A Technique of Staged Lateral Release to Correct Patellar Tracking in Total Knee Arthroplasty

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Abstract: Optimal patellar tracking and component alignment are important in achieving a well-functioning total knee arthroplasty (TKA). The patella is constrained partly by design of the prosthetic trochlear groove, and patellar tracking is governed by a combination of static and dynamic factors. Maltracking may result from excessive or unbalanced tension in the surrounding soft tissues. This article describes a staged progressive lateral release of the patellar retinaculum in TKA, which is classified into 6 stages. Stage 1 transects the deep lateral patellofemoral ligament; stages 2 to 6 extend the lateral patellar incision distally from vastus lateralis to the tibial tubercle. This technique was used in a series of 96 primary TKAs. We report the rates of the various stages of lateral release and the variables that might affect the decision to perform such a release. Key words: lateral release, lateral retinaculum, total knee arthroplasty, patella, maltracking.

The patella is integral to the overall success of total knee arthroplasty (TKA). The occurrence of complications such as anterior knee pain, maltracking, patellar subluxation and dislocation, abnormal polyethylene wear and damage, and loosening usually reflects an underlying problem in the surgical technique, component design, or both [1]. For a congruent patellofemoral articulation, the patella must track centrally in the trochlear groove. Patellar tracking is affected by a combination of static and dynamic factors. Static factors include patellar implant position, femoral component alignment, configuration of the prosthetic trochlear groove, and soft tissue balance. The dynamic factors are the direction and magnitude of the quadriceps action during knee movement. The anatomy of the lateral retinaculum has been described by several authors [2,3]. The incidence of some degree of lateral retinacular release has been reported to be as high as 40% but with a generally accepted rate of “full” release being around 6% [4]. However, compromise to skin and soft tissues, patellar avascular necrosis, and fragmentation can occur. In particular, those that involve an “all-or-nothing,” a full-thickness, or an “inside-to-out” technique seem prone to such complications [5-9].

In a prosthetic knee, a lateral release may be required to ensure central tracking of the patella [10]. The lateral retinaculum is a fibrous connective tissue complex on the lateral aspect of the knee. Despite numerous anatomical studies, a comprehensive illustration of the surgical technique of lateral retinacular release is lacking [2,11-15]. Studies have shown that there is no difference in the outcome when doing a lateral release, but these studies did not define the surgical technique of the
release [16]. The present authors recognize, therefore, that lateral release is a controversial subject, with different opinions about whether it should be done or not, and, if so, how frequently. In view of this, it seemed appropriate to develop a less invasive surgical procedure. This article describes a novel method of staged lateral parapatellar release that allows the tissue to be released only as much as is needed to establish correct patellar tracking during TKA surgery. It also presents the initial experience of the senior surgical author (first author) with this method.

Materials and Methods

Ninety-six patients with degenerative osteoarthritis of the knee had TKA with the Genesis II (Smith & Nephew, Memphis, Tenn) posterior cruciate-retaining prosthesis. There were 35 men and 61 women. Their mean age was 68 years. Fifty of the knees were left, and 46 were right. All the cases were operated on by the first author. Referrals included a significant proportion of complex primary cases.

The tourniquet was inflated with the knee maximally flexed, and a standard medial parapatellar approach was used in all cases. The femoral component with inbuilt 3° external rotation was placed in neutral rotation with respect to the epicondylar axis and further verified with reference to the anterior-posterior axis of the femur [17]. The tibial component was aligned perpendicular to the tibial axis in the coronal plane with a 3° to 5° posterior slope to match the preoperative radiographs. Internal rotation of the tibial component and medialization of the femur were avoided because these can cause patellar lateral maltracking. Radiographs obtained preoperatively and postoperatively included an anteroposterior radiograph with the patient weight bearing. Measurement of patellar tilt and displacement was carried out using the technique of Gomes et al [18]. Patellar position in relation to the femoral trochlear groove was quantified by measurement of the medial-lateral tilt in relation to the anterior intercondylar line and translation (sometimes known as shift) in relation to the deepest point on the femoral sulcus. These measurements were taken from radiographic axial views with the knee at 45° flexion, before and after surgery [19]. All measurements of patient radiographs were digitized using the Centricity Picture Archiving and Communication Systems 3.0 software (GE Healthcare, Chalfont St Giles, United Kingdom). Statistical analysis was performed on Statistical Package for Social Sciences version 13 (SPSS Corporation, Chicago, Ill). A paired-sample t test was used to compare patellar translation and tilt before and after surgery.

The patella was resurfaced in all cases with an inset patellar component centered on the median ridge [20]. The patella was cut freehand; and the edges of the resection were sloped, effectively removing osteophytes. Careful attention was paid to avoid overstuffing the patellofemoral compartment. This was verified by measurement with a caliper, with the aim being to reduce the thickness of the patella to approximately 1 to 2 mm less than the preoperative thickness.

Patellar tracking was assessed with trial components. The knee was flexed from 20° to 90° with the tourniquet left inflated and patellar tracking being observed firstly with the “no-touch” technique and then a “2-stitch” technique. The second evaluation was performed in a similar manner after 2 stitches were used to close the incised medial parapatellar retinaculum. One stitch was placed at the level of the superior pole of the patella and the second, at midpatellar level. A staged lateral release was performed when the patella did not track centrally in the trochlear groove with either a tilt or a lateral shift being observed. To appreciate tilting of the patella, it is helpful to have a “skyline” view of the patella by viewing it from the end of the table proximally. In addition, unequal contact of the patellar component with the femoral component was also assessed from the unclosed corner of the parapatellar incision just distal to the second suture at the midpatellar level. Smooth motion of the patella during the knee flexion cycle was also a goal, and jerky motion or shimmering of the patella required release. Patellar tracking was reassessed after cementation, and a further release was performed as necessary. Care was taken to avoid imbrication of the medial retinaculum of the patella during repair.

The technique of staged lateral release was refined with experience, and a classification for the staged lateral release was developed as in Table 1 and Fig. 1. Apart from stage 1, the release was performed from outside the joint beginning proximally. Careful dissection was performed to avoid breaching the capsulolosynovial layer and inadvertently entering the knee joint. This was to avoid a connection between the joint and the subcutaneous plane and therefore reduce the likelihood of a postoperative subcutaneous hematoma. The superior lateral genicular artery was identified before any stage 2 release.
**Table 1.** Classification of Staged Lateral Release

| Stage 1 | Release of the LPFL from the deep aspect |
| Stage 2 | Release of the lateral retinaculum starts 25 mm proximal to the patella, down to the level of the superior border of the patella, and 20 mm lateral to it. |
| Stage 3 | Release of the lateral retinaculum down to the level of the midpatella |
| Stage 4 | Release of the lateral retinaculum down to the distal pole of the patella |
| Stage 5 | Lateral release from the inferior border of the patella to the level of the knee joint line |
| Stage 6 | Lateral release down to the level of the Gerdy tubercle |

**Stage 1**

The lateral patellofemoral ligament (LPFL) may be palpated as it passes from the lateral epicondyle of the femur to the lateral margin of the patella as a thickening of the capsule (Fig. 2). It varies in thickness and width and is the first structure released from the deep aspect.

**Stage 2**

The leash of vessels approximately 25 mm proximal to the proximal-lateral corner of the patella is identified. This preserves the superior lateral genicular artery, which is an important blood supply to the patella. The lateral release starts at this point; and after defining the appropriate soft tissue plane, it follows the longitudinal fibers of the lateral retinaculum distally, cutting the fibers that are oblique near the superior pole of the patella, to a point 20 mm lateral to the superior lateral corner of the patella.

**Stage 3**

Stage 3 involves a further release of the lateral retinaculum from the level of the superior pole of the patella beginning 20 mm lateral to the lateral margin of the patella, to the level of the middle of the patella. The orientation of the fibers is now more oblique. This layer is intermixed with the underlying deeper tissue that is more dense and transverse from the iliotibial tract to the widest part of the patella. The tissues here tend to be thicker in the male population.

**Stage 4**

The lateral retinaculum, now composed of crisscrossing fibers oriented obliquely superficially and transversely deep, is released to the level of the distal pole of the patella (Fig. 3). The distal end of the incision is 25 mm lateral to the edge of the patellar tendon. The extent of this stage is identified by the distal limit of the deeper transverse fibers.

**Stage 5**

The release involves retinacular tissue that is relatively thin as it attaches along the length of the patellar tendon. The incision is extended distally to the level of the lateral joint line, remaining 25 mm from the edge of the patellar tendon. Beneath these fibers is the thin capsulosynovial sheath enclosing the knee joint, which is not cut.

**Stage 6**

The lateral retinaculum is released to the level of the Gerdy tubercle. This mainly involves fibrous extensions of the iliotibial tract.

**Results**

Seventy-six knees had a varus alignment preoperatively on anteroposterior weight-bearing radiographs, 10 had a neutral alignment (an anatomical axis 0° to 7° valgus), and 10 were in valgus. Postoperatively, there was one case of lateral collateral instability that was treated in a brace, one case of postoperative stiffness that required a manipulation under anesthesia, and one knee that developed a superficial wound infection. Three other patients complained of postoperative anterior knee pain between 12 and 14 weeks. Their postoperative component alignments, patellar shift, and

![Schematic diagram of staged lateral release.](image-url)
tilts were not significantly different from those who did not have anterior knee pain. There were no cases of postoperative hematoma formation.

Fifty knees required a lateral release in varying stages. In 9 knees, the patella had a shimer and tilted laterally during the no-touch evaluation; and these knees required no more than a stage 1 release. In the other 41 knees, the patellar tracking was still deemed abnormal with the 2-stitch evaluation; and these required further releases as shown in Table 2.

The remaining 46 knees in which there was no maltracking after the final components were implanted did not require a lateral release. None of the knees in the study had a dysplastic trochlear groove seen at surgery. In all knees, the patellar thickness with the implant in situ was within 2 mm of the patellar thickness before resection.

The box-whisker plots in Fig. 4 show the preoperative and postoperative lateral tilt and translation for the entire cohort of 96 patients, with a high proportion of these patients showing such abnormalities. There was a statistically significant difference between the preoperative patellar tilt and the postoperative patellar tilt \( (P < .001) \) as well as between the preoperative patellar translation and the postoperative patellar translation \( (P = .001) \). There were 13 patients who had a postoperative lateral tilt between 5° and 10°, and 3 patients with more than 10°. There were one patient with more than 10 mm postoperative lateral translation and 5 patients with more than 5 mm medial patellar translation (Table 3).

**Discussion**

This article has described a method for progressively adjusting the tracking of the patella during TKA by using a staged release of the patellar lateral retinaculae. Every series of cases must of course be judged individually in terms of the frequency and severity with which preoperative patellar maltracking is noted (Fig. 4). It was shown, in this particular series of 96 knees, that 50 cases were judged to need at least a minor lateral release to balance the patella and optimize the early phases of tracking, despite using a femoral component that included 3° of external rotation. The data in Table 2 show that only a small number of knees required progressively

<table>
<thead>
<tr>
<th>Stage</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Knees</td>
<td>46</td>
<td>9</td>
<td>10</td>
<td>16</td>
<td>13</td>
<td>2</td>
<td>0</td>
</tr>
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</table>
more extensive releases, making it clear that most patellofemoral joints can be balanced even in early flexion with only a minor proximal retinacular release. Thus, this study has shown that it is usually possible to obtain good results with less extensive incisions than a conventional open release, suggesting that many of these procedures may be more extensive than is necessary.

The authors are not aware of published evidence to show a correlation between the release of the LPFL and an improvement in patellar tracking. Nonetheless, in our study, the LPFL was the only structure that required release in 9 knees. The LPFL is a thickening of the joint capsule; it is conceivable that, in a diseased knee, this can create a tethering effect and accentuate patellar maltracking because this structure connects the lateral patella to the femur. It is generally accepted that cutting the LPFL permits slightly greater patellar eversion and enhances the medial parapatellar approach. We have assigned release of the LPFL as stage 1 because it was the least “invasive” maneuver to be performed first and it is opportune because one is already inside the joint. It certainly is worth trying before proceeding to the progressively more extensive retinacular incisions, and this is in keeping with our selective release philosophy.

A staged approach to lateral release for correcting patellar maltracking provides a method for progressively adjusting the tracking of the patella at the final stage of TKA surgery. It is known that conventional lateral retinacular releases may cause complications including reduced skin viability and wound healing, hemarthrosis, disruption of the lateral genicular arteries, and patellar hypovascularity and necrosis [5,6,9,21]. It is therefore logical to use the smallest retinacular incision that has the desired effect on patellar tracking without an unjustified risk of complications. Although this article has described the use of a retinacular release incision that starts proximally and is extended distally in stages, there have been different descriptions of the anatomy of the lateral parapatellar retinaculae and the most appropriate strategy. Others have also reported techniques that aim to reduce the potential for complications: a mesh expansion release of the retinaculum, decompressing the retinaculum by removing the lateral patella, and a “peel” technique [22-24].

The mesh expansion release involves pie crusting the lateral retinaculum in the part of the retinaculum between the lateral superior genicular artery

**Table 3.** Postoperative Patellar Lateral Tilt and Translation

<table>
<thead>
<tr>
<th>No. of Knees</th>
<th>Patellar Tilt</th>
<th>Patellar Translation</th>
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<tbody>
<tr>
<td>&gt;5°/mm medial</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>0°-5°/mm medial</td>
<td>14</td>
<td>29</td>
</tr>
<tr>
<td>0°-5°/mm lateral</td>
<td>65</td>
<td>61</td>
</tr>
<tr>
<td>5°-10°/mm lateral</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td>&gt;10°/mm lateral</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>96</td>
<td>96</td>
</tr>
</tbody>
</table>
and the lateral inferior genicular artery [22]. Thirteen knees of which 4 had a preoperative patellar tilt were followed up for 2 to 3 years. Postoperatively, one patient had anterior knee pain; and there were no postoperative patellar tilt or subluxation, although the criteria and method for radiographic measurement of this parameter were not detailed. This technique is commendable in that a graduated approach is used. However, the authors accept that it cannot be used in severe cases. If it were wrongly used in these cases, conversion to a full release would not be straightforward.

Wachtl and Jakob proposed decompression of the retinaculum by removing 7 to 9 mm of the lateral patella [23]. This would in theory not disturb the vascular supply provided that the soft tissue overlying the patella is not breached. This technique is not described as a stepwise approach, and so repeated adjustments of patellar tracking are not possible. With this approach, 15% of knees had a lateral postoperative patellar tilt of more than 5°, which is similar to the 16 of 96 in this study.

Using a conventional lateral retinacular release and standardized radiographic methods, Bindelglass and colleagues reported that of 234 knee arthroplasties, 18% had a postoperative lateral patellar tilt (>5°), 13% had a postoperative medial patellar tilt (>5°), and 15% had a lateral postoperative patellar shift (>5 mm) [25]. The same authors using the same methods but a different implant design reported a higher incidence of medial patellar tilt [26]. With the standard surgical approach, 2% had with a postoperative lateral patellar tilt (>5°), 22% had a postoperative medial patellar tilt (>5°), and 31% had a lateral postoperative patellar shift (>5 mm). Laskin used a standard outside-in lateral release with the Genesis II implant in his study [16]. By 3 months after surgery, 19% had a lateral patellar tilt of 1° to 10° and an additional 1% had a tilt of more than 10°; 16% had a lateral shift of 1 to 5 mm and 2% had a lateral shift of more than 10 mm. He did not describe medial patellar tilt or shift but that may also have occurred.

Although it is known that TKA itself alters the biomechanics of the knee and that component design and proper component alignment are essential to minimize the risk of patellar complications [25-28], there is not much information available about the specific role of the lateral patellar retinaculum or how their tensions might be affected by prosthetic design. It has been shown recently that lateral release can allow the patella to be displaced laterally by a significantly reduced force in a normal knee in vitro [29]. Furthermore, there is increasing evidence of the stability role of the medial patellofemoral ligament [30,31,33], which contributes most of the passive restraint to patellar lateral displacement when the knee is near extension.

The “no-thumb” technique is often used to assess patellar tracking before closure of the capsule during TKA, but it has been suggested that assessment of tracking with the medial incision left open may overestimate the need for lateral retinacular release [26,32]. These authors described the use of a towel clip to attach the medial retinaculum to the patella when assessing patella tracking. A similar “1-stitch” method has been described [34]. In this study, the smooth tracking of the patella was assessed initially via the no-thumb technique. The medial tissues were then secured to the patella using a 2-stitch technique, with one stitch at the level of the proximal pole, as in the 1-stitch method, plus another at the midpatellar level. This appeared to offer a better assessment of medial-lateral tracking because it reestablished continuity from the medial patellofemoral ligament across to the deep transverse fibers of the lateral retinaculum that pass from the patella to the iliotibial tract. With this technique, 46 of the 96 knees were deemed not to need any lateral release whatsoever including even minor releases of the lateral patellofemoral band (stage 1).

Such soft tissue imbalance, albeit minor in most cases, does seem important particularly in the early phases of flexion in terms of allowing the patella to engage well upon the prosthetic trochlea. However, the clinical results of such balancing seem also to be dependent upon obtaining satisfactory soft tissue tensions throughout a full range of flexion, where compressive and particularly lateral shear forces upon the patella in deeper flexion may lead to wear and prosthetic loosening. Indeed, long-term follow-up studies have noted that patellar complications can be a major cause of late revisions after total knee arthroplasty [35].

However, lateral patellar retinacular release in traditional form can be an extensive procedure and is linked to a number of complications. It therefore seems desirable to minimize any incision. The strength of this study is that the technique was performed by a single experienced surgeon and good results were obtained. Certainly, lateral release in TKA is controversial; and one of the reasons for this is that the assessment of tracking is subjective and different surgeons have different interpretations of tracking and thus threshold for performing a release. Although we have detailed our technique of tracking assessment and release, an inherent limitation would thus be that it is uncertain whether the results would be reproducible by others. Nonetheless, as
with the tibiofemoral joint during TKA, we advocate that sequential releases of stabilizing soft tissues may also be required for the patellofemoral compartment. This article has described the technique and early experience of staged release of the lateral retinaculum that can precisely correct patellar tracking while avoiding unnecessarily extensive soft tissue dissection.

References