The Subvastus Approach in Total Knee Arthroplasty

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Introduction

The concept of minimizing soft-tissue invasion during the surgical approach to the knee is not new. In fact, the subvastus muscle-sparing approach was originally described in 1929 by Erkes [6]. The proposed advantages of this approach were the reduction of post-operative pain and a more rapid recovery of motion. Over the next 40 years, there were few references to this technique in the American literature [1, 9]. Interest in the subvastus approach has been rekindled over the past decade as surgeons and patients have begun to focus their interests on improving the rate of recovery after knee arthroplasty. An internet search of the literature in 2004 (PubMed medline query) yielded 17 citations concerning the effect of the approach on total knee recovery published since 1991, and 11 of those have been written in the past 4 years.

Several short-term advantages of the muscle-sparing approach have been well documented in peer-reviewed journals. Studies have confirmed that the need for a lateral release is reduced using this technique. Bindeglass and Vince noted a lower release rate in a review of 83 cases using a posterior stabilized total knee [2]. This finding has been confirmed by two other retrospective studies [13, 15]. In an in vivo strain study, Ogata et al. demonstrated a reduction in post-implantation retinacular strain in subvastus cases, as well as a reduction in the lateral release rate [14]. In 1993, Faure et al. published a prospective randomized series confirming better patellar tracking with the extensor-sparing approach [7]. The study by Faure also revealed a more rapid recovery of strength in subvastus patients when compared to the conventional median parapatellar approach patients. Several retrospective studies have also demonstrated improved muscle strength in cases where the muscle-sparing approach is used [3, 4]. In a more recent randomized prospective study Roysam and Oakley also reported a more rapid recovery of strength, significant reductions in blood loss and narcotic requirements, and improved range of motion with the subvastus approach [18, 19].

The muscle-sparing approach also offers the theoretic advantage of preserving blood flow to the patella by preserving the medial retinacular artery [12]. This preservation of patellar blood supply, even in the presence of a lateral release, along with the well-documented findings of reduced pain, more rapid recovery of strength, quicker recovery of motion, and improved patellar tracking make the subvastus approach an obvious choice for minimally invasive knee replacement.

Anatomy

The subvastus region provides a muscle-sparing or minimally invasive plane for exposure of the knee joint between the posterior border of the vastus muscle and the intermuscular septum. The space is bounded anteriorly by the vastus medialis and laterally by the femur. The posterior boundary is made up of the intermuscular septum and the adductor magnus. As a route to the knee joint, the space extends proximally as far as the adductor hiatus. The contents of the space are the descending genicular artery and the saphenous nerve. The mobilization of the vastus muscle is limited proximally by the passage of the femoral artery and vein through the adductor hiatus to the posterior aspect of the thigh [20].
The knee is flexed and an anterior midline skin incision is made. A medial incision is not recommended because the majority of the blood flow to the skin passes from medial to lateral and so with a medial incision the length of the undermined lateral flap may be quite large and increase the risk of a skin slough. A standard midline incision is preferred in order to preserve as much blood flow to the lateral flap as possible. This is particularly important in valgus knees where a more extensive lateral exposure is needed to facilitate the required releases, needed to balance the knee. The length of the skin incision can be varied according to the preferences of the surgeon. However, if the patella is to be dislocated, the incision should go from the medial edge of the tibial tubercle to a point at least two patellar lengths above the superior pole of the patella. It is critically important that the skin incision be carried down through the deep facia in order to preserve the anastomotic vessels which lie on the deep side of the facia and supply the superficial skin vessels.

After the facia is incised, it is usually quite easy to elevate the deep facial layer from the extensor mechanism by simply sliding a finger into the interval between the facia and the vastus muscle and bluntly separating the two. The facia may be intimately attached to the underlying distal vastus medialis obliquus (VMO) and require a small amount of sharp release. The size of the flaps varies depending on the pre-operative deformity of the knee. In the more common varus knee the medial side of the extensor mechanism is exposed along with an area of lateral retinaculum about half as wide as the patella to allow eversion for easier bone preparation. In the valgus knee, the lateral flap is undermined out to the inferior border of the iliobial band. This allows the surgeon to gain adequate exposure for selective soft-tissue releases to correct tight lateral soft tissues.

The arthrotomy is begun by bluntly elevating the inferior border of the muscle off of the intramuscular septum. The index finger of the more cephalad hand is placed under the lower edge of the vastus muscle a few centimeters proximal to the joint line (Fig. 9.12). The surgeon then can use his free hand to push the dissecting finger proximally, sliding the vastus off of the intramuscular septum. The muscle should be elevated for 6–10 cm proximally to obtain adequate freedom to dislocate the patella if so desired. This is accomplished by pushing the dissecting hand as far proximal as possible. After elevating the muscle, the retinacular exposure is begun.

The capsulotomy is begun at the tibial tubercle about 2 mm into the patellar tendon cutting a gently curved incision running proximally and staying 1 cm or more medial to the patella to avoid the circumflex anastomotic vessels. The distal incision is beveled slightly medially so that the infra-patellar fat pad is left with the tendon. This capsular incision is carried up through the medial patella-femoral ligament taking care not to penetrate deeply which could result in a laceration of the medial collateral ligament. Proper depth of the incision can be easily judged by placing tension on the elevated vastus muscle (Fig. 9.13).
is not necessary to enter the synovium at this time. When the capsular incision has extended proximally enough, the patella will slide laterally as part of a continuous extensor sleeve.

The knee is now extended and the arthrotomy is completed. A Hohmann retractor is placed onto the anteromedial surface of the femur about 2 or 3 cm above the proximal articular margin. The Hohmann is advanced laterally under the suprapatellar pouch like a periosteal elevator allowing the pouch to be released from the femur (Fig. 9.14). The release of the intact pouch is completed sharply with electrocautery from the articular margin. It is also necessary to release the attachment of the infrapatellar fat pad from the anterior surface of the tibia to facilitate the elevation of the pouch so that the extensor sleeve becomes more freely mobile (Fig. 9.15).

After the extensor sleeve has been adequately released, the patellar tendon is reinforced with a tibial tubercle pin as described by Engh [5]. A 0.062 mm pin is placed into the medial edge of the patellar tendon at the level of its insertion (Fig. 9.16). The pin is directed laterally so that it will not interfere with an intramedullary guide or the stem of a tibial component. After the pin has been advanced approximately 2 cm into the tibia, it is cut at 3–4 cm proud, then bent 90° twice so that the cut end can be buried in the soft tissue to reduce the risk of injury to the surgical team. The knee can now be flexed with a very slight risk of extensor injury. The patella is easily everted and the remaining lateral attachment of the fat pad can be elevated from the anterolateral surface of the tibia to allow for easy placement of cutting jigs (Fig. 9.17).

Closure is begun by reattachment of the suprapatellar pouch to the anterior surface of the femur. This is accomplished with a single absorbable suture placed between the medial border of the pouch and the periosseous of the medial femur. The capsule is then closed with interrupted absorbable sutures under no tension.
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Technical Tips

The most common problems encountered when attempting this approach are the result of inadequate soft-tissue releases. Many authors talk about the upper limit of vastus elevation being 10 cm above the knee at the adductor hiatus. Although the hiatus is the safe upper limit of dissection, its location varies and in many patients the muscle can be safely released much further proximally. The release has been safely accomplished by the author in over 3000 cases by simply pushing the dissecting finger as far proximally as possible without entering the hiatus or damaging the femoral artery.

The suprapatellar pouch must also be fully released from the anterior surface of the femur. The lateral attachment of the pouch extends beyond the anterior lateral femoral flange and must be released subperiosteally. The second tether commonly overlooked is the lateral attachment of the infrapatellar fat pad to the tibia. This attachment extends around the front corner of the lateral tibia and must also be completely released subperiosteally to freely mobilize the extensor mechanism. In some cases with a very large quadriceps muscle or patella baja, eversion may be difficult and may result in a longitudinal fracture of the patella. In these cases where eversion seems difficult with the knee extended, the lateral patellar retinaculum can be subperiosteally elevated off the surface of the lateral third of the patella to facilitate eversion. If this problem is encountered in a case with a tight lateral retinaculum, a lateral release may make eversion easier. In cases of an extremely difficult exposure, the approach can be extended utilizing a tibial tubercle osteotomy.

Results

From 1989 to 2004 the subvastus approach has been used in every primary total knee replacement performed by the author (>3100), and in over 90% of knee revisions. In contrast to the recommendations of Hoffman [11], our indications for the muscle-sparing or subvastus approach are identical to those for the median parapatellar approach.

Over 50% of the primary patients undergoing knee replacements using the subvastus approach are able to straight leg raise by the morning after surgery. Eighty percent of inpatients have required parenteral narcotics for less than 48 h after surgery. The average hospital stay has been 3.2 days since 1991. In an electromyographic evaluation we have noted a return to normal levels of muscle activation by one month after surgery [16].

The rate of complications associated with this surgical approach has been few. Early on the author experienced difficulty, obtaining an adequate exposure in two cases which required a tibial tubercle osteotomy. In both cases the course of treatment and the outcomes were otherwise unaffected. There have been no patellar tracking
problems, and only one case of patellar loosening. One patient underwent patellectomy approximately 3 years after the index procedure due to stress fracture. There have been no other patellar fractures in the absence of significant trauma. Mild skin sloughs have occurred in 12 patients, three of whom required subsequent irrigation and debridement followed by delayed primary closure. The rest healed secondarily.

The occurrence of heterotopic ossification has been lower than the 5% to 26% reported in the literature for the median parapatellar approach in total knee arthroplasty [8, 10, 17]. During 1998 we performed a series of 150 cases in which we did not reattach the suprapatellar pouch to the anterior femur and 9% of those patients developed small areas of heterotopic bone around the distal femurs. None of these was felt to be clinically significant, but this finding did prompt us to resume repairing the attachment of the pouch which returned our rate of asymptomatic heterotopic ossification to less than 5%.

There have been four cases of patellar tendon rupture or avulsion in this primary series within 3 months of the index procedure. In each case the patients had some contributing problem such as renal failure, lupus, or morbid obesity. Prior to our use of the tibial tubercle pin in 2001, there were intra-operative partial patellar tendon avulsions in almost 20% of cases. These avulsions comprised less than one third of the total tendon in all cases, and appeared to have no clinical manifestations or consequence. With the use of the tibial tubercle pin this occurrence has been reduced to less than 1% in this series.

References