 Received 20-02-22; Accepted 26-03-22; Published 2-04-22

Effect of Limb Alignment in Medial Unicompartmental Knee Arthroplasty on Functional Outcomes and Patient Satisfaction

May Fong Chan, CHANMF91@GMAIL.COM
Orthopedic resident,
Tan Tock Seng Hospital,
Department of orthopaedic surgery

Kenneth Ming Foo Nah,
Medical officer,
Tan Tock Seng hospital,
Department of orthopaedic surgery.

Benjamin Tze Keong Ding,
Orthopedic resident,
Tan Tock Seng Hospital,
Department of orthopaedic surgery

Thomas Aloysius Wong,
Orthopedic resident,
Tan Tock Seng Hospital,
Department of orthopaedic surgery

Chung Yuan Kau
Senior consultant,
Tan Tock Seng Hospital,
Department of orthopaedic surgery.

*Corresponding Authors: May Fong Chan.

ABSTRACT

Background: Unicompartmental knee arthroplasty (UKA) is effective in the treatment of symptomatic unicompartmental knee osteoarthritis. However, ideal limb alignment and acceptable changes of alignment remains contentious.

Purpose: The purpose of this study is to look at the impact of post-operative mechanical limb alignment on short term functional outcomes in an Asian population.

Methods: We performed a retrospective review of all mobile bearing, Oxford UKAs performed from July 2016 to January 2019 by a single surgeon (43 patients, 47 knees). Pre- and post-operative weight bearing radiographic parameters were measured, as well as functional assessments via Oxford knee society (OKS) scores and the original Knee society score (KSS).

Results: The post-operative mechanical axis mean was varus 4.3◦ (range valgus 2◦ to varus 10◦), with a mean correction of 4.4◦ towards valgus. All our patients had an improvement in func- tional scores and range of movement post-operatively, however, patients with pre-operative alignment of varus 15◦ did not meet the cut off for minimal important change (MIC) in

Citation: May Fong Chan. Effect of Limb Alignment in Medial Unicompartmental Knee Arthroplasty on Functional Outcomes and Patient Satisfaction. Journal of Clinical Medicine & Surgery. 2022;1(1):2.

OKS scores. More varus pre-operative alignment resulted in a larger degree of change in limb alignment post-operatively. A larger change in alignment was also associated with higher satisfaction scores in patients.

Conclusion: Post-operative limb alignment of up to 10◦ varus does not compromise short term functional outcome scores in medial UKA. Caution is advised when selecting patients with varus 15◦ and above for UKA as they may not be able to achieve a minimal important change in functional scores post-operatively.

Keywords: Arthroplasty, Osteoarthritis, Unicompartmental.

I. INTRODUCTION

Unicompartmental knee arthroplasty (UKA) is an effective treatment option for symptomatic os- teoarthritis of the knee that is limited to a single compartment. Since McIntosh first proposed the theory of UKA in 1950s, various modifications to prosthesis design, surgical techniques and patient selection criteria have contributed to improved outcomes over time. [1-4]. In recent years, the introduction of the Oxford knee with the concept of a fully congruous mobile bearing has been a major advancement in the world of UKA [5].

The aim of the UKA is to restore knee kinematics to its pre-disease state and restore normal liga- mentous tension [6]. While the UKA is incapable of achieving as much correction as the total knee replacement (TKR), there is still an inevitable change to the overall alignment of the limb. In the case of UKA, post-operative alignment is dependent on the thickness of the tibial implant, level of resection of the tibia, on the ligamentous balance, and preoperative deformity [7,8].

Smith et al. previously cautioned against “overstuffing” the medial compartment into valgus as this could potentially exert greater contact stresses on the lateral compartment, resulting in accelerated progression of lateral compartment osteoarthritis [9]. However, between a neutral to varus alignment, there is a lack of consensus in the literature as to the ideal post-operative alignment that would maximize functional outcomes.

Our study is specific to the Asian population, where patients have been shown to have a higher degree of native varus knee alignment, with varying degrees of tibial vara [10]. This extra-articular deformity has also been associated with a more varus alignment of the limb post-operatively due to implant positioning [11].

Hence in this study, we aim to explore the relationship between mechanical axis correction after mobile-bearing medial UKA with short-term functional outcomes and satisfaction in an Asian population.

II. MATERIALS AND METHODS

We conducted a retrospective review of all patients who underwent medial UKA with mobile- bearing Oxford unicompartmental knee prostheses (Biomet UK Ltd., Bridgend, UK) in our institu- tion by a single surgeon.

The records of 60 patients who underwent unicompartmental knee arthroplasty in our institution by the target surgeon over the period of July 2016 to February 2020 were reviewed. Of these, 5 patients received a fixed-bearing cemented unicompartmental knee and were hence excluded. Of the remaining, patients who had incomplete records, insufficient radiographic imaging or

the dedicated views required for analysis, or who were lost to follow-up were excluded from the study, leaving us with 43 patients (47 knees) for analysis.

Patient selection for surgery was based on the indications previously described by Goodfellow et al, that has subsequently been expanded over the years. They had to have painful osteoarthritis with radiographic features corresponding to anterior-medial compartment wear.

Clinically, only patients with a flexion deformity of less than 15°, a correctable varus deformity, and an intact anterior cruciate ligament (ACL) and collateral ligaments were considered. [12-15], Joint line palpation was performed to identify and correspond the main site of tenderness to radiographic findings.

Weight-bearing anterior-posterior (AP), skyline, lateral, and Rosenburg views were performed for all patients. Weight bearing long-leg extremity films were also performed for assessment of alignment [16].

Patients were selected if their radiographs showed evidence of osteoarthritis corresponding to their symptoms, without features suspicious of ligamentous insufficiency.

Such features included lateral view radiographs showing anterior subluxation of the tibial on the fe- mur or posteromedial wear (possible ACL deficiency). Lateral compartment joint space narrowing on Rosenburg views also helped identify patients with more postero-lateral wear that may not have been seen on standard AP films. Weight-bearing long-leg extremity views provided an objective measurement of the limb alignment.

Patients with inflammatory arthritis were not offered UKA [17,18]. Age and body-mass index (BMI) was not considered as a contraindication for UKA in our population, as these have previously shown to be controversial in influencing outcomes [19-22].

Post-operatively, the patients were followed-up at the 1-month, 3-month, 6-month and 1-year mark in our out-patient clinic, where a history and physical examination was performed. Functional assessment was done via the Oxford knee score (OKS) and original knee society score (KSS). Weight bearing anterior-posterior, lateral and long-leg radiographs were performed immediately post-operatively and at the 3-month and 1-year mark.
The pre-operative demographic data of our population is listed in TABLE 1.

Table 1: Demographic information of patient population.

Total number		**43 patients (47 knees)**
Gender	Male Female	20 27
Side	Right	20

	Left	27
Type	Cemented Uncemented	20 27
Age (years)		63 (range 49-82, SD 7.90)
BMI (kg/m2)		28 (range 20.4-46.5, SD 5.5)

Measurements for femora-tibial mechanical alignment was defined by the hip-knee-angle (HKA). This was the angle between the femoral mechanical axis - taken from the centre of the femoral head to the intercondylar notch of the distal femur;and the tibial mechanical axis - drawn from the centre of the proximal tibial to the centre of ankle joint, as depicted in literature (FIGURE 1) [23,24], Varus alignment were documented as positive values, and valgus alignments as negative values. Measurements were performed by two individuals and the average of the values was used to take into account inter-observer reliability. These measurements were taken from the pre- operative radiographs, and from the 1-year follow-up visit.

Tibial vara was measured as the medial proximal tibial angle (MPTA). This is the medial angle between the knee joint line of the tibial and the mechanical axis of the tibial. (FIGURE 2)

This research was approved by the institutional review board of the authors' affiliated institutions.

Statistical analysis

Statistical analysis was performed using linear regression analysis of continuous variables and one- way ANOVA testing of categorical variables. P values < than 0.05 were considered to be significant.

OKS scores, KSS scores and post-operative satisfaction levels were analyzed with a regression analysis using the mechanical axis of the limb as an independent variable.

Operative technique

The implant utilized was the mobile-bearing Oxford unicompartmental knee prostheses (Biomet UK Ltd., Bridgend, UK), which is what is available at our institution. Pre-operatively, 2 grams of intravenous cefazolin was given before tourniquet insufflation as per institution guidelines.

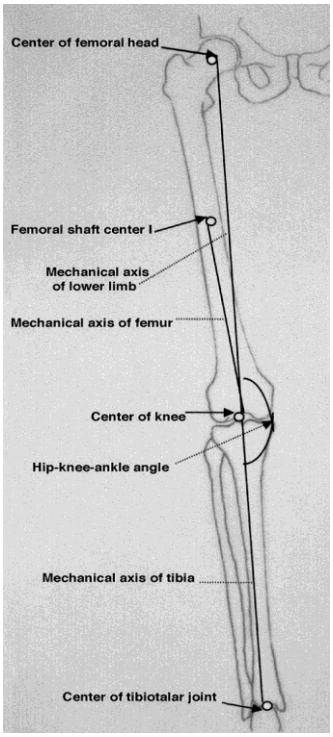

Figure 1: Mechanical axis of the limb taken as the hip-knee angle (Image from Luo CF. Referenceaxes for reconstruction of the knee. *Knee.* 2004 Aug;11(4):251-7)

All the surgeries were performed via a medial parapatellar approach. No ligament release was performed for any of the patients. After the initial exposure, an intra-operative joint survey of the lateral compartment, as well as visual inspection of the anterior cruciate ligament was done before progressing with the surgery.

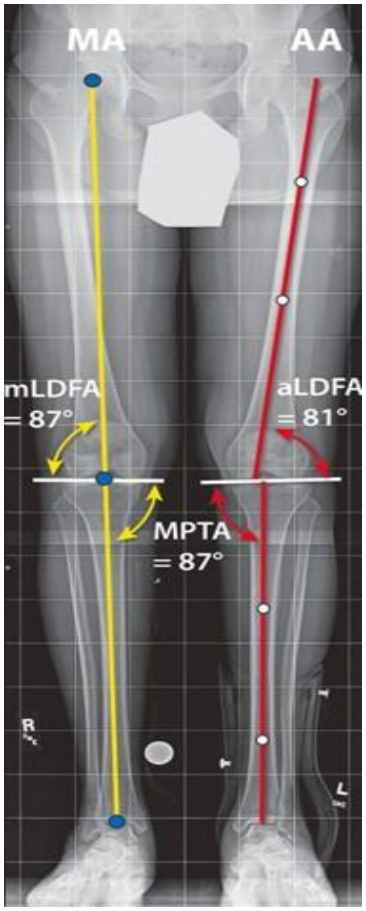

Figure 2: Measurement of the medial proximal tibial angle (MPTA). (Image from Vasso M, Antoniadis A, Helmy N. Update on unicompartmental knee arthroplasty: current indications and failure modes. EFORT Open Rev. 2018;3(8):442-448.)

Medial tibial plateau resection is first performed using the extra-medullary guide, with the excised plateau used to size the tibial tray. The initial tibial cut is performed at 2mm below the deepest erosion, and will be re-cut accordingly as required. The feeler gauge is then used to check that sufficient bone has been excised. Preparation of the medial femoral condyle is then performed. The implants are trialed with the appropriate bearing, ensuring equal 90◦ and 20◦ flexion gaps.
Remaining osteophytes are cleared, and the tibial plateau is prepared by making sagittal cuts to create grooves to sit the implant. The actual implants are then impacted onto the bone.

The decision for cementation was made depending on bone quality (eg. In cases of spontaneous osteonecrosis of the knee or osteoporotic bone), as well as for cases where lug holes were required to be re-drilled for minor adjustments of the implant positioning.

III. RESULTS

Mean mechanical alignment values, as well and pre- and post-operative scorings are summarized in TABLE 2.
TABLE 2 - Pre-operative and post-operative mechanical axis, Oxford Knee Society (OKS) scores, Knee Society scores (KSS), Range of movement (ROM) and Tibial vara.

Table 2: Confusion matrix obtained implementing SMO algorithm.

	Pre-operative	Post-operative
Mechanical axis	8.6° (2°-17°)	4.3° (-2°-10°)
OKS score	24.1 (5-40)	43.5 (30-48)
KSS	52.3 (10-90)	87.5 (50-100)
ROM	111.6 (80°-130°)	123.1 (100°-140°)
Tibial vara	4.7° (0-11.6°)	-

There was a mean improvement in KSS scores over the 1-year period by 35 points, and 19 points for OKS scores. There was also a mean change in mechanical alignment by 4.4 degrees towards valgus. Pre-operative tibial vara in our population was measured at a mean of 4.7° (0-11.6°).

None of the patients required revision surgery within the 1-year follow-up.

Pre-operative alignment

There was no significant co-relation between pre-operative mechanical alignment with functional scores (OKS or KSS) or ROM.

A greater degree of pre-operative alignment (more varus) resulted in a larger degree of change in limb alignment at 1 year post-operatively (R= 0.395, p = 0.006). (FIGURE 3)

Post-operative alignment

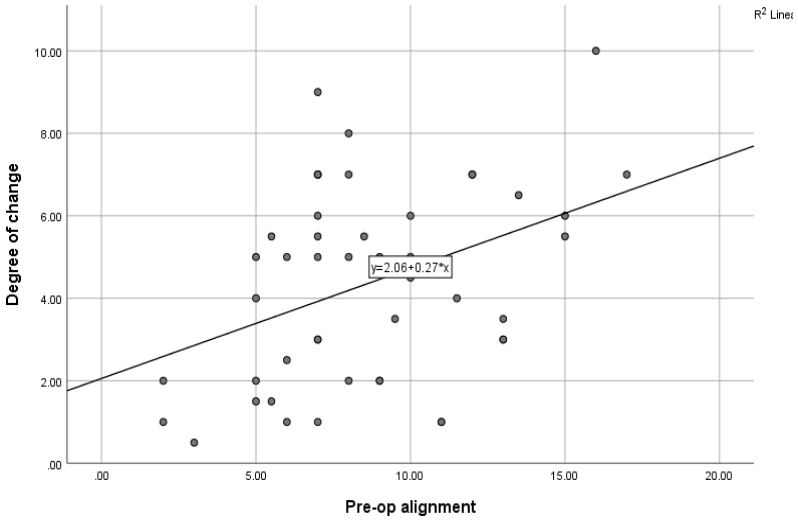

Figure 3: Regression analysis showing relationship between pre-operative alignment and degree ofalignment change

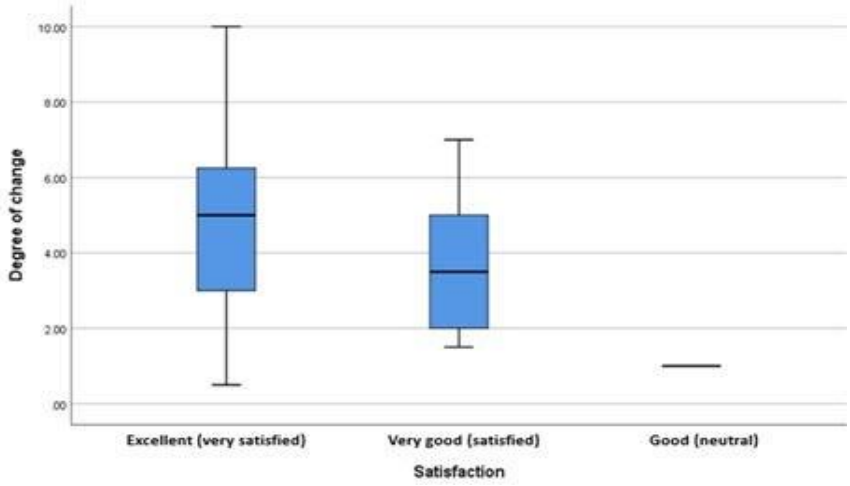

Figure 4: Box plot depicting relationship between change in alignment and satisfaction scores.

There was no significant co-relationship between the post-operative mechanical alignment with functional scores or ROM. A larger degree of alignment changes pre- to post-operatively was associated with better post- operative satisfaction scores in patients (R = -0.310, p = 0.036). (FIGURE 4) Satisfactions scores were part of the KSS questionnaire, where patients were asked to rate the overall results of the surgery for their knee condition, ranging from terrible to excellent.

IV. DISCUSSION

Ideal limb alignment after medial UKA is still a subject of debate [25-30]. There is a varying consensus in the literature, with Perkins and Rosenberger recommending an alignment close to neutral [25,26]. Zuiderbaan et al. reported that a post-operative varus mechanical axis of 1-4◦ correlated to significantly superior Western Ontario and McMaster Universities Arthritis Index (WOMAC) results at the 2-year mark [27]. Vasso on the other hand, showed that minor varus alignments (5-7◦) did not compromise mid to long term outcomes, and in fact gave better results than neutral or close-to-neutral alignments [28]. Chatellard et al warned against marked varus alignment (described as > 6◦) due to its association with increased mechanical failure rates [29]. Hernigou et al. reported less wear rates of polyethylene in knees with a post-operative axis of 1- 9◦of varus, but acknowledged that an under-correction could potentially lead to problems in the long term [30]. What was consistent was the recommendation to avoid over-correction into a valgus limb alignment, as this would lead to an increased risk of degenerative changes in the opposite compartment. These above studies, however, were all done in American and European centers with Caucasian populations.

An analysis of our data showed that the post-operative mechanical axes ranged from -2◦ to 10◦, where majority of the patients (74.4%) did not fall into the “ideal” 5-7◦ range previously described in the literature discussed above. However, when assessed as an independent variable, the alignment did not show any significant co-relation with post-operative functional scores or improvement in scores over time (p=0.313). This indicates that up to the 1-year mark, patients are still able to function well and have good short-term outcomes within this alignment range. None of the patients had evidence of complications such as early loosening or bearing dislocation, both of which can present within the first year post-operatively, even up to as early as three months [31].

A potential reason for the distribution of our results could be contributed from the presence of native tibial vara in our population. Shahi et al. described anatomical differences in Asian patients, and how Chinese adults tended to have a larger inferolateral angle of the knee as compared to Caucasian patients [32]. The mean medial inclination of the knee joint surfaces in male and female Chinese patients were reported to be 5.4 2.5◦and 4.9 2.3◦ respectively, while in Caucasian patients this was close to neutral. This extra-articular tibial vara alters the overall alignment of the limb, and results in a hip-knee-ankle angle that will not be neutral even at baseline, due to an overall varus limb alignment [33,34]. In UKA, the aim should be to restore the knee to its "pre-disease" mechanical axis for appropriate ligament tension [6]. Hence, in our Asian population, these patients may be able to tolerate a higher degree of post-operative varus alignment as this was their baseline to begin with.

Analysis of our data based on minimal important change (MIC) scores also showed that 45 out of the 47 knees were able to achieve an MIC of 9 points in their OKS at the one-year mark. This value was described by Beard et al. as the recommended MIC for OKS in a cohort over time [35]. MIC is used to identify the minimal effect or change that would be meaningful to a patient, as a statistically significant change to the physician may not reflect a significant change to the patient [36-38].

Notably, the only 2 patients who were unable to meet the MIC in their OKS scores had a pre- operative deformity of 15◦ varus, which is at the upper limits of what Kozinn and Scott described in their 1989 landmark paper [39]. Kleebad et al. also concluded that patients with such severe varus deformities can still be considered candidates for medial UKA, but advised caution for those > 15◦ as the likelihood of achieving an optimal post-operative alignment is lower [40]. In line with Kleebad's observation, the 1-year post-operative alignment for these patients were varus 9 -9.5◦, which would be outside the "optimal" ranges described It is important to note, however, that the MIC as described by Beard et al. was based on National joint Registry for both hip and knee (total and unicompartmental) arthroplasty. There was no MIC specific to UKA and OKS / KSS that has been described in the literature.A more varus pre-operative alignment also resulted in a larger degree of change in limb alignment post-operatively ($p < 0.05$) in our case series. This is likely due to adequate pre-operative assessment to ensure that our patients were in "correctable" varus before the surgery, and accurate peri-operative assessment of soft tissue tension by an experienced surgeon.

Our results also showed that a higher degree of alignment change was associated with greater post- operative satisfaction scores in patients ($p<0.05$). As the aim of a successful UKA is to achieve ideal ligamentous balancing and correction of the previously varus deformity (within acceptable limits), we infer that the functional and aesthetic outcome of this correction was may have been what positively influenced the patients' satisfaction post-surgery.

Limitations

The first limitation of our study is a moderate sample size with data that was retrospectively ana- lyzed. Secondly, a follow-up of 1 year provided us with data mainly for a short to mid-term assess- ment of the sample population. While there were no immediate post-operative complications during this time frame, complications such as progressive lateral compartment wear will only declare in a longer-term follow-up study.

Thirdly, accurate assessment of the radiographic parameters could be affected by pre-operative fixed-flexion or rotational deformities. Pain at the point in time of taking the radiograph may also affect the patient's standing and weight bearing position of the limb.

Lastly, the analysis of satisfaction was a secondary outcome that was measured as part of a 6-point scale in the KSS (Excellent-very satisfied, very good -satisfied, good - neutral, fair - dissatisfied, poor - very dissatisfied and terrible). Further in-depth analysis with other more holistic systems such as the Short Form Health Survey (SF-36) could be a consideration in the future, but is not within the scope of this study.

An extended period of study and data collection will be required to ascertain long term effects of limb alignment, and change of alignment on outcome scores and implant longevity.

V. CONFLICT OF INTEREST

One-year post-operative limb alignment of up to 10◦ varus does not compromise short term func- tional outcome scores in medial UKA in Asian patients, likely due to their pre-morbid varus incli- nation contributed from extra-articular deformities. Caution is advised when performing medial-UKA for knees with pre-operative 15◦ varus deformity and above, as the potential to achieve a significant improvement in alignment for patient satisfaction or functional scores may be limited. Decision to proceed for UKA in these patients should include pre-operative assessment of correctable varus via clinical examination, radiographic aids such as valgus-stress views, and lastly, intra-operative assessment with trial implants.
Longer follow-up is required to verify the long-term sequalae of the moderately post-operative varus alignment in these patients.

VI. ACKNOWLEDGEMENT

The authors have not received any financial support for the research, authorship and / or publication of this article.

VII. REFERENCES

1. Campi S, Tibrewal S, Cuthbert R. Tibrewal SB. Unicompartmental Knee Replacement-Current Perspectives. J Clin Orthop Trauma. 2018;9:17-23.
2. MacIntosh DL, Hunter GA. The Use of the Hemiarthroplasty Prosthesis for Advanced Osteoarthritis and Rheumatoid Arthritis of the Knee. J Bone Joint Surg. 1972;54:244-255.
3. Mckeever DC. The Choice of Prosthetic Materials and Evaluation of Results. Clin Orthop Relat Res. 1955;6:17-21.
4. Marmor L. The Modular Knee. Clin Orthop Relat Res 1973;94:242-248.
5. Goodfellow JW, Tibrewal SB, Sherman KP, O'Connor JJ. Unicompartmental Oxford Meniscal Knee Arthroplasty. J Arthroplasty 1987;2:1-9
6. Mittal A, Meshram P, Kim WH, Kim TK. Unicompartmental Knee Arthroplasty, an Enigma, and The Ten Enigmas of Medial UKA. J Orthop Traumatol. 2020;21:15.
7. Stockelman RE, Pohl KP: The Long-Term Efficacy of Unicompartmental Arthroplasty of the Knee. Clin Orthop 1991;271:88-95.
8. Weale AE, Murray DW, Baines J, Newman JH: Radiological Changes Five Years After Unicompartmental Knee Replacement. J Bone Joint Surg 2000;82B:996-1000
9. Smith TO, Hing CB, Davies L, Donnel ST. Fixed Versus Mobile Bearing Unicompartmental Knee Replacement: A Meta-Analysis. Orthop Traumatol Surg Res. 2009;95:599-605
10. Mori S, Akagi M, Asada S, Matsushita T, Hashimoto K. Tibial Vara Affects the Aspect Ratio of Tibial Resected Surface in Female Japanese Patients Undergoing TKA. Clin Orthop Relat Res. 2013;471:1465-71.

11. Mullaji A, Shetty G. Effect of Extra-Articular Deformities on Limb Alignment After Mobile- Bearing Unicompartmental Knee Arthroplasty. Orthopaedic Proceedings. 2019;101-B.
12. White SH, Goodfellow JW, O'connor JJ. Anteromedial Osteoarthritis of the Knee. J Bone Joint Surg Am. (Br). 1991;73:582-586.
13. Mancuso F, Dodd CA, Murray DW, Pandit H. Medial Unicompartmental Knee Arthroplasty in the ACL-Deficient Knee. J Orthop Traumatol. 2016;17:267-275.
14. Tian S, Wang B, Wang Y, Ha C, Liu L, et al. Combined Unicompartmental Knee Arthroplasty and Anterior Cruciate Ligament Reconstruction in Knees With Osteoarthritis and Deficient Anterior Cruciate Ligament. BMC Musculoskelet Disord. 2016;17:327.
15. Deschamps G, Chol C. Fixed-Bearing Unicompartmental Knee Arthroplasty. Patients' Selection and Operative Technique. Orthop Traumatol Surg Res. 2011;97:648-661.
16. Hamilton TW, Pandit HG, Inabathula A, Ostlere SJ, Jenkins C, Mellon SJ et al. Unsatisfactory Outcomes Following Unicompartmental Knee Arthroplasty in Patients With Partial Thickness Cartilage Loss: A Medium-Term Follow-up. Bone Joint J. 2017;99-B:475-482.
17. Vasso M, Antoniadis A, Helmy N. Update on Unicompartmental Knee Arthroplasty: Current Indications and Failure Modes. EFORT Open Rev. 2018;3:442-448.
18. Panni AS, Vasso M, Cerciello S, Felici A. Unicompartmental Knee Replacement Provides Early Clinical and Functional Improvement Stabilizing Over Time. Knee Surg Sports Traumatol Arthrosc. 2012;20:579-585.
19. Zengerink I, Duivenvoorden T, Niesten D, Verburg H, Bloem R, Mathijssen N. Obesity Does Not Influence the Outcome After Unicompartmental Knee Arthroplasty. Acta Orthop Belg. 2015;81:776-783.
20. Cavaignac E, Lafontan V, Reina N, Pailhe R, Wargny M, Laffosse JM, et al. Obesity Has No Adverse Effect on the Outcome of Unicompartmental Knee Replacement at a Minimum Follow-up of Seven Years. Bone Joint J. 2013;95:1064-1068.
21. Tabor OB, Jr, Tabor OB, Bernard M, Wan JY. Unicompartmental Knee Arthroplasty: Long- Term Success in Middle-Age and Obese Patients. J Surg Orthop Adv. 2005;14:59-63.
22. Woo YL, Chen YQJ, Lai MC, Tay KJD, Chia SL, et al. Does Obesity Influence Early Outcome of Fixed- Bearing Unicompartmental Knee Arthroplasty? J Orthop Surg (Hong Kong). 2017;25:2.
23. Cherian J, Kapadia B, Banerjee S, Jauregui J, Issa K, et al. Mechanical, Anatomical and Kinematic Axis in Tka: Concepts and Practical Applications. Curr Rev Musculoskelet Med. 2014;7:89-95.
24. Luo CF. Reference Axes for Reconstruction of the Knee. Knee. 2004;11:251-257.
25. Perkins TR, Gunckle W. Unicompartmental Knee Arthroplasty: 3- To 10-Year Results in a Community Hospital Setting. J Arthroplasty. 2002;17:293-297.
26. Rosenberger RE, Fink C, Quirbach S, Attal R, Tecklenburg K, et al. The Immediate Effect of Navigation on Implant Accuracy in Primarymini-Invasive Unicompartmental Knee Arthroplasty. Knee Surg Sports Traumatol Arthrosc. 2008;16:1133-1140.
27. Zuiderbaan HA, Van der List JP, Chawla H, Khamaisy S, Thein R, et al. Predictors of Subjective Outcome After Medial Unicompartmental Knee Arthroplasty. J Arthroplasty. 2016;31:1453-1458.
28. Vasso M, Regno CD, D'Amelio A, Viggiano D, Corona K, et al. Minor Varus Alignment Provides Better Results Than Neutral Alignment in Medial UKA. The Knee. 2015;22:117- 121.
29. Chatellard R, Sauleau V, Colmar M, Robert H, Raynaud, G et al. Medial Unicompartmental Knee Arthroplasty: Does Tibial Component Position Influence Clinical Outcomes and Arthroplasty Survival? Orthop Traumatol Surg Res. 2013;99:S219-S225.
30. Hernigou P, Deschamps G. Alignment Influences Wear in the Knee After Medial Unicompartmental Arthroplasty. Clin Orthop Relat Res. 2004;423:161-165.
31. Vardi G, Strover AE. Early Complications of Unicompartmental Knee Replacement. The Knee.2003;11:389-394.
32. https://www.intechopen.com/books/arthroplasty-update/special-considerations-in-asian- knee-arthroplasty
33. Moreland JR, Bassett LW, Hanker GJ. Radiographic Analysis of the Axial Alignment of the Lower Extremity. J Bone Joint Surg Am. 1987;69(??):745-9
34. Hsu RWW, Himeno S, Coventry MB, Chao EYS. Normal Axial Alignment of the Lower Extremity and Load-Bearing Distribution at the Knee. Clin Orthop Relat Res. 1990;255:215- 227.
35. Beard DJ, Harris K, Dawson J, Doll H, Murray D, et al. Meaningful changes for the Oxford hip and knee scores after joint replacement surgery. Journal of clinical epidemiology. 2015;68:73- 79
36. Mouelhi Y, Jouve E, Castelli C, Gentile S. How Is the Minimal Clinically Important Difference Established in Health-Related Quality of Life Instruments? Review of anchors and methods. Health Qual Life Outcomes. 2020;18:136.
37. Troosters T. How Important Is a Minimal Difference? European Respiratory Journal.2011;37:755-756.

38. Cöster MC, Nilsdotter A, Brudin L, Bremander A. Minimally Important Change, Measurement Error, and Responsiveness for the Self-Reported Foot and Ankle Score. Acta Orthop. 2017;88:300-304.
39. Kozinn SC, Scott R. Unicondylar knee Arthroplasty. J Bone Joint Surg Am. 1989;71:145-150.
40. Kleebad L, List J, Pearle A, Fragomen A, Rozbruch SR. Predi. Predicting the Feasibility of Correcting Mechanical Axis in Large Varus Deformities With Unicompartmental Knee Arthroplasty. J. Arthroplasty. 2018;33:372-378.