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REVIEW ARTICLE

Lateral unicondylar knee arthroplasty (UKA): Contemporary indications, surgical technique, and results

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Abstract Unicompartmental femoro-tibial osteoarthritis usually affects the medial compartment of the knee, but in 10 %, the lateral compartment is primarily involved. Femoral osteotomy is attractive to avoid TKA in younger patients with low-grade unicompartmental osteoarthritis and a valgus deformity. However, only limited functional results can be expected for patients with Ahlback grade 2 or greater osteoarthritis. Moreover, because of previous skin incisions and hardware removal, TKA after femoral osteotomy remains a complex procedure with poor functional results. Unicompartmental knee arthroplasty for both the medial and the lateral compartments has been performed since the 1970s. In a patient with involvement of only one compartment, a medial or a lateral UKA can provide a quicker recovery and enhanced function when compared to TKA. In addition, it preserves bone stock and can be "easily" revised by a TKA. Technical improvements, combined with strict patient selection, have resulted in ten year survivorships greater than 90 %. However, lateral UKA is technically more challenging than medial UKA due to the lower number of indications, as well as the functional anatomy of the lateral compartment. The goals of this article are to present up-to-date information concerning indications, patients' selection, surgical technique and results of lateral compartment UKA.

Keywords Unicompartimental knee arthroplasty · Results · Technique · Indication · Lateral

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Introduction

Unicompartmental femorotibial osteoarthritis usually affects the medial compartment of the knee, but in 10 % the lateral compartment is primarily involved [1]. The non-arthroplasty treatment options of lateral compartment arthritis include conservative management with bracing, arthroscopic debridement, or femoral osteotomy. Arthroplasty options are either a unicompartmental knee arthroplasty (UKA) or total knee arthroplasty (TKA) [2–6]. Femoral osteotomy is attractive to avoid TKA in younger patients [7] with low-grade unicompartmental osteoarthritis and a valgus deformity. However, only limited functional results can be expected for patients with Ahlback grade 2 or greater osteoarthritis [8, 9]. Moreover, because of previous skin incisions and hardware removal, TKA after femoral osteotomy remains a complex procedure with poor functional results [10]. Unicompartmental knee arthroplasty for both the medial and the lateral compartments has been performed since the 1970s. In a patient with involvement of only one compartment, a medial or a lateral UKA can provide a quicker recovery and enhanced function when compared to TKA [3–6]. In addition, it preserves bone stock and can be "easily" revised by a TKA [11, 12]. Technical improvements, combined with strict patient selection, has resulted in ten-year survivorships greater than 90 % [4, 5]. However, lateral UKA is technically more challenging than medial UKA due to the lower number of indications, as well as the functional anatomy of the lateral compartment [13]. The goals of this article are to present the indications, pre-operative preparation, surgical technique, and results of lateral compartment UKA.

Indications

Our indications for lateral UKA are painful osteoarthritis (OA), osteonecrosis (OCN), or post-traumatic arthritis limited to the lateral compartment of the knee associated with significant loss of joint space on the radiographs [2–4, 6, 14]. While survivorship studies of modern UKA are comparable to that of TKA after the first decade, the selection process must be reconsidered in patients who are in their 60s and 70s [3, 13]. Age is not a consideration for us as long as the patient is suffering from bone-on-bone arthritis in one compartment with a preserved anterior cruciate ligament (ACL). While early reports of UKA considered obesity a relative contraindication, recent studies have not found a correlation between body mass index (BMI) and outcomes [4, 5]. It is our belief that UKA wear is more related to activity, rather than BMI [4, 5]. However, we consider any form of inflammatory arthritis an absolute contraindication to a lateral UKA due to the potential for rapid degeneration in the remaining compartments.

Pre-operative preparation

Physical examination criteria

During the clinical examination of a knee considered for a lateral UKA, it is essential for the surgeon to assess the range of motion (ROM). We require a minimum 100° of flexion, and no lack of extension. The clinical evaluation of the patellofemoral joint is also essential if the patient has any anterior knee pain. The stability of the joint should be carefully evaluated in the coronal and sagittal planes. Assessment of the ACL should be performed with caution, as the pivot shift test may be limited due to the pain and swelling in this arthritic knee [15]. During the varus stress test, the valgus deformation should be fully correctible.

Imaging

The radiological analysis systematically includes anteroposterior (AP) and lateral views of the knee, full-length radiographs in bipedal and single leg stance, varus and valgus stress radiographs, and a skyline view at 45° of knee flexion [16]. As first described by Kozin [17] and Scott (and later by other authors), UKA should be limited to those with a pre-operative valgus deformity of the lower limb <15°. However, in our experience, the most important factor is the ability to fully correct the deformity as uncorrectable deformities require soft-tissue releases, which should not be performed in a UKA as this may contribute to coronal femoro-tibial subluxation [17]. Varus and valgus stress radiographs are performed with the patient supine using a dedicated knee stress system. Such radiographs are absolutely essential to assess the presence of full-thickness articular cartilage loss in the uninvolved compartment and to confirm that the deformity is fully correctable to neutral [16]. In cases in which the deformity is not fully correctable, soft-tissue releases are required and thus a TKA should be completed. The lateral view of the joint confirms the absence of anterior tibial translation greater than 10 mm (referencing the posterior edge of the tibial plateau) and also shows that tibial erosion is limited to the anterior and mid-portions of the tibial plateau, confirming that the ACL is competent [16]. A skyline view of patellofemoral joint should also be completed to ensure that there is no joint space narrowing at 45° of flexion. The presence of periarticular osteophytes are not an absolute contraindication for a lateral UKA [18]. Occasionally, a magnetic resonance imaging (MRI) is completed when there is a clinical query about the competence of the ACL.

Patient expectations

Lateral arthritis is typically well-tolerated for a longer period of time than medial arthritis. As such, it is important to understand why patients are undergoing lateral UKA if they are young and active. If the main motivation is to return to high-level sporting activities, then a lateral UKA is not the appropriate solution. Intractable pain and a strong limitation in the daily activities (ADLs) are the only reasons to justify surgery, particularly for young and active patients. Patients must be prepared for a lateral UKA, including both physical and psychological preparation. The physical preparation includes maintaining range of motion to limit the risk of a postoperative knee contracture and to prepare the patient for the post-operative rehabilitation program. In addition, it is essential to optimize the quadriceps' and hamstrings' strength at the time of surgery. The goals for each postoperative day are presented to the patient pre-operatively in an effort to manage their expectations.

Surgical technique

The procedure is performed either under general or epidural anesthesia on a standard operating table using two leg holders, with or without tourniquet (according to the surgeon preference). One leg holder is placed at the lateral aspect of the thigh, and the second is placed below the foot. After the knee is prepped and draped in the usual standard fashion, it is flexed to 90° for the skin incision. The upper limit of the incision is at the superior pole of the patella, and extends distally toward the

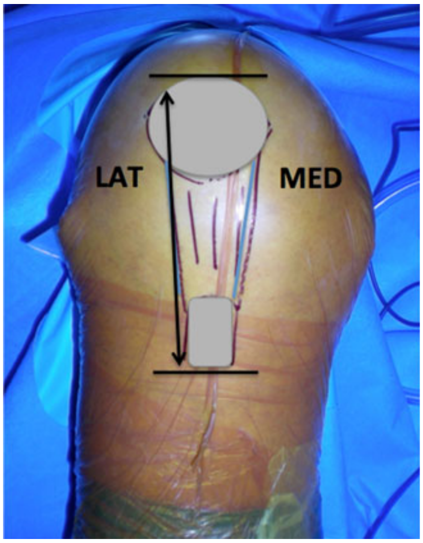


Fig. 1 This intra-operative photograph depicts the skin incision. The upper limit is the superior pole of the patella, while the incision is extended distally toward the lateral side of the tibial tuberosity

lateral side of the tibial tuberosity, but ending 2 cm under the joint line previously located (Fig. 1).

A lateral arthrotomy is performed and the joint is opened. Thereafter, the lateral portion of the fat pad is excised to properly visualize the condyle, ACL, and corresponding lateral tibial plateau (Fig. 2). It is important to note that the principles of ligament balancing cannot be applied to a lateral UKA and the collateral ligaments should not be balanced or released. The knee is then brought to 60° of flexion to evaluate the joint by checking the resistance of the ACL and noting the state of both the medial compartment and the patellofemoral joint. Next, the osteophytes should be removed in the intercondylar notch to avoid late impingement with the ACL on the notch.

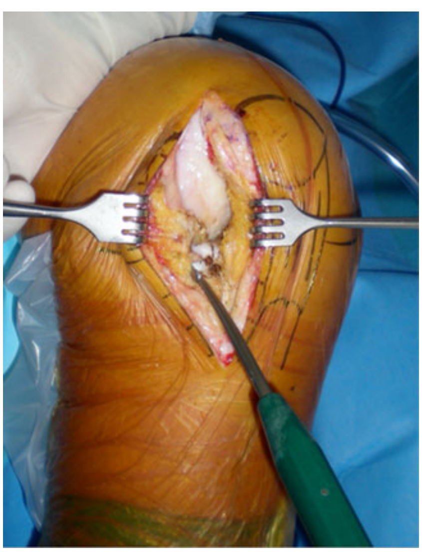


Fig. 2 After the lateral arthrotomy, the joint is opened and the lateral part of the fat pad is excised to expose the lateral femoral condyle, tibial plateau and ACL

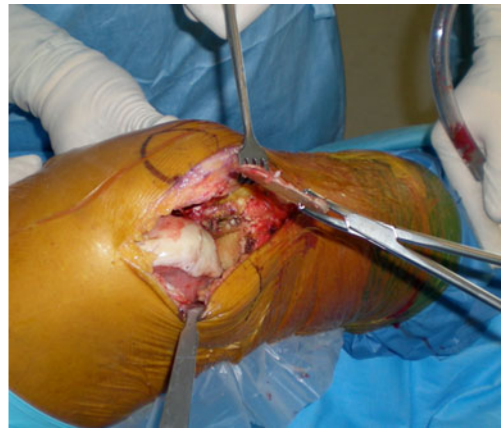


Fig. 3 Intra-operative photograph showing the thickness of the tibial resection, as the disease is more often on the femoral side, the tibial resection should be conservative and correlated to the implant thickness

The osteophytes on the lateral femoral condyle should not be removed, as these osteophytes will be helpful for the positioning of the femoral compartment [18, 19]. Before completing the vertical tibial cut, it is important to identify and mark the anterior contact point between the tibial native tibial plateau and the anterior part of the femoral condyle.

Tibial cut

There are three important points concerning the tibial cut related to the functional anatomy of the lateral compartment. First, the tibial resection should be minimal (2–4 mm maximum), because the disease more often affects the femoral side

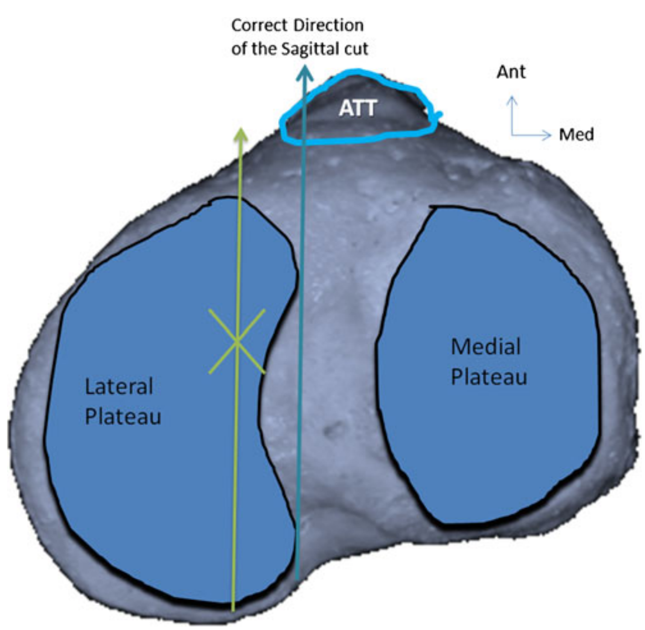


Fig. 4 The sagittal tibial cut should be performed respecting the tibial spine eminence, and should follow the line joining the most medial point of the mid-portion of lateral plateau (posterior to the ACL insertion) and the most medial border of the lateral plateau (anterior to the ACL insertion)

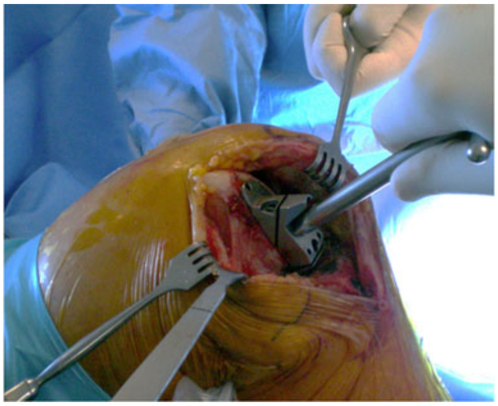


Fig. 5 Search for the best compromise between an anatomically centered position on the femoral condyle and the long axis perpendicular to the resected tibial plateau

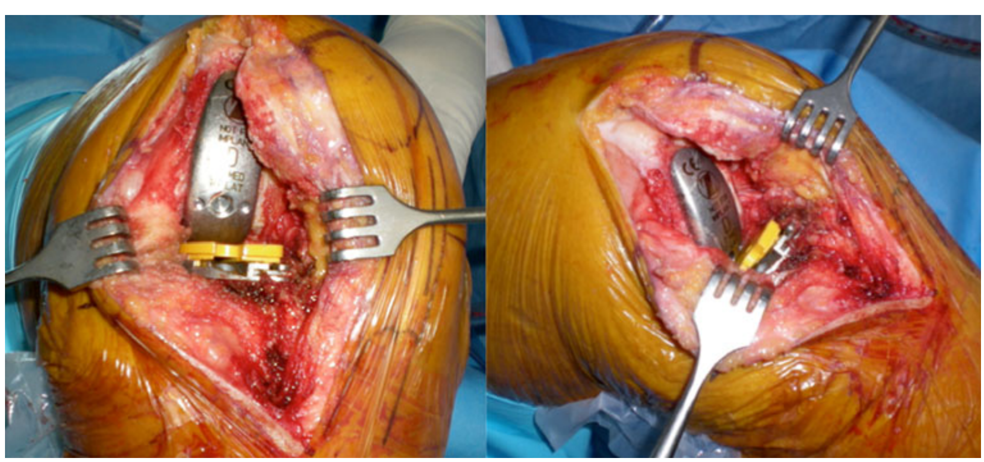
(Fig. 3). It is important to keep the depth of the tibial cut as conservative as possible to take advantage of the strength of the tibial cortex. In addition, this increases the area of contact proximally. An extramedullary guide is used to make the tibial cut. The proximal part of the guide rests on the anterior tibia, pointing toward the axis of the tibial spines. The cutting slot rests on the upper lateral tibia to be resected. Second, the natural slope (which is around 0° on the lateral compartment) should be reproduced. The last important point concerns the sagittal cut. It should be performed respecting the tibial spine eminence following the line joining the most medial point of the mid-portion of lateral plateau (posterior to the ACL insertion) seen in flexion and the most medial border of the lateral plateau of the anterior part of the lateral plateau (anterior to the ACL insertion) seen in extension. After determination of these two points, the line joining these two points should be marked with the electrocautery. Due to the natural orientation of lateral tibial plateau (Fig. 4), this line crosses the patellar tendon which is then in the way of the saw blade. While another team [17] recommends performing the cut through the patellar tendon, we recommend a careful retraction of the tendon to make this sagittal cut free-hand following the line drawn with the electrocautery.

Femoral cuts

The entrance hole of the distal femur for the intramedullary technique is centered above the roof of the intercondylar notch. The knee is brought to 60° of flexion to drill the femoral medullary canal. The distal femoral cut can be made based upon the angle between the anatomic and mechanical axis previously calculated on the full weight-bearing view (usually 4–6°). The extension space is then checked using a dedicated spacer block. Next, the remainder of the femoral cuts (posterior cut and chamfers) are completed with the appropriately sized cutting block when the below rotation is set.

Rotation of the cutting blocks is essential. The lateral aspect of the femoral cutting block should follow the lateral aspect of the condyle to avoid any excessive internal rotation in extension due to the screw-home mechanism related to the natural divergence of the lateral femoral condyle (compared to the medial condyle) (Fig. 5). The size of the cutting block is determined by searching for the best compromise between an anatomically centered position on the femoral condyle and a long axis perpendicular to the resected tibial plateau. Particular care should been given to avoid oversizing of the femoral component. We do recommend to use the following landmark—the top of this finishing guide should be localized 1–2 mm below the deepest layer of the cartilage to avoid a potential notch between the femoral implant and the patella. Once the posterior cut and chamfers have been made and the cutting guide is removed, removal of any posterior osteophytes is necessary as the removal of any bony or soft tissue remnant in the posterior space of the knee is crucial to obtain good range of flexion to avoid any posterior impingement with the polyethylene in high flexion.

Fig. 6 The flexion-extension gaps are stressed with the trial components in place, including a trial polyethylene liner



Tibial finishing and trials

The size of the tibial tray should now be determined, resulting in the best compromise between maximal tibial coverage, but without any overhang in the MP and AL planes. The knee is then brought into maximal flexion and internally rotated to facilitate the final preparation of the tibia with the appropriate guide with the underlying keel impacted into the subchondral bone. The flexion-extension gaps should then be tested with the trial components in place and inserting a trial polyethylene liner (Fig. 6). At that step, it is important to search for any impingement of the femur against the tibial spine eminences in extension due to a lack of external rotation in flexion. In flexion and in extension, during the trials, the medial part of the femoral component should be in line with the middle of the tibial component. The polyethylene insert is often thicker here than for the medial side due to the femoral dysplasia. However, it is essential to undercorrect the deformity in lateral UKAs to avoid any overstuffing of the unresurfaced medial compartment, which is essential for successful long-term results. The final cemented tibial component is inserted first with the knee in full flexion and internally rotated to improve the exposure of the lateral compartment. Once the femoral implant has been inserted, bringing the knee close to extension helps to remove any posterior cement. Finally, the polyethylene can be inserted in flexion after the cleaning and the drying of the metal-backed tibial implant.

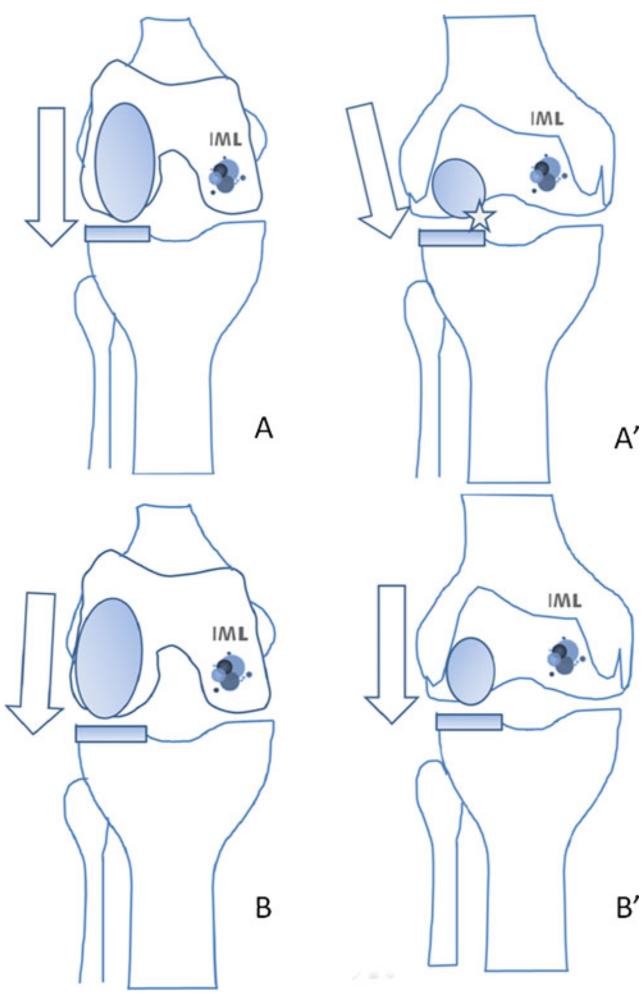


Fig. 7 Effect of the "screw home mechanism" on femoral implant positioning (flexion-extension)

The screw home mechanism

The "screw-home" mechanism is considered to be a key element to knee stability for standing upright, as this is the rotation between the tibia and femur [20] (Fig. 7). At the end of knee extension, between full extension and 20° of knee flexion, external rotation of the tibia occurs and results in tightening of both cruciate ligaments, which locks the knee. The tibia is then in the position of maximal stability with respect to the femur [20]. Due to this phenomenon, surgeons must keep in mind that a good femoral implant position in flexion may lead to an excessive internal rotation in extension and impingement on the tibial spine eminence. Therefore, the positioning in flexion should exaggerate the lateral rotation and the lateral positioning (almost on the lateral osteophytes to obtain a satisfactory position in extension).

Fig. 8 Post-operative long axis X-rays of a 55-year-old man, operated for osteoarthritis limited to the lateral compartment of the knee

Results of lateral UKA

As UKA in the lateral compartment is technically more challenging and ten times less commonly performed than medial UKAs, only limited data are available concerning outcomes of lateral UKA [21, 22]. Scott et al. reported only one failure out of 19 patients at 89 months of followup [10]. Recently, two other series reported high functional scores without revision at 5.2 years and at 12.4 years, respectively [20, 22]. In 2008, we presented the results of a consecutive series of 39 lateral UKA [2]. The aetiologies of the lateral osteoarthritis were primary osteoarthritis (60 %), post traumatic (30 %), and osteonecrosis (10 %). The Knee Society pain and function scores improved significantly after lateral UKA between the pre-operative and the final evaluation (mean follow-up of 12.6±4.2 years). All but ten patients returned to their pre-operative activity level (63 %). Pre-operatively, the mean active knee flexion was 115°±8° (range, 100–135°), and 134°±7° (range, 122–153°) at final follow-up. At the time of the final follow-up, 23 patients (62.3 %) were enthusiastic about the procedure. Concerning the post-operative radiological outcomes, the mean HKA was 183° ±2, the mean AP axis of the tibial component 90°±3, the mean tibial slope 3°±4 and the mean AP femoral axis was 91°±5 (Fig. 8). Our results demonstrate that lateral UKA can provide reasonable clinical and radiographic results, with survivorship at ten and 20 years comparable to the survivorship obtained for medial UKA [23]. The rate of radiolucencies observed in our series (10 % of nonprogressive tibial radiolucencies) was comparable with those observed in previous series of lateral UKA at the same followup [20, 22, 24, 25].

Some authors [2] have reported a high rate of failure using the mobile-bearing Oxford lateral unicompartmental prosthesis, with a 10 % rate of bearing dislocation. When studying in vivo kinematics of patients implanted with either a medial or lateral UKA, we showed an important posterior femoral translation of the lateral condyle during flexion compared with the medial one [26]. According to these results, fixed-bearing implants seem more appropriate to fit the biomechanical properties of the lateral compartment [27–30].

Conclusion

Since both the anatomic and the biomechanical characteristics are different in the medial and lateral compartments, some surgical considerations must be outlined for the lateral compartment UKA [27, 28]. First, the rule of undercorrection of the deformity should be strictly applied during lateral UKA [29, 30] to avoid medial OA progression. Second, the natural divergence of the lateral femoral condyle when the knee is flexed must be taken into consideration when positioning the femoral component to avoid impingement with the tibial spines when brought into extension [29, 30]. Third, at the time of implant positioning, excessive lateral placement in extension should be avoided as this may lead to an overload of the lateral part of the tibial plateau when the knee is flexed to 30° [29, 30]. Finally, internal rotation of the tibial component when performing lateral UKA must accommodate the typical "screw-home" mechanism that occurs during knee flexion, and this should be included when performing the sagittal tibial cut [31].

With careful patient selection and appropriate surgical technique, lateral unicompartmental knee arthroplasty can provide a durable construct with long-term success and reliable pain relief.

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