywords Total knee arthroplasty; Robotic-assisted total knee arthroplasty; Imageless robotic TKA; Imageless Navigation, Complications; Patient-reported outcomes

Functional Gait after inverse kinematic aligned Total Knee Arthroplasty resembles healthy controls: a comparative, blinded, Gait analysis of 45 subjects at 2 Years postop

Philip Winnock de Grave[1,2], Tamaya Van Criekinge[1], Thomas Luyckx[2,3], Kurt Claeys[1]
[1]KU Leuven, Dept. Rehabilitation Sciences, Brugge; [2]AZ Delta, Dept. Orthopaedic Surgery, Roeselare; [3]UZ Leuven, Dept. Orthopaedic Surgery, Leuven, Belgium

Background:
Reports on patient specific alignment in total knee arthroplasty (TKA) show prosperous patient reported outcome measures (PROMs), however, the clinical effect of restoring native joint line obliquity (JLO) and native knee anatomy is still debated. The purpose of this study was to compare the gait of a mechanical aligned TKA cohort (adjusted mechanical alignment; aMA) with a patient specific alignment TKA cohort (inverse kinematic alignment; iKA).

Methods:
At 2 years postoperative, 15 aMA and 15 iKA patients were analyzed. All patients were operated with robotically assistance (Mako) using an identical perioperative protocol. Patients' demographics were identical. **(Table 1)** As a control group, 15 healthy subjects were used, matched for age and sex. **(Figure 1)** Gait analysis was done using a 3D motion capture system (VICON)**.** Data collection was done by a blinded investigator. Primary outcomes were sagittal knee kinematics, knee adduction moment and spatiotemporal parameters (STPs). Secondary outcomes were Oxford Knee Score (OKS-12) and Forgotten Joint Score (FJS-12).

Results:
Concerning sagittal knee kinematics during gait, no significant differences were observed regarding functional knee flexion between iKA and healthy controls, while aMA differs significantly with iKA and healthy controls ($p<0.001$; aMA 41,8°; iKA: 50,4°; controls 52,0°). **(Table 2 + Figure 2)** Knee adduction moments during stance with iKA are lower (225 Nmm/kg) compared to aMA (276 Nmm/kg) and healthy controls (280Nmm/kg), though none were significant. **(Figure 3)** Regarding STPs, no significant differences are seen between iKA and healthy controls. Six out of 7 STPs differ significantly between aMA and healthy controls. OKS-12 of iKA is significantly better compared to aMA: 45.4 vs. 40.9; $p=0.05$. FJS-12 is significantly better with iKA compared to aMA: 84.8 vs. 55.5; $p= 0.002$. **(Table 2)**

Conclusion:
At 2 years postoperative, functional knee flexion and quality of the gait is better with iKA, compared to aMA. The restoration of joint line obliquity and native anatomy enhances clinical and patient reported outcomes.

TABLE 1: DEMOGRAPHICS

	iKA (n=15)			aMA (n=15)			CONTROL (n=15)			P-value		
	mean (n/%)	±SD	min-max	mean (n/%)	±SD	min-max	mean (n)	±SD	min-max	iKA vs. aMA	iKA vs. CONTROL	aMA vs. CONTROL
age (year)	72	±5,4	(60-79)	65	±8,1	(51-83)	68	±7,9	(60-79)	**0,03**	0,38	0,40
sex (m/f)	10/5			9/6			8/7			0,75		
length (m)	1,69	±0,1	(1,45-1,81)	1,68	±0,1	(1,54-1,84)	1,68	±0,1	(1,57-1,87)	0,92	0,89	0,99
weight (kg)	88,3	±14,8	(63-117)	92,9	±10,0	(70-106)	76,7	±9,2	(65-98)	0,53	**0,02**	**0,001**
BMI (kg/m2)	30,8	±4,3	(24,6-39,1)	33,1	±5,0	(25,3-43,9)	27,3	±3,0	(22,8-43,9)	0,30	0,07	**0,01**
postop (m)	21,1	±4,8	(14-28)	24,4	±3,2	(16-28)				0,34		
Tinetti POMA (/28)	26,1	±2,3	(21-28)	25,2	±2,9	(18-28)	27,1	±1,1	(24-28)	0,49	0,44	0,06
PCS (/52)	12,1	±8,7	(0-28)	11,1	±12,0	(0-44)	9,9	±5,2	(0-20)	0,96	0,8	0,93
TSK-11 (/44)	21,8	±6,5	(11-33)	25,1	±8,0	(11-43)	23,0	±6,3	(12-36)	0,41	0,90	0,68
preop OKS (/48)	27,6	±5,6	(18-35)	27,4	±5,4	(17-35)				0,93		
Kellgren-Lawrence Classification												
Medial compartment												
<=2	2			4								
3	4			5						0,08		
4	9			6								
Lateral compartment												
<=2	7			8								
3	5			1						0,29		
4	3			6								
Patellofemoral compartment												
<=2	3			1								
3	6			7						0,56		
4	6			7								
HKA preop (°, - varus)	-3,1	±4,5	(-9 - 6)	-2	±4,6	(-9 - 5)				0,50		

TABLE 2: RESULTS

	iKA (n=19)			aMA (n=17)			CONTROL (n=30)			P-value		
	mean	±SD	min-max	mean	±SD	min-max	mean	±SD	min-max	iKA vs. aMA	iKA vs. CONTROL	aMA vs. CONTROL
Spatiotemporal Parameters												
cadence (steps/min)	112,0	±7,5	(98,2 - 127,7)	111,7	±9,6	(95,0 - 129,1)	116,1	±10,7	(95,6-136,2)	0,99	0,43	0,39
walking speed (m/s)	1,09	±0,19	(0,84 - 1,49)	1,03	±0,27	(0,40 - 1,39)	1,26	±0,21	(0,73 - 1,52)	0,70	0,98	**0,02**
stride length (m)	1,17	±0,17	(0,96 - 1,58)	1,10	±0,25	(0,49 - 1,40)	1,30	±0,16	(0,92 - 1,51)	0,54	0,17	**0,02**
step length (m)	0,58	±0,88	(0,47 - 0,78)	0,55	±0,12	(0,25 - 0,70)	0,65	±0,08	(0,46 - 0,75)	0,54	0,19	**0,03**
foot off (%)	61,4	±2,7	(57,6 - 67,1	62,6	±3,6	(59,0 - 72,8)	59,3	±2,3	(56,8 - 64,9)	0,47	0,12	**0,009**
single support (%)	38,5	±1,8	(35,2 - 42,0)	37,6	±2,6	(32,0 - 41,7)	40,1	±2,5	(34,3 - 43,3)	0,49	0,13	**0,12**
double support (%)	22,9	±4,34	(15,7 - 30,6)	25,1	±5,96	(17,2 - 40,7)	19,1	±4,85	(13,5 - 30,6)	0,38	0,10	**0,005**
Kinematics												
pelvis - frontal (ROM)	5,98	±3,6	(1,6 - 13,7)	4,8	±2,0	(1,7 - 9,6)	5,60	±2,7	(1,6 - 11,3)	0,40	0,89	0,60
hip - sagittal (ROM)	40,3	±6,9	(29,0 - 56,5)	38,0	±5,8	(23,3 - 45,8)	44,4	±4,7	(36,1 - 54,3)	0,48	**0,047**	**0,002**
knee - sagittal (ROM)	50,41	±8,08	(37,9 - 64,7)	41,79	±6,12	(33,0 - 52,4)	51,99	±6,16	(42,6 - 63,8)	**0,001**	0,72	**0,00002**
knee - sagittal (min)	2,59	±5,05	(-9,0 - 11,4)	5,76	±5,74	-1,97 - 14,51	3,15	±4,85	(-6 - 10,33)	0,17	0,93	0,23
knee - sagittal (max)	53,0	±7,73	(42,6 - 66,4)	47,4	±7,33	(35,0 - 62,6)	55,1	±6,60	(39,7 - 67,0)	0,06	0,59	**0,002**
ankle - sagittal (ROM)	29,0	±9,6	(18,4 - 56,0)	21,72	±5,9	(7,6 - 30,4)	23,9	±4,6	(15,7 - 36,4)	**0,006**	0,36	0,54
Kinetics												
hip - frontal (max)	411	±99	(262 - 607)	563	±271	(123 - 1177)	532	±381	(208 - 1532)	0,29	0,37	0,94
hip - sagittal (min)	-406	±191	(-858 - -147)	-479	±148	(-852 - -178)	-485	±193	(-801 - -151)	0,47	0,32	0,99
knee - frontal (max)	225	±85	(104 - 341)	276	±168	(67 - 649)	280	±118	(133 - 787)	0,46	0,33	0,99
knee - sagittal stance (max)	123	±123	(-125 - 343)	191	±141	(-61 - 459)	247	±117	(82 - 566)	0,25	**0,005**	0,33
knee - sagittal swing (min)	-413	±144	(-678 - 191	-416	±142	(-641 - -14)	-525	±152	(-789 - -296)	0,99	**0,037**	**0,049**
ankle - sagittal (max)	419	±192	(90 - 751)	573	±335	(160 - 1567)	558	±246	(199 - 1518)	0,20	0,19	0,98
Static Frontal Alignment												
HKA postop (°, - varus)	-1,72	±2,04	(-6 - 2)	0,05	±1,54	(-2,5 - 3)				**0,006**		
HKA postop - preop (difference, °)	-1,33	±2,83	(-5 - 4,6)	-2,05	±3,44	(-7,3 - 3)				0,5		
PROMs												
OKS (/48)	45,4	±3,7	(37 - 48)	40,9	±8,8	(17 - 48)				**0,05**		
FJS (/100)	84,8	±21,8	(18,75 - 100)	55,5	±31,6	(0 - 100)				**0,002**		
VAS Pain (/10)	0,42	±1,3	(0 - 5)	3,29	±3,6	(0 - 10)				**0,003**		

FIGURE 1: STUDY SET-UP

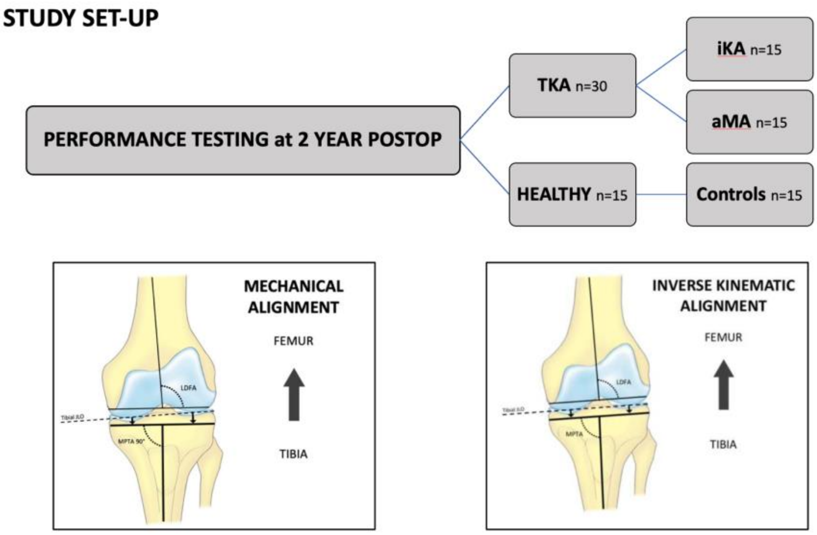


FIGURE 2: FUNCTIONAL KNEE FLEXION

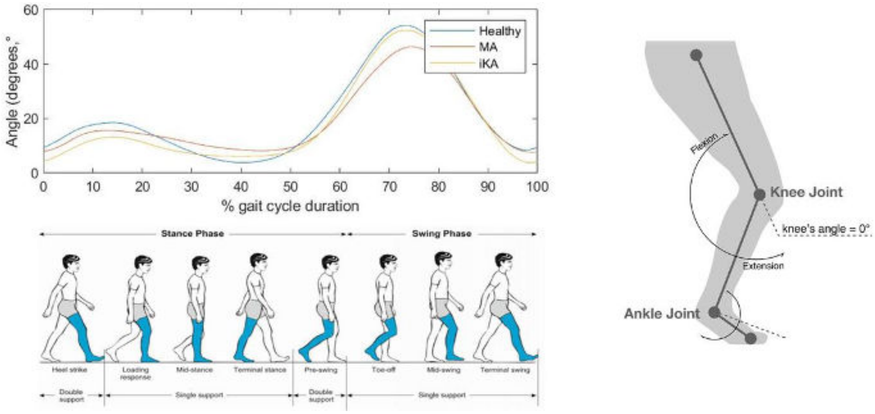
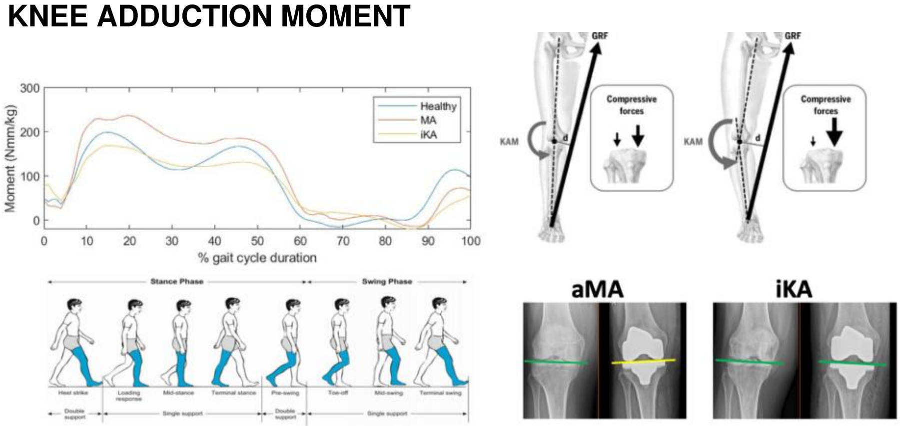


FIGURE 3: KNEE ADDUCTION MOMENT



Remote patient monitoring with wearable sensors following robotic-assisted and conventional knee arthroplasty

F. Zaidi[1], S.M. Bolam[1,2], T.C. Yeung[3], M. Hanlon[2], J.T. Munro[1,2], T.F Besier[3,4], A.P. Monk[2,3]
[1]Dept. of Surgery, Faculty of Medical and Health Sciences, The University of Auckland, Auckland; [2]Dept. of Orthopaedics, Auckland City Hospital, Auckland; [3]Auckland Bioengineering Institute, The University of Auckland, Auckland; [4]Dept. of Engineering Sciences, The University of Auckland, Auckland, New Zealand

Introduction:
Traditional patient-reported outcome measures (PROMs) have failed to highlight differences in outcome when comparing knee replacement designs and implantation techniques. Wearable sensors, such as inertial measurement units (IMUs), provide a cost-effective, portable solution for evaluation of post-operative outcome in combination with traditional PROMs. The aims of this study were [1] to demonstrate the feasibility and reliability of using ankle-worn IMUs for remote patient monitoring (RPM); and [2] to compare IMUs and PROMs outcomes in patients with conventional total knee arthroplasty (TKA), unicompartmental knee arthroplasty (UKA), and robotic-assisted TKA (RA-TKA) in early post-operative period.

Materials and Methods:
44 patients undergoing primary knee arthroplasty (19 RA-TKA, 17 TKA, and 8 UKA) for osteoarthritis were prospectively enrolled. Community-based RPM was performed pre-operatively, then weekly from post-operative weeks 2 to 6 using IMUs and PROMs. IMU-based metrics included: cumulative impact load, bone stimulus, and impact asymmetry. PROMs scores included: Oxford Knee Score (OKS), and EuroQol Five-dimension with EuroQol visual analogue scale.

Results: Preliminary results showed significant improvements in mean impact asymmetry by 67% ($P=0.0055$), bone stimulus by 41% ($P<0.0001$), and cumulative impact load by 121% ($P=0.0349$) between post-operative week 2 and 6. The mean change scores for OKS were 7.5 (RA-TKA), 11.4 (TKA), and 11.2 (UKA) over the early post-operative period ($P=0.144$). Interestingly, OKS did not always reflect the same trend as IMU-derived limb usage between the three implantation techniques.

Conclusions: We present a scalable, low-maintenance RPM system using quantitative measures from IMUs that can supplement traditional PROMs to provide a more holistic overview of post-operative recovery. These data suggest a difference in the functional outcome of TKA and UKA patients that might be overlooked by using PROMs alone.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