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Review Article

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Complications of Patella in Total Knee Arthroplasty (TKA)

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Annotation
Background and Methods: Postoperative complications may impair the outcome of total knee arthroplasty (TKA). Patellar instability is a major cause of postoperative pain and functional limitation for which revision surgery may be necessary [1]. It may occur after TKA with or without patellar resurfacing. RESULTS AND CONCLUSIONS: Subluxation is more common than dislocation; the incidence of symptomatic instability leading to revision is low (0.5 to 0.8%) [2, 3]. In a multicentre study of low contact stress mobile bearing TKAs, only 6 of 259 revisions were associated with patellar instability, which accounted for a revision rate of 0.1% after a mean follow-up duration of 5.7 years [4]. A revision rate of 12% was reported secondary to complications of the extensor mechanism [5]. The aetiology of patellofemoral instability can be related to (1) the surgical technique and component positioning, (2) extensor mechanism imbalance, and (3) other causes.

In this review, there are not figures and outcomes.

Keywords: knee Arthroplasty; Patella; Complications

Introduction
Patellar instability after total knee arthroplasty (TKA) is a serious complication that impairs functional outcome and may lead to revision surgery. Its aetiology can be related to the surgical technique and component positioning, extensor mechanism imbalance, and other causes. After TKA, the presence of anterior knee pain, especially during stressful activities, is indicative of patellar instability. Diagnosis can be made by radiological evaluation of the patella position, alignment, and component fixation. Main treatment options include revision of the TKA components (in case of malposition) and lateral retinacular release with or without a proximal or distal realignment (in case of soft-tissue imbalance).

Aetiology
Surgical Technique
Component malposition during surgery is one of the most common causes of patellar instability [6-10]. A tendency to place the components in internal rotation in the transverse plane increases the Q angle of the knee joint and predisposes to lateral patellar maltracking and patellar instability [11]. Understanding the anatomic relationships enables accurate restoration of the articular surfaces. Compared to conventional methods, computer-assisted navigation improves orientation and alignment of the components, although other studies found no significant differences between them [12-17]. Cementation and impaction of the components can introduce a considerable error in alignment, regardless of the accuracy of the resection planes [18]. Computer-assisted navigation improves the accuracy and reproducibility of prosthetic component orientation although there was no significant difference in clinical outcome or complication rates [19, 20].

Femoral Component
Distal femoral resection uses anatomic landmarks to match the degree of normal femoral external rotation to the normal proximal tibial slope of about 93º and to maintain the normal femoral position [21]. Three different methods have been used for femoral resection: (1) cutting of the femur parallel to the posterior condylar axis (a technique based on restoring anatomic relations of the femoral condyles), (2) external rotation of the posterior femoral condyles by 3º to 5° in order to improve patellar tracking, and (3) cutting the femoral condyles (after cutting the tibia) based on balancing of ligaments.

The difference between the posterior condylar axis and the transepicondylar axis (from the lateral epicondyle to the sulcus of the medial epicondyle) was approximately 3.5º for males and 0.3º for females ($p<0.05$). However, the clinical angle formed with the prominence of the medial epicondyle was 4.7º for males and 5.2º for females. In normal femurs, the variance could range from 1º to 9.3º [22]. The angle of the posterior condylar axis reference to the transepicondylar axis could range from 0.1º to 9.7º [23].

The transepicondylar axis is more consistent than the posterior condylar axis. It is perpendicular to the long axis of the tibial shaft, and parallel to the axis of knee flexion [24]. Cutting the posterior condyles parallel to this axis places the femoral intercondylar groove in the normal anatomic position [3, 9]. Similarly, the Whiteside line drawn from the femoral intercondylar groove down to the centre of the femoral notch is almost perpendicular to the transepicondylar axis. Resection of the distal femur using a fixed posterior condylar reference guide results in rotational errors of at least 3º in 45% of knees [25]. The transepicondylar reference is the most consistent for determining a balanced flexion space, whereas using 3º rotation off the posterior condyles was least consistent [26]. Therefore, the transepicondylar axis is more reliable in determining the femoral rotational alignment, especially in valgus knees [27].

Placing the femoral component into external rotation improves patellar tracking and decreases the incidence of intra-operative lateral release. Lateral release is associated with an increased rate of patellar complications [28]. The femoral groove tends to be 2.5 mm lateral to the midplane of the distal femur based on the dimensions of the condyles and position of the femoral notch, but could be up to 8 mm in outliers [29]. Most contemporary implants have a symmetrical design, such that condyles are roughly equal in dimension, and the placement of the prosthetic femoral groove bisects these condyles. Placing the femoral prosthesis in an anatomically correct or symmetrical position in relation to the femoral notch may actually medialise the femoral intercondylar groove. Positioning the trochlear groove into a relatively medial position may increase lateral tracking. The consequent tension to the lateral side multiplies any tendency for subluxation or dislocation of the patella. The problem may be solved by marking the femoral intercondylar groove during preparation and then matching this position with that of the prosthesis. This may cause some overhang of the lateral femoral condyle, but is preferable to an abnormal increase of the Q angle.

Tibial Component

When the exposure of the posterolateral tibial plateau is inadequate owing to patellar evertion during surgery, the tibial component may be placed into relative internal rotation to the correct axis of the knee. This leads to lateral placement of the tibial tubercle and aggravation of the Q angle. The knee axis is variable and some osteoarthritic patients have external version of the tibia in relation to the femur [30]. This magnifies the extent of varus deformity that may accrue with disease. It is therefore suggested the tibial component be centred on the medial third of the proximal tibial tubercle. Drawing a line from the patient's femoral intercondylar groove down to the proximal tibia and matching that position throughout the procedure may aggravate alignment errors, particularly when using a sloped cut of the distal tibia (as in making the cut out of the plane). The best method is a trial of the implant on insertion to ensure a midline tibial articulation, which is not rotated onto the anterior surface of the medial tibial insert.

Patellar Component

Patellar component malposition usually reflects a technical error in cutting the patella. A symmetrical hockey puck–shaped structure with equal thickness is the goal. Resection of the lateral facet or the distal pole leads to tightness of the lateral retinaculum and a tendency to subluxation [31, 32]. Increasing patellar thickness or stuffing the joint may lead to lateral instability of the patella [33]. Another challenge is to centre the patellar dome on the midpoint of the patellar remnant and not allow it to drift toward the most-medial edge [34]. In the normal patella (37 mm in width), the mean medial and lateral facets are about 14 mm and 23 mm thick, respectively. Lateral dome placement increases the Q angle and aggravates lateral retinacular tension. Patellar component medialisation is associated with little need of lateral retinacular release and therefore avoids the risk of patellar fractures [35].

Patellar resurfacing during TKA remains controversial. Several patellar complications such as fracture, avascular necrosis, and instability are related to resurfacing [2]. On the contrary, some authors report lower re-operation rates and postoperative pain when the patella is resurfaced [36, 37]. Attention should be directed to the ultimate patellar thickness. Resurfacing or not should be determined based on the exact initial thickness. A thicker patella is prone to instability, whereas a thinner patella is associated with higher complication rates.

Component Design

The depth of the trochlear groove and the symmetry of the components should be taken into account to reduce post-TKA patellofemoral instability [11, 38]. The use of an eccentrically shaped dome or an anatomic low contact stress mobile-bearing device, which appropriately matches patellar anatomy is a preferred method. Earlier designs were boxier in shape and tended to add metal thickness to the intercondylar groove, in effect stuffing the joint. More recent designs have ameliorated this problem by incorporating deeper prosthetic intercondylar grooves, resulting in a dramatic reduction of patellar complications in long-term studies. The low contact stress mobile-bearing prosthesis has a patellar component survivorship of 98.5% at the 14-year follow-up [4].

Soft-Tissue Imbalance

Lateral retinacular tightness remains a subtle cause of patellar instability, but usually does not result in clinical problems. Femoral resection based on the posterior condylar axis may result in internal rotation of the femur and thus require lateral release. Therefore, surgeons must look for other causes that give rise to patellar instability rather than simple tightness of the lateral retinaculum, except in a chronically dislocated or subluxed patella where retinacular tightness is the primary cause. Such cases may be complicated by medial retinacular weakness or atrophy. Meticulous care to the principles of reconstruction is required. Attention to detail is needed such as using a lateral parapatellar approach, carefully aligning the implants, and then positioning the implants to optimise patellar tracking with the need to reef or reconstruct the stretched medial soft tissues.

The presence of an inflated tourniquet seems to affect patellar tracking. Nonetheless, the position of the limb during tourniquet inflation does not seem to affect clinical and radiographic data pertaining to patellar tracking [39, 40].

Knee replacement is mainly a soft-tissue surgery, rather than simple carpentry entailing bone cuts and component positioning. Although difficult to quantify, soft-tissue release is crucial, particularly with regard to the extent of the procedure. Adequate release of the medial ligaments and lateral retinaculum is important to obtain a stable knee with good congruence in both joints. In deformed arthritic knees (i.e. varus knees with fixed-flexion deformity), the progressive release of the medial collateral ligaments, pes anserinus, and posteromedial capsule becomes necessary. This is to overcome ligamentous and capsular contractures, although patellar instability may ensue in cases of excessive release. An increase of the Q angle from the internal rotation of the femoral component to avoid spin out may be the reason. Therefore, meticulous care should be paid to obtain optimal ligamentous balance.

Other Causes

Valgus knees are also predisposed to patellar instability [12, 41]. Most of these knees present with a chronically dislocated patella, a smaller lateral condyle, and lateral retinacular tightness. If the posterior condylar axis is used for distal femoral resection, there may be a tendency to internally rotate the femoral component, and increase the Q angle. With the use of an intramedullary femoral guide and even computer-assisted navigation, the risk of a postoperative valgus deformity is minimised. Based on complication rates of the patella associated with different surgical approaches, subvastus, midvastus, and a lateral approach have been proposed instead of the medial parapatellar approach. Patellar eversion during soft-tissue balancing may interfere with the anteroposterior alignment of complication rates following different surgical approaches remains controversial [42-44].

Medial retinacular weakness or disruption is possible after TKA and may result from an expanding haematoma, inadequate surgical closure, overintensive physical therapy, or injury [9, 45]. Surgical repair is needed if medial laxity occurs with patellar subluxation. Rare causes of patellar instability secondary to surgical misadventure include misplacing the right femoral component in the left knee, and misplacing an anatomic patellar component with ridges (such that the ridge is parallel rather than vertical to the transverse joint plane [46, 47]. Patient characteristics including marked preoperative deformity, neuromuscular pathology, and obesity are also responsible for knee instability and should be taken into account during preoperative planning.48

Diagnosis

Symptoms

The main symptom of patellar instability is anterior knee pain during stressful activities such as stair climbing or rising from a chair. Pain is usually located at the patellofemoral joint and differs from that prior to TKA. Pain can be in a peripatellar location or the lateral or medial aspect of the knee. It ranges from minor to severe causing disability. The onset of pain is usually indicative of its origin. A sudden onset after a non-symptomatic period is more likely to be related to failure of the component or extensor mechanism. A history of persisting pain after TKA is likely to be related to the surgical technique.

A dramatic giving way or buckling sensation of the knee may or may not be associated with the knee pain. Subluxation usually leads to the sensation of the knee slipping out of place. Decreased range of motion, mainly inability to perform full flexion, may indicate patellar subluxation. Knee stiffness is the typical complaint.

Clinical Examination

Palpation of the extensor mechanism throughout the passive and active range of motion reveals defects in continuity. Areas of localised tenderness can be identified by patients. Dislocation or subluxation can be detected by palpating the patella through the range of motion. Excess patellar mobility or lateral retinaculum tightness can be identified. Manoeuvres such as attempting to sublux the patella laterally during active flexion can elicit pain or distress. Patella alta should be looked for as this may render the patella somewhat higher in the femoral groove. Some patients may have asymptomatic lateral subluxation without any objective findings except vague medial knee pain. They should be examined with radiography, as many patellar implants are subject to early polyethylene wear in the presence of this abnormal articulation.

Imaging Studies

Radiographic evaluation of the patella primarily uses the lateral view and the sunrise or Merchant's view. The lateral view reveals the patellar thickness, inferior or superior positioning, as well as adequate fixation and position of the components. The sunrise view demonstrates patellar rotation and alignment related to the femoral groove. The symmetry of the patellar cut and thickness of the patellar composite is apparent and may be compared with the opposite normal patella. Positioning of the patellar component (centralised or tilted in relation to the trochlear sulcus or subluxed/dislocated) is clearly seen and may reveal the cause of instability. Tilt can be defined as medial or lateral, depending on its relation to the femoral condyles. Subluxation can be measured as displacement from the centre of the prosthetic femoral intercondylar groove.

Computed tomography is the most reliable method of assessing component alignment and positioning, as well as rotation [48, 49]. The latter is determined using 4 scans: the medial and lateral epicondyles, the tibial plateau immediately below the tibial base plate, the tibial tubercle, and through the tibial insert [50]. The femoral component's rotation is determined by measuring the angle formed by the line drawn through the medial and lateral epicondyles and the line connecting the posterior flanges of the implant. Tibial component rotation is determined by superimposing the geometric centre of the proximal tibia onto the image with the tibial tubercle. The tibial tubercle axis (the line drawn to the highest point of the tubercle) is then placed on the image with the tibial insert with a line drawn perpendicular to the posterior surface of the tibial insert. The normal extent of tibial rotation is 18º.

Treatment and Conclusion

The treatment of choice for patellar instability is surgery. Despite rarely being effective, conservative methods should be applied prior to any surgery. These include quadriceps exercises, bracing, and avoiding activities that aggravate instability. With time, scarring of the retinacular tissues may lead to resolution of symptoms.

In those with chronic instability or frank dislocation, surgical intervention is necessary. The possible prosthetic causes (such as component malposition, limb malalignment, and soft-tissue problems around the patella) should be carefully looked for to avoid unnecessary revision. If the components are positioned appropriately and the condition is due to soft-tissue problems, the treatment of choice is lateral retinacular release, using an outside-in or inside-out technique [3, 11, 45, 51-53]. Patellar necrosis, fracture, and dislocation have been associated with avascularity of the patella secondary to lateral release [51, 54, 55]. Retaining the superior lateral geniculate artery during lateral release is controversial [56]. In 12 cases, long lateral release from inside the joint outwards, and then imbrication of the medial vastus retinaculum over at least 50 to 75% of the width of the quadriceps tendon resulted in no recurrence, and only one case of skin necrosis and one case of patellar fracture [57].

Lateral release can be combined with proximal or distal realignment using a fairly long osteotomy33 or a modified Trillat procedure [58]. In 15 cases of patellar dislocation, the latter resulted in no recurrence or problem with the patellar ligament [59]. All the above techniques target the change of Q angle. Care must be taken to ensure that an adequate piece of bone (at least 8 cm) is taken and that apposition and fixation is optimal. Wound complications, rupture of the patellar tendon, and fracture of the bony remnant are inherent risks of this approach. Therefore, proximal realignment is recommended in the absence of component malposition.58 Combination of distal and proximal realignments is also recommended of 25 knees with 14 having proximal realignment, 4 recurred [60, 33]. Of 9 knees treated with both proximal and distal realignments, no dislocation recurred, although 2 knees sustained distal patellar tendon ruptures and 2 others had revision of components (one of whom had a further subluxation).

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