Total Knee Arthroplasty: The Basics, Surgical Technique to Get Your Total Knee Arthroplasty Right

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Victoria B. Duthon, Fredrik K. Almqvist, Peter C.M. Verdonk, Paolo Adravanti, Philippe Neyret, Jean-Louis Briard, Andrea Baldini, Jan Victor, and P-J. Vandekerckhove

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V.B. Duthon (✉)
Service de chirurgie orthopédique et traumatologie, Hôpitaux Universitaires de Genève, Genève, Suisse
e-mail: victoria.duthon@hcuge.ch

F.K. Almqvist, M.D., Ph.D. • P.C.M. Verdonk, M.D., Ph.D. • J. Victor, M.D., Ph.D. • P-J. Vandekerckhove
Department of Orthopaedic Surgery, Ghent University Hospital, Ghent, Belgium
e-mail: fredrik.almqvist@ugent.be; pverdonk@yahoo.com; j.victor@skynet.be

P. Adravanti
Clinic "Città di Parma", Parma, Italy
e-mail: info@paoloadravanti.com

P. Neyret
Centre Albert Trillat, Hospices Civils de Lyon, Lyon, France
e-mail: philippe.neyret@chu-lyon.fr

J-L. Briard
Clinique du cèdre, Bois Guillaume, France
e-mail: jlbriard@wanadoo.fr

A. Baldini, M.D.
IFCA Institute, Florence, Italy
e-mail: drbaldiniandrea@yahoo.it

Humanitas Institute, Via Manzoni 56, Rozzano Milan, Italy
e-mail: drbaldiniandrea@yahoo.it

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15.1 Pearls for a Consistent and Reliable Exposure

Fredrik K. Almqvist, M.D., Ph.D.,
P-J. Vandekerckhove,
Peter C.M. Verdonk, M.D., Ph.D., and
Jan Victor, M.D., Ph.D.

Total knee arthroplasty (TKA) is a successful procedure that is performed increasingly due to more present painful knee osteoarthritis. After a correct indication for a TKA, a good exposure during this procedure will assure a good clinical and radiological result.

A systematic approach to expose the knee joint will allow for a rapid and safe exposure even in severe deformities and complex cases.

The most performed approach to the knee joint in TKA is the *anteromedial incision* [26]. This approach starts 5 cm above the patella and ends at the medial part of the anterior tibial tubercle. In order not to compromise the vascularity of the soft tissue, no subcutaneous dissection should be performed before opening the superficial aponeurosis. This aponeurosis is a thin structure but easily distinguished from the subcutaneous fatty tissue. Once this aponeurotic plane has been reached, further dissection can be performed without any risk. The anterior plane of the patella is visualized up to the lateral part of the knee cap. The quadriceps tendon is seen superior to the patella, and below the knee cap, the medial part of the patella tendon is visualized (Fig. 15.1).

The anteromedial arthrotomy is then realized, beginning with a longitudinal opening medial to the quadriceps tendon (a midvastus, subvastus, or quad-sparing approach could also be considered) with a thin layer of the tendon left at the medial vastus muscle assuring and facilitating a firm closure at the end of the procedure. The incision is pursued on the medial part of the patella, and the arthrotomy continues at the medial border of the patella tendon ending at the superomedial part of its insertion on the anterior tibial tubercle. The medial meniscus is further on resected, and the medial capsule is released to the bone from its anteromedial part of the tibial plateau. This is the triangle detachment of the anteromedial capsulomeniscal tissue. The deep fibers of the medial collateral ligament are released on the superior part of the tibia plateau, and, consequently, the complete resection of the medial meniscus completes the visualization of the medial compartment of the knee joint.

The knee is then extended, and the patella is everted or luxated followed by flexion of the knee without any damage to the insertion of the patella tendon. The synovial tissue present anterior to the femur is extensively resected to visualize the supratrochlear region. The Hoffa fat pad could also be resected, and the lateral meniscus is then removed. To optimize the exposure, all the osteophytes are removed and the intercondylar notch is carefully cleaned up with removal of the anterior cruciate ligament (posterior cruciate ligament). The tibia could then be luxated anteriorly to give a full exposure of the tibia plateau, once again taking care of the insertion of the patella tendon.

Proper retractor placement will facilitate the procedure. A blunt Homann retractor at the medial femoral condyle will reduce the risk of any damage or transection of the medial collateral ligament. The same is true for protecting the popliteal tendon when performing the posterolateral femoral cuts.

The *lateral approach or Keblish approach* could be performed in a contracted valgus deformity and in the valgus knee combined to patellofemoral osteoarthritis with subluxation. This approach differs substantially from the standard medial parapatellar approach. The arthrotomy is performed lateral to the patella tendon, the patella, and the quadriceps tendon [28]. In cases where the luxation of the patella is difficult or when the visualization of the tibia plateau is insufficient, a tibial tubercle osteotomy could be performed [27]. When the valgus deformity is partially reducible, an inside-out lateral release with the piecrusting technique can be safely performed. If the deformity is contracted, a lateral epicondylar sliding osteotomy is a reliable technique to balance the replaced joint in flexion and extension. Care should be taken not to damage the popliteal tendon as this potentially will increase the flexion laxity.

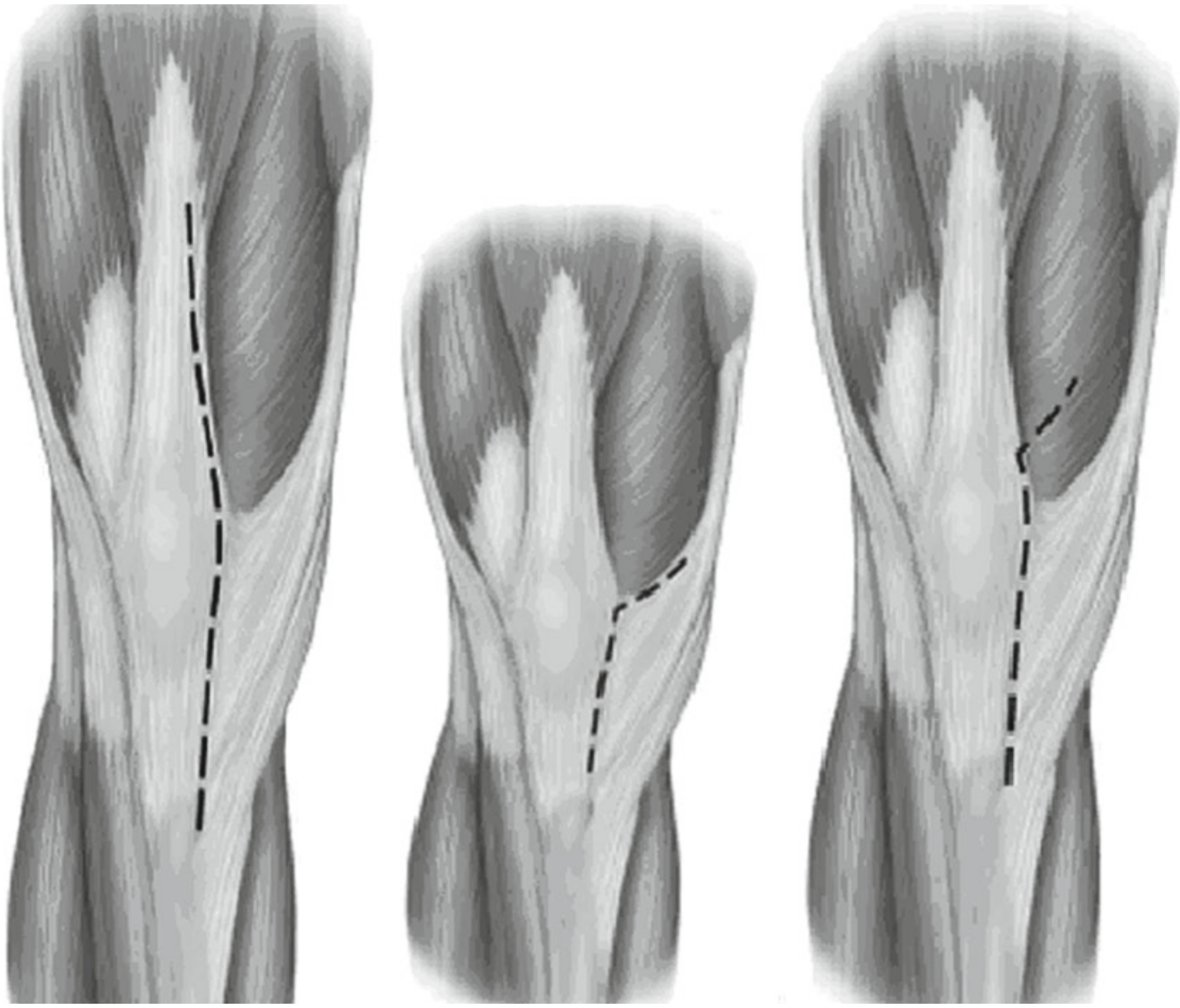

Fig. 15.1 Three different anteromedial approaches to the knee joint – parapatellar, subvastus, and midvastus

15.2 Joint Line Preservation in the Deformed Primary Knee

Paolo Adravanti

15.2.1 Introduction

The main issues of total knee arthroplasty (TKA) are (1) restoration of femorotibial alignment, (2) reproduction of similar flexion and extension space configurations, (3) soft tissue balancing, (4) optimization of the patellofemoral biomechanics, and (5) restoration of the joint line.

Joint line position is an important factor in overall functioning of the knee and therefore must be taken into account when performing total knee arthroplasty (TKA) [1]. Changes in joint line position are likely to have multiple effects involving the femoral-tibial articulation and the patellofemoral extensor complex. Indeed, a decrease in the Insall-Salvati ratio is associated with a reduction in knee joint function and in the ability to climb stairs [2, 3].

The preservation of the correct joint line strictly depends on the bone cuts and on the ligament balancing. Evaluation of the patellofemoral compartment is the key point to correctly perform the bone cuts. Moreover, the inextensibility of the patellar tendon is an essential parameter to choose the correct femoral size in order to obtain an ideal patellar height.

15.2.2 Surgical Approach

15.2.2.1 Joint Line Preservation in Extension

Starting from the distal femoral cut, it is important to remove the bone according to the thickness of the distal femoral prosthesis, but especially in the deformed knee, the loss of the cartilage needs to be taken in count. Indeed, when the jig gets in contact with the subchondral bone, surgeon should reduce the distal femoral resection in order to avoid elevation of the joint line. On the contrary, the thickness of the tibial cut does not affect the joint line since it is substituted by the tibial metal-backed component and by the insert.

The conservative distal femoral and the proximal tibial cuts have to be performed so as to use the minimum tibial PE insert; then, it is fundamental to obtain the balancing in extension avoiding over-release, in particular in deformed knees where over-release causes the elevation of the joint line.

15.2.2.2 Joint Line Preservation in Flexion

The main objective of this step is to reestablish the posterior condylar offset (PCO) (Fig. 15.2) since it allows a greater degree of flexion [4] and a correct positioning of the joint line. For this reason, bone cuts have to guarantee the same A/P size of the femur, considering the cartilage loss of the posterior femoral condyles. Therefore, surgeon should be able to predict the space in flexion before

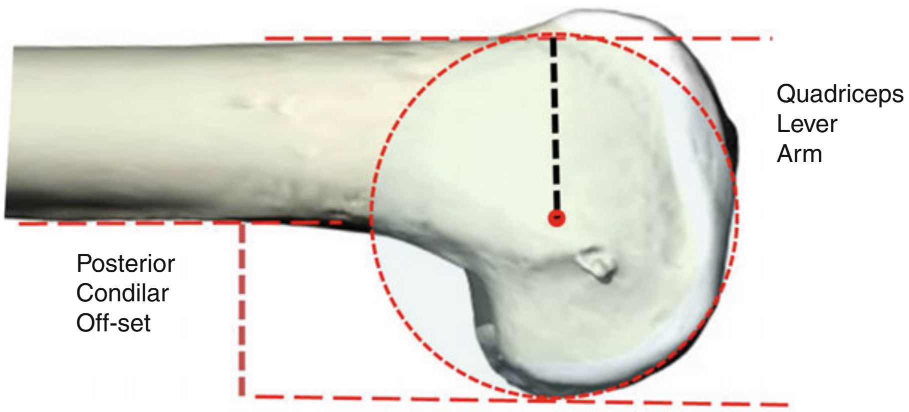

Fig.15.2 The posterior condylar off-set and the quadriceps lever arm

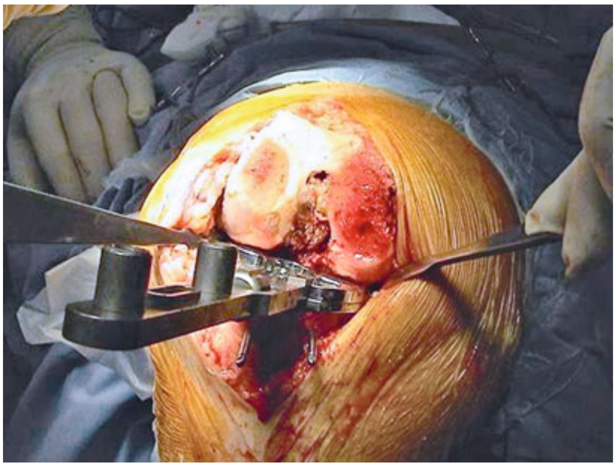

Fig. 15.3 Spacer used to analyse the amount of space in flexion

cutting the posterior femoral condyles. Moreover, the volume in flexion is strictly dependent from the type of implant (CR-PS) [5, 6]. This new volumetric concept is totally independent both from anterior and posterior reference instrument sets. Spacers that allow analyzing the amount of the space in flexion could be therefore very useful (Fig. 15.3). Another important issue concerns the reestablishment of the quadriceps lever arm (QLA) (Fig. 15.2), avoiding notching of the anterior femoral cortex and overstuffing of the patellofemoral joint [7].

Extra rotation can also affect joint line in flexion; indeed, many instrument sets used to calculate the extra rotation pivot centrally, increasing the resection of the posterior condyle medially and decreasing it in the same way laterally. Especially in the deformed knee, it would be useful to have jigs able to determine extra rotation pivoting on the medial femoral condyle, with reference just to joint line medially due to the patient-specific anatomic laxity of the lateral compartment in flexion.

To achieve an adequate joint line position, it is possible only with modular femoral components that differ minimally in size, which then allow to posteriorize as far as possible the component, while maintaining a correct anterior cut and particularly without compromising flexion and extension spaces.

15.3 Dealing with Fixed Flexion Deformity

Peter C.M. Verdonk, M.D., Ph.D.,
K. Fredrik Almqvist, M.D., Ph.D., and
Jan Victor, M.D., Ph.D.

15.3.1 Introduction

Flexion contracture (FC) is a common finding in the degenerative knee. The incidence is estimated to be approximately 30% of patients who are candidates for primary total knee arthroplasty. Most commonly, this deformity is caused by pain and effusion in combination with posterior femoral and tibial osteophytes. The posterior capsule is tented around these osteophytes, resulting in a functional shortening of the posterior capsule (Fig. 15.4). Often, flexion contracture is combined with angular deformities of the lower limb, most commonly varus malalignment. In a small number of patients, isolated bone deformities can explain the phenomenon.

In a large database, the mean flexion contracture was 5° in osteoarthritic joints, 10.5° in rheumatoid arthritis, and 14.1° in posttraumatic cases. Flexion contracture is also notorious in hemophilic arthropathy.

The importance of FC is illustrated by the effect it has on the outcome of primary TKA procedure: persistent FC after TKA results in a significant poorer clinical outcome and lower patient satisfaction. During normal gait, the knee is in full extension at heel strike and then gradually flexes during stance and swing phase. Inability to fully extend the knee will result in increased quadriceps contractions to prevent the knee from buckling. In addition, lack of full extension will shorten the leg, resulting in limping and potential pain in the hip and lower back. Flexion contracture should therefore be addressed during TKA and full extension should be obtained.

In this chapter, we will provide an overview of the known risk factors for persistent FC after TKA and provide a surgical algorithm to address FC during primary TKA.

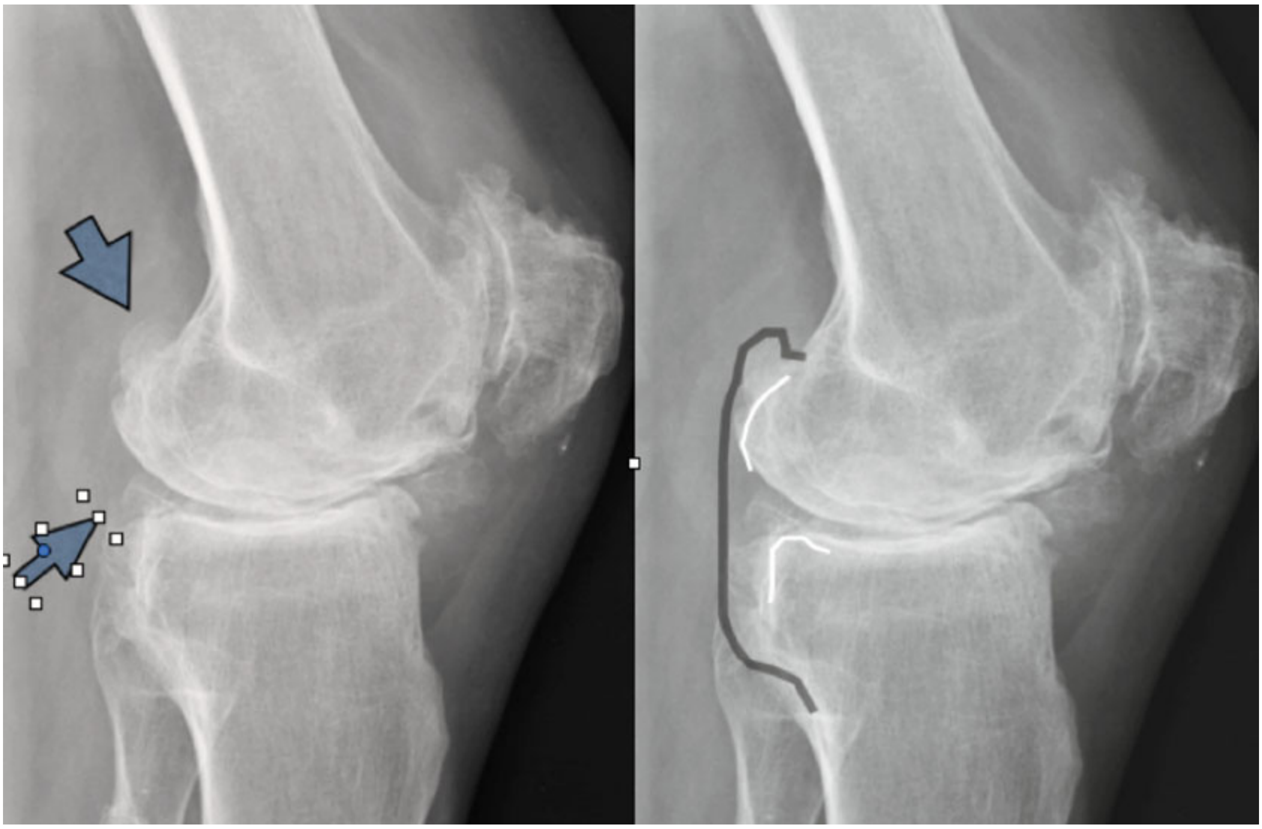

Fig. 15.4 Radiographs showing posterior osteophytes and the position of the posterior capsule

15.3.2 Patient-Related Risk Factors for Persistent Flexion Contracture After Primary TKA

Several patient-related risk factors have been identified for persistent FC after primary TKA. The incidence of FC after primary TKA was 3.6% at 2 years in a recent study. Men were 2.6 times more likely than women to have FC. Preoperative FC resulted in a 2.3 times increased risk for postoperative FC. Increased age was also associated with an increased risk. There was no significant difference in patients treated with navigated vs. conventional surgery nor did obesity influence the occurrence or persistence of FC after TKA.

15.3.3 Surgical Algorithm for Treating Flexion Contracture at Time of TKA

Flexion contracture is most commonly caused by a functional shortening of the posterior capsule. The functional shortening is a direct consequence of the tenting of this capsule around posterior osteophytes (Fig. 15.4). Most surgeons therefore proposed to meticulously remove all osteophytes especially in the back of the knee (step 1). If full extension is not yet achieved at this point, a progressive release of the posterior capsule and head of gastrocnemius is performed (step 2). Over-resection of the distal femoral cut by up to 4 mm can be deemed necessary if extension is not reached (step 3). A tenotomy of the medial hamstrings is only rarely necessary (step 4). In a recent study by Bellemans et al., full extension could be achieved in 98.6% of cases after steps 1 and 2. Even in flexion contractures greater than 30°, steps 3 and 4 had to be performed in only 29% and 23% of cases, respectively.

15.3.3.1 Tips and Tricks

Access to the posterior compartment of the knee can be challenging. Complete removal of all osteophytes is essential prior to any ligament release in extension and flexion.

To open up the posterior compartment in order to reach the femoral posterior osteophytes, a laminar spreader can be used in flexion (Fig. 15.5). Careful resection using a chisel or bone resector is advised (Fig. 15.6).

The posterior femoral capsular release can be performed using a rugine while always staying in

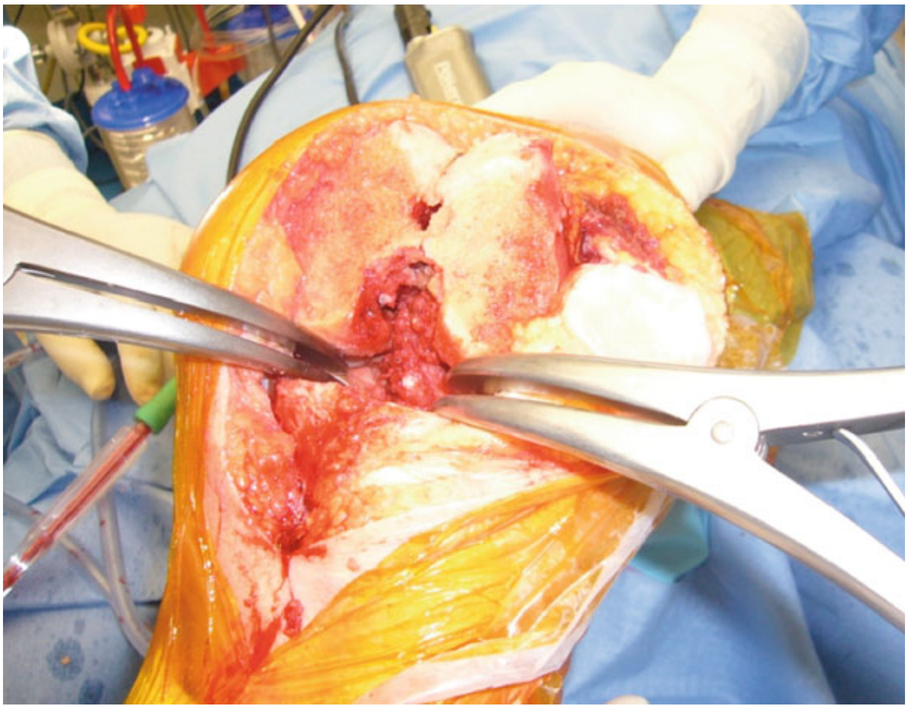

Fig. 15.5 Laminar spreaders are used to expose the posterior compartment in flexion

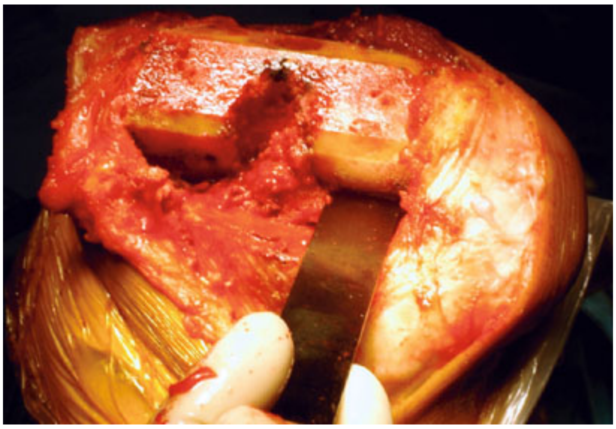

Fig. 15.6 Resection of posterior ostephytes

contact with the bone. A powerful trick is the use of swaps in addition to the rugine. This "volume" distraction results in a safe and soft release of the posterior capsule. On the tibial side, the posterior capsule can be released in flexion. To do so, the tibia is forced into external rotation and pushed forward of the femur. The attachment of the musculus semimembranosus is sharply dissected from the posteromedial corner of the tibia (Fig. 15.7). The capsule can then be further released from the posterior edge of the tibia onto the insertion site of the PCL.

The PCL does not contribute to flexion contracture as its release affects the flexion gap more than the extension gap.

15.3.3.2 Surgical Errors

Surgical errors and component malpositioning can also account for the occurrence of a flexion contracture postoperatively. A tight extension gap resulting from an insufficient resection of the tibia or distal femur often results in a flexion contracture. The surgeon should also be knowledgeable of the configuration of the prosthetic design. Excessive flexion of the femoral component can result in a post-cam conflict limiting full extension. Excessive tibial slope in combination with a tibial component with a high anterior buildup (ultracongruent) can result in anterior impingement and extension loss. In posterior-stabilized TKA, the cam has to consider the extra volume in between the condyles and can create an additional conflict with the posterior capsule in extension (Fig. 15.8). This may result in a FC. Therefore, the authors pay specific attention to the release of the femoral capsular attachments in the posterior notch area.

15.3.4 Postoperative Treatment

Postoperatively, an FC can develop based on intra-articular swelling and hematoma. Frequently, the patient will use a pillow or other bolster under the knee. If this occurs on a repeated basis in the first weeks, FC can develop.

Of interest is a recent study looking into the natural history of FC after TKA in patients with limited FC preoperatively (preoperative FC less than 15°). In that series, 10.5% of patients presented initial FC after TKA. The vast majority were diagnosed with a limited FC of less than 15°. 8.8% presented an initial post-op FC of more than

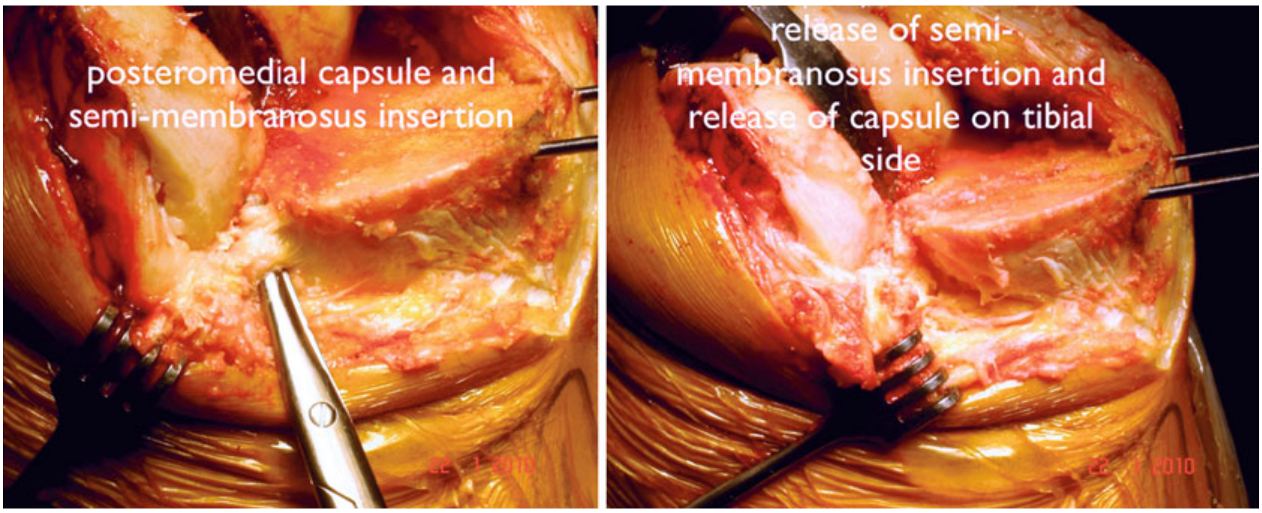

Fig. 15.7 Posterior capsule release on the tibia

Fig. 15.8 The cam of the femoral component of a posterior stabilized TKA (*center* and *right* pictures) creates an extra volume between the condyles, as compared to the femoral component of a PCL-preserving TKA (*left picture*)

15°. FC gradually improved in over half to normalize at 12 months. FC persisted in only 5.9% of patients. In another study, FC greater than 15° at 3 months had a tendency to persist at 2 years.

In the postoperative stage, physical therapy with focus on quad strengthening exercises and serial casting or splinting can be beneficial. However, correction can be slow and partial.

15.4 Rotational Alignment of the Tibial and Femoral Component

Victoria B. Duthon and Philippe Neyret

15.4.1 Introduction

Correct rotational alignment of the femoral and tibial component is an important factor for successful TKA. Rotational malalignment may lead to patellar maltracking, anterior knee pain, femorotibial flexion instability, and premature wear of the polyethylene inlay, leading to higher revision rates and less favorable clinical results.

15.4.2 Rotational Alignment of the Femoral Component

Femoral component rotation affects the kinematics of both tibiofemoral and patellofemoral joints after TKA. For example, a biomechanical study has shown that internal rotation of 5° causes tibial abduction at 90° of flexion, and external rotation of 5° causes tibial adduction at 90° of flexion [8].

Rotational alignment of the femoral component can be determined by two methods: a *technique based on bony landmarks* (also called "measured resection technique") and a *technique based on ligament balancing* (also called "gap balancing technique") described by Insall [9].

Several anatomical axes have been described to evaluate femoral component rotation (Fig. 15.9):

- *The transepicondylar axis* (TEA) defined as the line connecting the lateral epicondylar prominence and the medial sulcus of the medial epicondyle [10]. However, the epicondyles may be difficult to find during surgery because of the soft tissues. Then Yoshino et al. [11] defined a "clinical" and a "surgical" TEA. A recent anatomic study showed that using this axis as the only landmark to position the femoral component during a first intention TKA is not recommended [12].
- *The posterior condylar axis* (PCA) defined as a line connecting the posterior condylar surfaces of the femur; the mean angle between the PCA and the TEA is called "condylar twist angle" and is 4.7° for men and 5.2° for women.

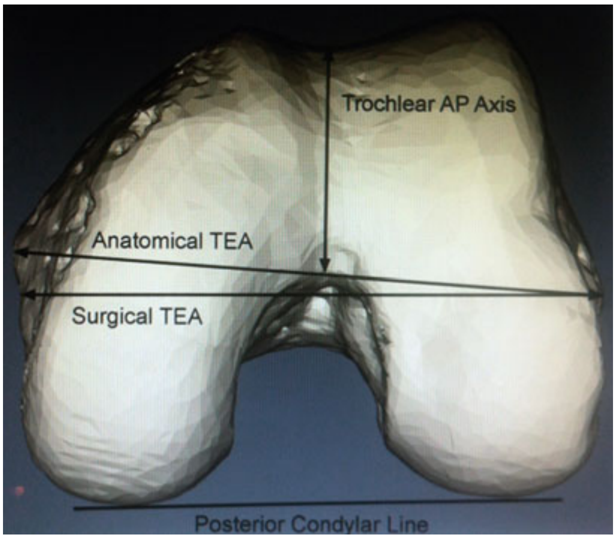

Fig. 15.9 Common axes used to evaluate femoral component rotation

- *The anteroposterior axis* (Whiteside's line) defined as the line connecting the deepest part of the patellar groove anteriorly and the center of the intercondylar notch posteriorly [13]; the mean external rotation of the anteroposterior axis relative to the PCA is 4°.

Based on those anatomic angles, surgeons commonly place the femoral component of a TKA in different ways:

- With a fixed external rotation of 3° relative to the posterior condylar axis, as proposed by many instrumentation systems, the idea is to compensate for the angular discrepancy that results from the proximal tibial cut because the tibial articular surface is in 3° varus in normal knees [14]; Akagi et al. ([15]) confirmed that setting the femoral component with an external rotation of 3°–6° relative to the PCA is appropriate in a knee with common varus or neutral alignment but is not recommended in cases of severe valgus deformity with abnormally small lateral condyle.
- Aligned with the PCA and then without any rotation.
- Aligned with the TEA or 4° externally rotated from the PCA, the anterior femoral cut then has a bimodal shape with the lateral peak twice the height as the medial peak: this is called the "grand-piano sign" [16].
- The technique of "condylar asymmetry report" (based on the TEA). In this technique, the

rotation depends on the asymmetry of the distal femoral cut. If the jig touches only the medial condyle, the distal cut will be bigger on the medial condyle than on the lateral one. This asymmetric cut is reported in flexion by turning the jig in order to cut less on the posterior lateral condyle than on the posterior medial condyle. This posterior cut will induce an external rotation of the femoral component equivalent to the asymmetry of the distal cut. This is even more important in severe valgus knees with hypoplastic external femoral condyle. However, in case of femoral varus (femoral mechanical angle < 90°), the asymmetric distal cut is not reproduced to prevent internal rotation of the femoral component. The cut is done with no rotation, and we accept some amount of residual femoral varus. Nevertheless in case of very severe femoral varus, one may consider a more constrained prosthesis or a correction of the femoral extra-articular deformity.

We apply the method of measured resection with condylar asymmetry report and subsequent ligament balancing according to the differential nature of the collateral structures between flexion and extension. Once correct bony alignment is achieved, any ligament imbalance can be corrected.

A preoperative computed tomography (CT) is recommended to evaluate individual morphology and to do a correct preoperative planning [17]. Indeed the optimal adjustment of femoral component rotation is individual and depends on the type of deformity and femoropatellar joint pathology. The results of radiographic measurement analysis will allow the surgeon to plan the operative strategy and select a suitable type of instrumentation system and implant.

15.4.3 Rotational Alignment of the Tibial Component

There is little consensus in the literature over the ideal rotational alignment of the tibial component. Internal rotation of the tibial component leads to subluxation of the patella and to stiff TKA [18].

Described landmarks are anterior tibial tubercle (ATT), PCL insertion, posterior tibial margin (PTM), and the widest dimension of the tibial surface.

Another option is the “self-seeking method” which aligns the tibial component according to the rotational alignment of the femoral component during trial reduction. This technique positions the tibial plateau parallel to the femoral component and prevents rotational discrepancy between femoral and tibial components [19]. However, the risk is to transfer a femoral malrotation to the tibia.

Most surgeons use the ATT as reference point. A recent study states that the medial third seems to be better than medial border of tibial tuberosity [20]. However, Bonnin et al. [21] recently showed that ATT is not a reliable landmark for rotation of the tibial component. Knee prosthesis is still essentially symmetrical, and design of the tibial component restricts the choice of rotational alignment because the goal is to optimize simultaneously prosthetic cut coverage and alignment with the extensor mechanism. He concludes that it is important to keep the centers of the prosthetic compartments on the centers of the osseous compartment. That often means no parallelism with the posterior tibial margin, which however has been described to be the least variable local landmark for tibial component positioning at deep resection levels (during TKA revision) [22].

To compensate for tibial malrotation, mobile bearing tibial plates can be used. They allow decoupling of bone coverage and rotational alignment either with fixed bearings, which allow rotation at the femur/insert interface, or with rotating platforms, which allow rotation at the insert/baseplate interface.

15.4.4 Evaluation of Rotational Alignment of the Tibial and Femoral Component

The postoperative radiological measurement of tibial and femoral component rotation is necessary when patients present knee stiffness, altered knee kinematics, or abnormal femoropatellar tracking. CT with a software lowering metallic artifacts is necessary in order to see bony landmarks important for measures [23]. The condylar

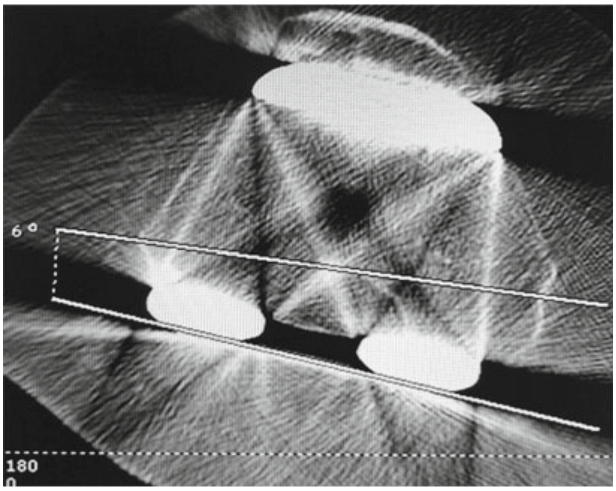

Fig. 15.10 Condylar twist angle measured on CT

twist angle should be measured for the femoral component (Fig. 15.10). The tibial component position is evaluated relative to the ATT or to the posterior border of the tibial condyles. Femoral component rotation alone can be measured on standard radiographs as described by Eckhoff [24] and Kanekasu [25], but it is less accurate than scanographic measures.

No “normal values” are described in the literature, but it is well known that internal rotation leads to poor outcome and that the condylar twist angle ranges between 0° and 7° in the majority of patients preoperatively. Considering that TKA aims at reproducing normal knee kinematics, this angle should approximate these values postoperatively.

15.4.5 Conclusion

Correct rotational alignment of femoral and tibial component of a TKA is crucial to obtain ideal femorotibial and femoropatellar kinematics and should be evaluated by CT in case of poor clinical outcome.

15.5 How to Achieve Tibiofemoral Stability

Jean-Louis Briard

Until today, surgeons are trying to approach "neutral" tibiofemoral alignment with bone cuts insisting that we should never overcorrect. As already addressed, they tend to preserve the joint line level by making the distal femoral cut with reference to the most prominent condyle [36, 39].

Next step is to achieve good ligament balance through the whole range of motion (ROM).

Stability is achieved by the design of the prosthesis (+ weight bearing) and the guiding of the capsule and ligaments which trigger muscular response.

When operating a deformed knee, the deformity must be analyzed:

1. Is there extra-articular (EA) deformity? The surgeons must know how to correct it: with an extra-articular osteotomy or with intra-articular release anticipating the consequences.
2. Is there flexion deformity?
3. What is the status of the collateral ligament frame in the concavity (retraction?) and in the convexity (elongation?)?

Stability in extension is provided by the posterior capsule and the posterior corners. But as soon as the knee bends, the collateral structures come into action and provide the medial and lateral stability through the whole ROM [37].

When the posterior cruciate ligament (PCL) is excised, this creates some tibiofemoral distraction or laxity between 3 and 7 mm at 90° flexion, which must be taken in account. This is one reason why PS surgeons use spacer block to decide of flexion and extension gaps.

If the surgeon wants to correct EA deformity inside the joint, he will have to create some coronal laxity in extension with a release of the concave posterior capsule, corner and collateral structures. If the deformity is femoral, this will also influence the balance of the flexion gap and the rotation of the femoral implant.

Next, the posterior capsule may need to be addressed after excision of the posterior osteophytes and release of adhesions. Retraction of the posterior capsule is responsible of coronal deformity. For example, retraction of the posterior medial capsule after long-standing inflammation is responsible by itself of fixed varus deformity near to extension. This will require release of the posterior capsule with the expansions of the semimembranosus including the posterior medial corner [41].

Then the real condition of the collateral ligament frame can be appreciated. In practice, for varus knee (after the excisions of all the osteophytes), a valgus stress is applied at 30° flexion:

1. If the knee is in neutral (provided that there is no convex laxity) and the collateral ligament frame is balanced, then the knee is brought in extension:
   – It is in neutral, the posterior capsule is fine.
   – It is still in varus, there is still retraction of the posterior structures which need to be released.
2. If the knee is in varus at 30° flexion, there is either EA deformity or the medial structures are contracted. A posterior and medial release should be performed until reaching neutral alignment at 30° and then at 0°.

The technique of release of the soft tissues must be progressive with sequential controls to avoid over-release and instability. Medial and lateral structures are quite different, but we should proceed from posterior to anterior. The release can be achieved with piecrusting technique or with a sleeve technique elevating the soft tissue from the tibia as in genu varum, a sleeve keeping all the structures together so that they remain strong and continuous.

Laterally, the soft tissues are more complex [40] and consist of posterior capsule (mostly the arcuate complex which is behind the popliteofibular ligament at the level of the tibial cut). Then the fascia lata may need piecrusting. If the knee is still too tight laterally, further piecrusting of the posterolateral structures will involve lateral collateral ligament, but the popliteus tendon must be preserved as a good secondary stabilizer. In case of significant femur valgum, a sliding lateral condylar osteotomy is a safe mean to open the space laterally and gives good access for safe release of the posterior capsule.

If after such releases, the medial lateral stability is not achieved, more constrained (VVC) designs may be necessary.

Excellent stability near to extension is essential for good gait with full extension. The fine tuning of the tension between collateral structures and posterior capsule is quite important and should avoid midflexion instability [38]. Instability after 30° and at 90° is still too frequent and leads to insufficient results which may require revisions (25% of early revisions are due to instability).

15.6 How to Achieve Correct Patellar Tracking

Andrea Baldini, M.D.

Total knee arthroplasty has been a successful procedure for various decades. Complications originating from the patellofemoral side compromised the results of TKA for several years. Actually, this aspect of the replaced knee does not represent anymore the most frequent source of problems, but it is often involved in postoperative residual pain or suboptimal results.

Functional result after TKA is now being emphasized, including maximal range of motion recover. Extensor mechanism management has a crucial role in this new challenge. Optimization of the technique for patella resurfacing can eliminate postoperative complications from this source and guarantee an excellent extensor mechanism function even in the presence of high demand.

Based on the literature review, we believe that patella resurfacing can achieve the best results with the following guidelines:

- Have a low threshold to resurface the patella.
- Consider to leave the patella unresurfaced (with a proper patient's consensus) if intraoperative PF tracking is good, mostly in male patients or in relatively young (<65 years) patients.
- Resect the same amount of bone you replace (final composite thickness should be equal or 1–2 mm less than the initial one).
- Double check the symmetry of the patellar bone remnant in all quadrants (refer to the anterior patellar surface).
- Resurface the patella with a cemented all-polyethylene three-pegged dome component.

Tibiofemoral design features to patellofemoral complications	
Short trochlea	Cannot guide patellar tracking adequately
	May facilitate clunks (particularly in PS knees)
Shallow trochlea	Does not capture the patella enough throughout ROM leading to patellar instability
Femoral flange with high lateral ridge	May increase tension on lateral patellar retinaculum, increasing patellar tilting and shear forces
Prominent shoulder (femoral "boxy" profile)	Increases PF joint force in flexion
	Facilitates synovial entrapments (clunks/crepitus)
Thick anterior femoral flange	Contributes to overstuff the anterior compartment in flexion
Prominent anterior wall of polyethylene insert	Patellar tendon impingement in flexion (particularly in deep dishes)
Highly constrained tibiofemoral joint	Does not accommodate for knee rotation leading to patellar instability (particularely in fixed hinges)
Tibiofemoral factors related to patellofemoral complications	
Anteriorized femoral component	Overstuff anterior compartment thereby increasing patellar strain
Flexed femoral component	Same as before (only in early flexion) if femoral flange is proximally elevated
Medialized femoral component	Increases the Q angle
Internally rotated femoral component	Increases PF joint shear forces leading to maltracking with tilt and subluxation
Excessively externally rotated femoral component	May add tension to the medial patellar retinaculum causing patellar maltracking
Excessive valgus femoral component	Medializes the trochlea leading to maltracking
Overall excessive valgus alignment	Increases the Q angle leading to maltracking
Anteriorized tibial component	May overstuff the anterior compartment impinging the patellar tendon
Internally rotated tibial component	Increases the Q angle leading to maltracking
Raised joint line	Causes patella baja with abnormal PF kinematics
Absent femorotibial rollback	Increases PF strain in flexion

- Medialize the component and chamfer the excessive uncovered lateral bone to avoid bone-implant impingement.
- If maltracking is evident with trial components, recheck component rotation, cement the final components, deflate the tourniquet, and check it again, pulling the slack of the quadriceps tendon superomedially.
- If a lateral release is required, perform a lateral subperiosteal peel of the retinaculum. If it is not enough, perform a release with multiple punctures into the tight retinaculum avoiding the SLGA.
- Check patellar alignment and tracking at follow-up with a standing patellar axial view.

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