ORIGINAL ARTICLE

Incidence of Soft-Tissue Releases, Clinical and Radiological Outcomes of Lateral Parapatellar Approach for Valgus Arthritic Knees: A 4-year Follow-up Study with A Review of Literature

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Abstract

Purpose To analyse the incidence of additional soft tissue releases with the lateral parapatellar approach, and the clinical and radiological outcomes of total knee arthroplasties performed using the lateral parapatellar approach for valgus arthritic knees. A review of the existing literature on valgus arthritic knees undergoing knee replacement was performed and our results compared.

Materials and Methods This is a prospective cohort study of 50 patients operated by this approach. Operation and clinical records were assessed to determine the number and sequence of soft tissue releases. Functional outcome was measured using the Oxford Knee Score. Radiological assessment included measurement of alignment and implant positioning.

Results 46 patients included. Mean follow-up of 4 years. Additional lateral releases were performed in 11 (24%) cases. Mean valgus alignment corrected from 13.1 degrees pre-operatively to 5.7 degrees post-operatively. Oxford Knee Score improved from a mean pre-operative score of 11.9 to a mean post-operative score of 38.3 at final follow-up. Radiographs revealed lateralisation of the tibial component in 4 patients. No immediate or late post-operative wound complications, late instabilities or revisions were observed.

Conclusion Lateral parapatellar approach is highly effective in correcting the valgus deformity with a low incidence of additional soft tissue releases. Medium-term results indicate an excellent functional outcome with no complications.

Keywords Knee · Valgus arthritis · Lateral parapatellar · Arthroplasty

Abbreviations

TKA	Total Knee Arthroplasty
ITB	Iliotibial band
LCL	Lateral collateral ligament
PLC	Posterolateral capsule
PCL	Posterior cruciate ligament
POP	Popliteus tendon
ERAS	Enhanced Recovery After Surgery
TED	Thromboembolic Deterrent
AP	Anteroposterior
SD	Standard deviation
TTO	Tibial Tubercle Osteotomy
LRR	Lateral Retinacular Release

Introduction

Total knee arthroplasty (TKA) for arthritis with valgus knee deformities can be more challenging technically compared to osteoarthritis with varus deformity. Approximately 10% [1, 2] of patients requiring total knee arthroplasty have a valgus deformity. Valgus deformity has posed technical challenges and has produced variable clinical results in terms of correction of the deformity, instability, and overall results. Patients with valgus knee deformities typically exhibit tightening of lateral soft tissue structures. These structures include iliotibial band (ITB), lateral collateral ligament (LCL), posterolateral capsule (PLC), posterior cruciate ligament (PCL), and popliteus tendon (POP). Not only can the soft tissue contractures lead to a tendency for lateral patellar subluxation and patellofemoral mal-tracking, but is also a prevalent cause of postoperative knee instability [3]. Furthermore, medial soft tissue structures, namely the medial collateral ligament, can be attenuated and at times incompetent when

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the deformity is severe. Thus, attaining a well-balanced TKA can be difficult and challenging [4, 5].

Medial parapatellar approach is the most commonly used approach for TKA and has been described traditionally for TKA in valgus knee arthritis. However, this involves multiple lateral soft tissue releases [6]. In an effort to improve patella maltracking and preserve medial blood supply, Keblish in 1991 [3] recommended a lateral capsular approach with an elevation of the tibial tubercle for valgus knee arthroplasty, which was later refined by Buechel [7]. The lateral parapatellar approach, in spite of its advantages of providing better access and visualisation to the contracted tissues, has remained unpopular, largely because of technical difficulties with patella eversion, unfamiliarity and inconsistent views about its potential complications which include soft tissue closure and wound healing problems. There is a paucity of recent literature showing the outcomes and advantages using this less familiar approach for valgus osteoarthritic knees. The main purpose of the study is to emphasize the importance of the lateral approach which can be used to address the affected pathology directly without disrupting the relatively normal medial soft-tissue envelope. The primary aim of the current study is to note the incidence of additional soft tissue releases for total knee arthroplasties performed using the lateral parapatellar approach for valgus knees. The secondary aims of the study are to analyse the clinical, radiological and functional outcomes of these patients and comparing our results with the literature.

Materials and Methods

All patients who underwent a cemented TKA, under 3 different authors, at our hospital between 2013 to 2018 were identified from our total joint registry. Out of a total number of 2300 patients operated for Total Knee replacement in our institute between 2013 and 2018, 50 consecutive patients with a fixed valgus deformity were selected to give a continuous series. This is a prospective cohort study of 50 patients operated for fixed valgus arthritic knees, between 2013 and 2018, by 3 different senior surgeons. All 3 surgeons followed the same releases sequences and protocol. Exclusion criteria were patients with revision TKAs. 2 patients' clinical records were not found and 2 patients' operative notes were not clear regarding additional soft tissue releases, leaving a total of 46 patients (31 female, 15 male) who formed the cohort for our study for further analysis. Patient demographics and classification according to the severity of valgus deformity as per Ranawat classification [2] are as shown in Table 1. All implants were Genesis II (Smith and Nephew, Memphis, USA).

Table 1 Patient demographics

Characteristic	Value
Patients (<i>n</i>)	46
Female patients (%)	31 (67)
Male patients (%)	15 (33)
Rheumatoid arthritis (%)	8 (17.4)
Mean follow-up, years (range)	4 (2.2–7.1)
Mean age, years (range)	69.7 (49–90)
Mean body mass index, kg/m ² (range)	33 (21–45)
Type of deformity (Ranawat)	
Type 1(%)	8 (17)
Type 2(%)	35 (76)
Type 3(%)	3 (7)
Constraint	
Cruciate retaining, <i>n</i> (%)	43 (94)
Posterior stabilised, <i>n</i> (%)	3 (6)

Intervention

Enhanced Recovery After Surgery (ERAS) protocol was used for all surgeries [8]. All patients received a single intravenous dose of cefuroxime 1.5 g at the time of induction. No tourniquet was used. All patients were operated by standard fat-pad preserving lateral parapatellar approach as described by Keblish [3] (Fig. 1a). Using an intramedullary guide, the distal femoral cut was made in 5 degrees of valgus in all cases. Tibial cuts were made using an extramedullary jig. Opposite sided half tibial cutting block jigs were used with the extramedullary alignment technique, e.g. right medial cutting block was used for a left knee and vice versa. The foot needs to be kept internally rotated rather than externally rotated to give adequate exposure of the tibial plateau. This, however, needs to be kept in mind when determining the rotation of the tibial baseplate. Femoral component rotation was determined as per the transepicondylar axis and Whiteside's line. With the femoral sizing jig pinned to the distal femur, the knee is brought to 90 degrees flexion. In absence of mal rotation or hypoplasia, the posterior paddles of the femoral jig should sit flat on the proximal tibial cut surface with no abnormal gap between the tibial cut surface and the lateral posterior paddle of the femoral sizing jig. In the case of lateral condylar hypoplasia, an osteotome was placed under lateral femoral condyle before placing the femoral sizing jig, to minimise the error of internal rotation. Appropriate and selective soft-tissue release was performed after checking the alignment (Fig. 1b) and stability using spacer blocks. Further details regarding the protocol of soft-tissue releases are mentioned in the discussion section. Cemented cruciate retaining or posterior

Fig. 1 **a** Photo showing complete joint exposure and visualisation with preservation of fat pad using lateral parapatellar approach. **b** Photo showing alignment can be checked without any compromise. **c**

Photo showing closure of the fat-pad without tension. **d** Photo showing well-healed scar similar in length to that for medial parapatellar approach

stabilised implants were used in all cases. PCL resection was also considered a part of the release. No case required constrained prosthesis. Patella was resurfaced or left as it was, depending on the intra-operative findings. No drain was used post-operatively and Jones bandage was used for the first 24 h after which the dressings were reduced (Fig. 1c, d).

Rehabilitation and Follow-up

All patients received mechanical (TED stockings and Flowtrons) and pharmacological thromboprophylaxis (Clexane) for 14 days post-surgery. Early mobilisation was encouraged from Day 0 and patients were discharged after they were assessed and deemed safe for independent mobilisation by the in-patient dedicated Physiotherapy

and Occupational therapy team. Follow-up was until death, re-operation, revision or final clinical follow-up. Complication rates, re-operation or revision rates were noted and confirmed by a thorough review of the medical records. All patients were followed up at 2 weeks, 6 weeks, 3 months, 6 months and 1 year in the orthopaedic clinic for a clinical review and calculation of Oxford Knee scores, and then annually in the nurse-led clinic. Follow-up X-rays were taken immediate post-operatively, at 3 months, 1 year and then further if indicated.

Outcomes

Operative and clinical records were reviewed for the progress and follow-up. Additional soft-tissue releases, type of prosthesis implanted and any problems or complications encountered were noted. We used Oxford Knee Scores to assess the clinical progress and functional outcome for all patients. Scores were calculated at the time of pre-assessment and post-operatively at 6 weeks, 3 months, 6 months, 1 year and then annually. To calculate radiological parameters, we assessed the plain radiographs in terms of alignment and positioning. Radiographs were reviewed by a single, blinded author, not involved in any of the procedures. Pre and post-operative tibiofemoral angles of the involved limb were calculated on standing AP radiographs (taken at pre-assessment and at final follow-up respectively) taking into account the anatomical axis of femur and tibia [9] (Fig. 2a, b). The alignment and positioning of the implanted components were measured using the technique described by Sarmah et al. [10] (Fig. 2c, d). To reduce a possible bias due to malrotation alignment, the rotation was judged as satisfactory when a superimposition of one-third of the fibula head by the tibia was observed [11]. Synapse PACS software was used for all measurements. All measurements were done by a single author.

Statistical Analysis

All statistical analyses were performed using IBM SPSS Software version 17. For all variables including age, angle measurements and Oxford Knee Scores, descriptive statistics with mean, range and standard deviation were reported. Kolmogorov–Smirnov test was used to identify the normal distribution of variables. Paired t-test was used to determine the significance of the clinical and radiographic parameters. P value of less than 0.5 was considered to be statistically significant.

Fig. 2 **a** Pre-operative AP standing radiograph of a 62 year old patient with tibiofemoral angle of 15 degrees. **b** Pre-operative lateral radiograph of the same patient. **c** 1 year Post-operative AP standing radiograph showing excellent correction of deformity. Tibiofemoral angle is 4 degrees. **d** Post-operative lateral radiograph of the same patient

Survey

In addition to this study, we performed an independent survey of all the current Deanery trainee registrars in our region. The main purpose of the survey was to determine the awareness and experience of young upcoming surgeons regarding this approach. This survey included questions related to the number of cases they had observed or performed using the lateral parapatellar approach for valgus osteoarthritic knees and whether they had experienced any problems or difficulties in exposure, positioning of femoral and tibial components and closure.

Table 2 Comparison of cases requiring additional soft-tissue releases

Soft-tissue release		Number of patients
None		35
One	ITB tenotomy ^a	5
	LCL ^b	3
	PCL ^c	3

^aIliotibial Band^bLateral Collateral Ligament^cPosterior Cruciate Ligament

Results

Soft-tissue Releases

Out of the 46 patients who were operated by the standard lateral parapatellar approach, 11 required additional soft-tissue releases. ITB tenotomy was done in 5 of them and LCL was released in 3 cases. PCL was resected in 3 cases. (Table 2). 3 patients had Grade 3 valgus deformity and 8 patients had grade 2 valgus deformity.

Functional Results

The comparison between the mean Oxford Knee scores at the time of pre-assessment and at the latest follow-up is as shown in the graph in Fig. 3.

As shown in the graph, the mean Oxford Knee Score improved from 11.9 (range 4–18) preoperatively to 38.3 (range 33–44) at the latest follow-up post-operatively. On applying paired t test to these values, there is a very significant statistical difference in the Functional outcomes ($p < 0.01$). No immediate or delayed post-operative wound complications, instabilities or revisions were observed. Mean range of movements improved from 4.4–95 degrees of flexion to 0.5–112 degrees of flexion ($p > 0.05$).

Radiographic Results

Radiographic Analyses of pre and post-operative (at final follow-up) Tibiofemoral angles, Femoral and tibial component angles (Mean (± 2.5 SD)) are as shown in Tables 3 and 4.

Grade 1 notching of the anterior femoral cortex was observed in 3 of the patients. Apart from that, we observed that there was lateralisation of the tibial component in 4 patients by a mean of 2.7 mm after correction according to the magnification. However, the Oxford Knee scores of these patients were comparable to the other patients ($p > 0.05$) and they had an uneventful recovery post-operatively with

Comparison of mean Oxford Knee scores-pre-operative and at latest follow-up(mean 4 years) **Fig. 3** Graph showing comparison between the mean Oxford Knee scores at the time of pre-assessment and at latest follow-up**Table 3** Comparison of pre-operative and post-operative tibiofemoral angles

	Pre-operative	Post-operative	P value
Tibio-femoral angles mean (± 2.5 SD)	13.1 (± 3.3)	5.7 (± 2.2)	< 0.001
	Range 8–22 degrees	Range 2–8 degrees	

Table 4 Post-operative alignment of femoral and tibial components

Femoral component alignment-mean (± 2.5 SD)		Tibial component alignment-mean (± 2.5 SD)	
Sagittal	Coronal	Sagittal	Coronal
88.6 (± 2.9)	95.5 (± 2.1)	86.8 (± 2.1)	89.4 (± 1.3)

regards to pain, range of movements and performing day-to-day activities.

Survey

13 (52%) of the current trainees had seen the lateral parapatellar approach but had not performed. Only 2 (8%) had done the lateral approach themselves (under supervision). 7 trainees observed that there is difficulty in tibial exposure and preparation. None observed any difficulty in femoral preparation or wound closure.

Survivorship

None of the patients in follow-up (Mean-4 years, range 2.2–7.1 years) were noted to have returned to theatre for complications following the primary surgery. 2 patients, both of whom were on warfarin, had delayed healing of the surgical wound post-operatively. However, this was not

complicated with wound gaping or infection (superficial or deep).

Discussion

Although approximately 10% TKAs are performed for valgus osteoarthritis every year, there is still an ongoing debate about the best lateral soft-tissue release technique to balance the valgus knee during TKA [1, 2].

Multiple surgical techniques using either medial or lateral approach have been described for soft tissue balancing for correction of valgus deformity during TKA. Krackow et al. [12] advocated releasing the ITB and LCL first using a subperiosteal technique with the knee in extension, followed by POP and PLC, and finally lateral head of gastrocnemius is released only if there is a flexion contracture. Whiteside [13] reported a selective soft tissue release depending on the presence of tightness in either extension or flexion. The selective soft tissue release includes a release of the LCL and popliteus if the knee is tight in flexion, whereas a release of ITB and posterolateral capsule if the knee is tight in extension. Ranawat et al. [2] reported an “inside-out” technique in which the PCL is first released, followed by a release of the PLC using the electrocautery and a “pie-crusting” of the ITB using multiple “inside-out” stab incisions while preserving the Popliteus. The ITB is described as an effective lateral stabilizer only in the full extension until 30° of flexion [14]. Boettner et al. [15] described a “cook-book” approach where the ITB, LCL, and PLC were routinely released in all knees while preserving POP. The authors reported a revision rate of 1.1% for instability, but required use of constrained inserts in 20.4% of the knees. MacAuley et al. [16] observed that revision risk was increased 20 times if both the lateral collateral ligament and popliteus tendon were released during TKA, and thus recommended preservation of at least one of these structures for long-term implant survival. Satish et al. [17] demonstrated the preservation of at least one of these structures in 30 of 32 patients undergoing TKA via a lateral parapatellar approach without TTO. In the subset of patients with moderate knee valgus in their series, the release of tight lateral structures comprised only the ITB in all 13 cases.

All patients in the current study underwent the standard fat-pad preserving lateral parapatellar approach [3]. We followed the selective soft-tissue release technique as mentioned by Whiteside et al. [13], depending on the tightness in flexion, extension or both. This technique is very reproducible and resulted in excellent functional outcomes at 4 years after surgery. The main advantage of the lateral approach is better visualisation of the tight lateral tissues and less need for additional soft-tissue releases for the patella, as a lateral release technique forms part of the approach. In our series, additional soft-tissue release after the standard exposure was

required in 11 out of the 46 patients (24%). This is much less compared to the study done by Xie [6] which reports additional soft-tissue releases in 85% patients in his study of 181 patients. All patients in his study were operated by the medial parapatellar approach. In addition, 40 percent of the patients required an LRR. A further advantage of the lateral approach is the avoidance of a medial retinacular release. As a lateral retinacular release is sometimes necessary in cases of valgus deformity operated by medial parapatellar approach as observed in Xie et al. [6], the performance of both medial and lateral patellar releases is not desirable due to concern of patellar devascularisation.

In his series of 48 TKAs performed using either approach, Sekiya et al. [18] found a tendency towards a lesser number of releases in the lateral approach group (two release procedure per knee in the medial group and 1.5 per knee in the lateral group; $p=0.14$). This finding suggests that additional extensive lateral release is often unnecessary to obtain good ligament balancing via the lateral approach, as lateral arthrotomy is enough in most cases.

Apostolopoulos et al. [19] also described the lateral parapatellar approach for patients with valgus deformity, reporting good outcomes in the correction of deformity (2–7°, mean = 5.5°) and osteotomy union in all 24 patients. Their approach incorporated tibial tubercle osteotomy to improve access and for mechanical realignment purposes, which we did not find to be necessary for our patient group. They described the value of the lateral parapatellar approach in the valgus knee as giving improved access to release tight lateral structures and the potential to incorporate lateral release as part of the surgical approach.

In addition, most current papers consider a popliteus tendon release as a surgical release option. Our patient outcomes show that excellent results can be achieved without addressing the popliteus tendon. The authors consider the popliteus muscle a dynamic stabilizer, which in contrast to tight ligaments (LCL, ITB) and capsule, will stretch out over time. Its release increases the chance of flexion instability [20] and according to the current study is not required to balance the moderate or even severely deformed valgus knees. In our study, with the use of selective soft-tissue release technique [13], only 6% of the knees required posterior-stabilised implants. There were no revisions for instability. The LCL was released in 3 of our cases. Although the LCL is described as a major stabilizer throughout the arc from 0° to 90° flexion [14, 21], no lateral instability was observed in the current study. The authors are of the opinion that a selective soft-tissue release is more advantageous than a standardised “cook-book” approach and requires less constraint in balancing the knee.

Patellofemoral instability is a common cause of postoperative pain and functional limitations in TKA and may lead

to revision surgery [22, 23]. The lateral approach may also result in improved patellar tracking in some patients following TKA [4, 24, 25]. Hay et al. [24] compared a medial parapatellar approach and a lateral approach with a TTO and found a significantly greater incidence of lateral patellar subluxation in the medial group (3 of 12) compared with the lateral group (0 of 16) ($p=0.034$). The authors recommended considering a lateral approach in patients in whom problems with patella tracking were anticipated.

Li et al. [26] in his case series of 30 patients operated with modified technique using Z-capsuloplasty, observed a significant improvement of Knee society objective and functional scores to 91.8 and 84.3 respectively. 3 cases (8.6%) had post-operative complications, including transient common peroneal palsy, hematoma and deep infection, while none had patellofemoral problems or late instability.

Satish and his colleagues evaluated 32 patients operated for valgus arthritic knees (mean 25.4 degrees) by the lateral parapatellar approach. In his study, there was a significant improvement in the mean Knee Society score (36–83 points) with a mean follow-up of 5 years. No patients had patellofemoral complications post-operatively and constrained implants were not used in any cases [17].

Greenberg et al. in his study [27], compared medial and lateral approach TKA for valgus knees. They concluded that compared to the medial approach, a lateral approach allows better correction of the deformity, shorter operating times and perhaps less use of constrained implants. They also reviewed similar literature from the past decade and observed that out of the 7 papers, 6 of them cited equivalent or better results with the lateral approach.

There is a lot of debate in the literature with regards to the valgus cutting angle to be used with a valgus deformity. This may be a factor to consider with computer navigated surgery, however, as there is no conclusive evidence in the current literature to vary the valgus angle when using a traditional technique for performing a knee replacement and as the standard implant jig did not provide for 3 degree valgus cutting angles, a valgus cut of 5 degrees was used [28, 29].

The survey carried out for the trainees in our deanery was to get an overview of the awareness and exposure of the young upcoming surgeons to this effective, but less practised approach. Only about 60% of the current specialty training registrars had either observed, assisted or performed this approach. The authors firmly believe that more exposure to this approach should be included in the training, so as to make the surgeons familiar with the technique. This is a less practised approach not because of the difficulty, but because of the unfamiliarity of using this approach. In the long run, it can be useful to achieve excellent outcomes, particularly for severe valgus osteoarthritic knees and would also be useful to manage complex intra-articular fractures of the lateral

femoral condyle as suggested in the studies done by Metwally [30] and Bologna et al. [31].

The study has the following limitations. First, the rotational alignment of the components could not be assessed as post-operative CT scan was not done in any patients. Second, there was no matched control group in our study to compare our results to determine any superiority in the approach. Finally, a 4-year follow-up does not allow drawing long-term conclusions. However, the parameters that were analysed such as Oxford Knee Scores, alignment and positioning have given reasonable conclusions showing excellent outcomes in the medium term. Importantly, this series rekindles interest and adds to a recently dwindling body of literature that supports this technique as a viable alternative to the medial parapatellar approach with distinct advantages in fixed valgus deformed arthritic knees. There is no need to disrupt the soft-tissues on the medial side of the patella as the main structures which are contracted are on the lateral side which are directly addressed through this approach. Valgus deformities are often associated with patellar tracking problems. This approach provides better stability and tracking as shown by Hay et al. [24]. Our study confirms that it is safe to perform a good knee replacement through the lateral parapatellar approach with no increased risk of post-operative complications or short term or medium-term risk of failures.

Conclusion

Lateral parapatellar approach is a less practised but highly effective approach to deal with valgus arthritic knees. The technique is safe and reliable in achieving excellent functional and radiological outcomes without increasing prosthetic constraint and additional soft-tissue releases. It can be used for fixed valgus deformities, and it can preserve the soft-tissue stabilizers that are needed to maintain the stability and survival of prosthesis over the long term.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical standard statement This article does not contain any studies with human or animal subjects performed by the any of the authors.

Informed consent For this type of study informed consent is not required.

References

- Lange, J., & Haas, S. B. (2017). Correcting severe valgus deformity: taking out the knock. *The Bone & Joint Journal*, 99(1_Supple_A), 60–64.
- Ranawat, A. S., Ranawat, C. S., Elkus, M., et al. (2005). Total knee arthroplasty for severe valgus deformity. *Journal of Bone and Joint Surgery. American Volume*, 87(Suppl 1), 271.
- Keblish, P. A. (1991). The lateral approach to the valgus knee. Surgical technique and analysis of 53 cases with over two-year follow-up evaluation. *Clinical Orthopaedics and Related Research*, (271), 52.
- Rossi, R., et al. (2014). Total knee arthroplasty in the valgus knee. *International Orthopaedics*, 38, 273.
- Krackow, K. A., et al. (2002). Total knee arthroplasty in the valgus knee. *JAAOS-Journal of the American Academy of Orthopaedic Surgeons*, 10(1), 16–24.
- Xie, K., & Lyons, S. (2017). Soft tissue releases in Total Knee Arthroplasty for Valgus Deformities. *Journal of Arthroplasty*, 32(6), 1814–1818.
- Buechel, F. F. (1990). A sequential three-step lateral release for correcting fixed valgus knee deformities during total knee arthroplasty. *Clinical orthopaedics and related research*, 260, 170–175.
- Soffin, E. M., & Yadeau, J. T. (2016). Enhanced recovery after surgery for primary hip and knee arthroplasty: A review of the evidence. *BJA: British Journal of Anaesthesia*, 117(suppl_3), iii62–iii72.
- Specogna, A. V., et al. (2007). Radiographic measures of knee alignment in patients with varus gonarthrosis: Effect of weight-bearing status and associations with dynamic joint load. *American Journal of Sports Medicine*, 35(1), 65–70.
- Sarmah, et al. (2012). The radiological assessment of total and unicompartmental knee replacements. *Journal of Bone and Joint Surgery. British Volume*, 94(10), 1321–1329.
- Dexel, J., Kirschner, S., Günther, K., et al. (2014). Agreement between radiological and computer navigation measurement of lower limb alignment. *Knee Surgery, Sports Traumatology, Arthroscopy*, 22, 2721–2727.
- Krackow, K. A., Jones, M. M., & Teeny, S. M. (1991). Primary total knee arthroplasty in patients with fixed valgus deformity. *Clinical Orthopaedics and Related Research*, 273, 9–18.
- Whiteside, L. A. (1999). Selective ligament release in total knee arthroplasty of the knee in valgus. *Clinical Orthopaedics and Related Research*, 367, 130–140.
- Kanamiya, T., Whiteside, L. A., Nakamura, T., Mihalko, W. M., Steiger, J., & Naito, M. (2002). Effect of selective lateral ligament release on stability in knee arthroplasty. *Clinical Orthopaedics and Related Research*, 1976–2007(404), 24–31.
- Boettner, F., Renner, L., Narbarte, D. A., Egidy, C., & Faschingbauer, M. (2016). Total knee arthroplasty for valgus osteoarthritis: the results of a standardized soft-tissue release technique. *Knee Surgery, Sports Traumatology, Arthroscopy*, 24(8), 2525–2531.
- McAuley, J. P., Collier, M. B., Hamilton, W. G., et al. (2008). Posterior cruciate-retaining total knee arthroplasty for valgus osteoarthritis. *Clinical Orthopaedics and Related Research*, 466, 2644–2649.
- Satish, B. R. J., et al. (2013). Efficacy and mid term results of lateral parapatellar approach without tibial tubercle osteotomy for primary total knee arthroplasty in fixed valgus knees. *Journal of Arthroplasty*, 28, 1751–1756.
- Sekiya, H., Takatoku, K., Takada, H., et al. (2014). Lateral approach is advantageous in total knee arthroplasty for valgus deformed knee. *European Journal of Orthopaedic Surgery Traumatology*, 24, 111–115.
- Apostolopoulos, A. P., Nikolopoulos, D. D., Polyzois, I., Nakos, A., Liarakis, S., Stefanakis, G., & Michos, I. V. (2010). Total knee arthroplasty in severe valgus deformity: Interest of combining a lateral approach with a tibial tubercle osteotomy. *Orthopaedics & Traumatology: Surgery & Research*, 96(7), 777–784.
- Matsueda, M., et al. (1999). Soft tissue release in total knee arthroplasty: Cadaver study using knees without deformities. *Clinical Orthopaedics and Related Research*, 366, 264–273.
- Luring, C., Oczipka, F., Grifka, J., & Perlick, L. (2008). The computer assisted sequential lateral soft-tissue release in total knee arthroplasty for valgus knees. *International Orthopaedics*, 32(2), 229–235.
- Petersen, W., Rembitzki, I. V., Brüggemann, G.-P., et al. (2014). Anterior knee pain after total knee arthroplasty: A narrative review. *International orthopaedics (SICOT)*, 38, 319–328.
- Malo, M., & Vince, K. G. (2003). The unstable patella after total knee arthroplasty: Etiology, prevention, and management. *Journal of American Academy of Orthopaedic Surgeons*, 11, 364–371.
- Hay, G. C. G., Kampshoff, J. J., & Kuster, M. S. M. (2010). Lateral subvastus approach with osteotomy of the tibial tubercle for total knee replacement: A 2-year prospective, randomised, blinded controlled trial. *J Bone Joint Surg (Br)*, 92, 862–866.
- Chalidis, B. E., Ye, K., Sachinis, N. P., et al. (2014). Lateral parapatellar approach with tibial tubercle osteotomy for the treatment of noncorrectable valgus knee osteoarthritis. *The Knee*, 21, 204–208.
- Li, H., Ponzio, D. Y., Ong, A., Wei, W., Wang, B., Li, Z., & Zhou, D. (2020). Total knee arthroplasty for fixed valgus deformity correction using a modified lateral parapatellar approach. *The Journal of Knee Surgery*, 33(04), 372–377.
- Greenberg A, Kandel L, Liebergall M, Mattan Y, Rivkin G. Total Knee Arthroplasty for Valgus Deformity via a Lateral Approach: Clinical Results, Comparison to Medial Approach, and Review of Recent Literature [published online ahead of print, 2020 Mar 30]. *J Arthroplasty*. 2020
- Davis, J. A., Hogan, C., & Dayton, M. (2015). Postoperative coronal alignment after total knee arthroplasty: Does tailoring the femoral valgus cut angle really matter? *Journal of Arthroplasty*, 30(8), 1444–1448.
- Zhou, K., Ling, T., Xu, Y., et al. (2018). Effect of individualized distal femoral valgus resection angle in primary total knee arthroplasty: A systematic review and meta-analysis involving 1300 subjects. *International Journal of Surgery*, 50, 87–93.
- Metwally, R. G., & Zakaria, Z. M. (2018). Single-incision double-plating approach in the management of isolated, closed osteoporotic distal femoral fractures. *Geriatric Orthopaedic Surgery & Rehabilitation*, 9, 2151459318799856.
- Bologna, M. G., Claudio, M. G., Shields, K. J., Katz, C., Salopek, T., & Westrick, E. R. (2019). Dual plate fixation results in improved union rates in comminuted distal femur fractures compared to single plate fixation. *J Orthop*, 76–79.

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