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A key to the success of revision total knee arthroplasty (TKA) is a safe surgical approach using an exposure that minimises complications. In most patients, a medial parapatellar arthrotomy with complete synovectomy is sufficient. If additional exposure is needed, a quadriceps snip performed through the quadriceps tendon often provides the additional exposure required. It is simple to perform and does not alter the post-operative rehabilitative protocol. In rare cases, in which additional exposure is needed, or when removal of a cemented long-stemmed tibial component is required, a tibial tubercle osteotomy (TTO) may be used. Given the risk of post-operative extensor lag, a V-Y quadricepsplasty is rarely indicated and usually considered only if TTO is not possible.

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The requirement for revision total knee arthroplasty (TKA) in the United States was projected to grow by 601% between 2005 and 2030.2 There are many causes of failure of a TKA and the need for revision.2-11 Regardless of the cause of failure, a safe surgical exposure, and delicate management of the soft-tissue envelope, is essential. Various surgical approaches can be used at revision surgery including a medial parapatellar approach with synovectomy, a quadriceps snip, a tibial tubercle osteotomy (TTO) and a V-Y quadricepsplasty.

Prior skin incisions

The first, and maybe most important, decision is the choice of a safe and anatomically appropriate incision. Previous incisions should be clearly marked to ensure they are adequately visualised when the limb is fully prepped and draped.12 While it is preferable to use a long, straight midline incision, previous incisions often make this impossible.

In order to select the safest incision, it is important to remember that the blood supply to the anterior aspect of the knee is predominantly from the medial side.13 As such, the lateral-most incision should be used if there are many previous incisions.13 It is also important to note that the cutaneous blood supply travels from deep to superficial. Hence, full thickness skin flaps must be developed. In addition, transverse incisions, such as those seen after a previous high tibial osteotomy, should be transected at a perpendicular angle (Fig. 1).14 In order to avoid skin necrosis, an angle of < 60° to a previous incision should be avoided. Finally, some surgeons have recommended that bridges of skin should be at least 7 cm wide to avoid necrosis.15

Medial parapatellar approach with synovectomy

In contemporary revision TKA practice, the usual exposure remains the medial parapatellar with a complete anterior and posterior (i.e. posterior capsule) synovectomy. However, for this approach to be completed safely, there are several important technical points. Foremost, a wide intra-articular synovectomy must be performed, removing all fibrous adhesions from the suprapatellar pouch, as well as the medial and lateral gutters. This includes any adherent fibrous tissue on the dorsal aspect of the quadriceps tendon proximal to the patella. Next, a subperiosteal dissection of the medial retinaculum and deep medial collateral ligament to the semimembranosus insertion is completed with external rotation of the tibia (Fig. 2). External rotation of the flexed tibia reduces tension on the extensor mechanism by displacing the tubercle laterally, facilitating exposure. This frequently allows delivery of the entire medial tibia.

Next, the distal extensor mechanism needs to be mobilised safely. To do this, the fibrous tissue between the patellar tendon and anterolateral tibia, distal to the patella, must be defined, released, and excised. The scar tissue on the lateral aspect of the patella is gently released, allowing subluxation of the patella.
While the patella can be everted in some patients, it is our preference to sublux the patella laterally in order to minimise the risk of injury to the patellar tendon.

At this point, if the previous TKA was modular, the polyethylene liner is removed. In most cases, this allows enough exposure to remove the femoral, tibial, and patellar components if needed. However, if additional exposure is needed, release of the lateral retinaculum can be completed from inside to out, typically from the lateral aspect of the patella to the lateral aspect of the patella tendon where it attaches to the anterolateral aspect of the tibial tubercle. Although used to improve patellar tracking, a lateral release may also assist with lateral subluxation of the patella and extensor mechanism.

Following removal of the components, a posterior synovectomy is performed. This further enhances exposure by freeing the tibia from the femur, allowing it to be subluxed anteriorly more easily, for tibial preparation. A thorough posterior release allows the surgeon to avoid the tendency to raise the joint line by allowing for both distal femoral augmentation and full knee extension. In a series of 126 consecutive revision TKAs, Della Valle et al\textsuperscript{12} found that this approach allowed adequate exposure in 92\% of patients.

**Quadriceps snip**

The approach described above is occasionally inadequate; in which case the next manoeuvre is typically a quadriceps snip.\textsuperscript{16} This further releases the proximal tension on the quadriceps mechanism. The advantages of this approach include its technical ease, and the fact that the post-operative rehabilitation protocol does not need to be modified.\textsuperscript{16}

From a technical standpoint, the arthrotomy is extended obliquely and laterally at $45^\circ$ with respect to the fibres of vastus lateralis. The quadriceps snip must be completed across tendon to allow for side-to-side healing, and it is performed from distal-medial to proximal-lateral. In aseptic cases, it is our preference to place two non-absorbable sutures at the corners of where the quadriceps snip is initiated, allowing for an anatomical repair.

**TTO**

These approaches occasionally do not allow a satisfactory exposure, in which case an osteotomy of the tibial tubercle may be required. This allows distal release of the extensor mechanism. In contemporary practice, the most common indication for such an approach is removal of a long-stemmed cemented tibial component, or when there is arthrofibrosis or patella baja.

The TTO is typically 7 cm to 10 cm in length, with the coronal osteotomy made from the medial side.\textsuperscript{17-20} Proximally, the thickness should be approximately 1 cm, tapering distally to approximately 3 mm. This is completed with a small oscillating saw, which is also used to make a transverse cut at the distal aspect of the osteotomy. The proximal transverse osteotomy is made parallel to the joint line with a small osteotome. Ideally, a proximal bony bridge is maintained to prevent migration of the tubercle during healing. However, this is not possible in all situations.\textsuperscript{12} Next, two large osteotomes are used to elevate the fragment of the tubercle, while maintaining the soft-tissue envelope laterally. The patella can then be everted and the knee flexed to complete the procedure.
In order to close the osteotomy, the knee is extended and the displaced fragment of tubercle is brought back to its anatomical location. While many techniques have been reported, it is our preference to use three 16-gauge wires to fix the osteotomy. Specifically, three small drill holes are made in the lateral aspect of the bony fragment and three holes in the medial tibia approximately 1 cm posterior to the edge of the osteotomy and slightly distal. This allows for the repair to function in tension when closed. Flexion is limited to < 90° with a brace for six weeks. During mobilisation, the brace is locked in extension. Active flexion is allowed, but active extension and straight leg raises are avoided.

V-Y quadricepsplasty

A V-Y quadricepsplasty is rarely required and is typically reserved for situations when true lengthening of the extensor mechanism is desired. However, surgeons must be aware of the risk of an extensor lag. A V-Y quadricepsplasty may also be indicated if the skin over the tibia is compromised, or if the bone stock is of such poor quality that a TTO will not heal.

A V-Y quadricepsplasty is a combination of a standard medial parapatellar approach and lateral release. After a medial parapatellar approach, a second incision is made in the extensor mechanism 45° to the proximal end of the parapatellar incision. This is carried distally through the tendonous insertion of vastus lateralis and through the lateral retinaculum. This exposure puts the blood supply of the patella at risk and necrosis of the extensor mechanism can be the result. Closure is typically done with the knee at 30° of flexion. If a lateral release is needed for appropriate patellar tracking, part of the V-Y quadricepsplasty may be left open. As after a TTO, flexion is limited to < 90° with a brace for six weeks and it is locked in extension during mobilisation. Active flexion is allowed, but active extension and straight-leg raises are once more avoided.

In conclusion, a key to the success of revision TKA is adequate exposure that allows the surgeon to remove the components that are in place safely and introduce revision components while avoiding damage to the extensor mechanism. In most patients, a medial parapatellar arthroscopy with a thorough synovectomy is sufficient. If additional exposure is needed, a quadriceps snip through tendon is often helpful, and does not alter the post-operative rehabilitative protocol. In rare cases in which additional exposure is needed, or when removal of a cemented long-stemmed tibial component is required, a TTO may be used. A V-Y quadricepsplasty is also rarely indicated, given the risk of a post-operative extensor lag, and should only be considered when a TTO is not possible.

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M. P. Abdel: Literature review, manuscript preparation and review.
C. J. Della Valle: Literature review, manuscript preparation and review.

References