Original Research
The Medial Trivector Approach in Total Knee Arthroplasty
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ABSTRACT
This study compares the clinical results of the medial trivector approach to the standard parapatellar approach in primary total knee arthroplasty. Ten patients undergoing simultaneous bilateral total knee arthroplasty were included in this study. Right and left knees were randomized for a standard medial parapatellar arthroplasty or a medial trivector approach. Patients were assessed by the number of days to achieve straight leg raising and range of motion at discharge. In addition, knee scores were obtained at 6 weeks and 6 months with careful assessment of any pain or tenderness around the quadriceps mechanism. At 6 months, patients were tested on a KINCOM machine assessing their concentric and eccentric quadriceps strength.

While there was no difference in total range of motion at the time of discharge, patients undergoing a medial trivector approach achieved independent straight-leg raising 2 days sooner than patients undergoing a standard medial parapatellar arthroplasty. No significant differences existed in knee scores, pain scores, or range of motion at 6 weeks or 6 months. KINCOM testing at 6 months revealed the knees undergoing trivector approach to be 15% stronger in concentric contractions. No complications were encountered with the use of the medial trivector approach in these patients. Subjectively, patients reported less discomfort and more strength in the knees having undergone a medial trivector approach.

The medial trivector approach may enhance postoperative recovery without adversely affecting the quadriceps function following total knee arthroplasty. The medial trivector approach to the knee does not weaken quadriceps muscle function or adversely affect clinical results of total knee arthroplasty.

The most commonly used surgical approach in total knee arthroplasty (TKA) is the standard medial parapatellar arthroplasty as described by Insall. This surgical approach affords excellent exposure of all three compartments of the knee. Another option for a medial approach to the knee has been the southern or subvastus approach. The potential advantages of this incision include retention of the quadriceps mechanism and improved quadriceps strength postoperatively. While this approach affords excellent exposure of the medial compartment, exposure of the posterolateral corner of the tibia can be limited.

The medial trivector retaining arthroplasty has been described by Bramlett as a surgical approach that offers advantages over each of the previous procedures. While this surgical approach preserves much of the quadriceps mechanism, it can still afford excellent exposure of all three compartments of the knee.

This prospective randomized study evaluates two surgical approaches to TKA.

MATERIALS AND METHODS
Ten patients undergoing simultaneous bilateral TKA were included in this study. All patients had osteoarthritis of both knees with similar radiographic findings preoperatively. A randomization table was used to assign a surgical approach to each knee. In each patient, one knee had a standard medial parapatellar arthroplasty, while the other knee had a medial trivector retaining arthroplasty. All knees implanted were Biomet AGC (Biomet, Warsaw, Ind) cemented components. All procedures were performed by the same surgeon.

Patients and physical therapists were blinded to the randomization table. The therapists made recordings of quadriceps strength, range of motion, and ability to transfer and ambulate at each interaction. The number of days to achieve straight leg raising was recorded as well as the range of
motion at discharge, 6 weeks, and 6 months. Knee Society knee scores were recorded at 6 weeks and 6 months, and radiographs were interpreted at those intervals.

Quadriceps strength was measured at 6 months after surgery with standardized KINCOM isokinetic testing (Chattecx, Chattanooga, Tenn). Testing was performed using concentric and eccentric testing at 60°/sec and 120°/sec. A subjective evaluation was performed by patients with specific questions as to type and degree of pain in the knee and pain or tenderness along the incision or in the quadriceps mechanism.

The surgical approach for each knee included an identical skin incision that extended from 3 to 4 inches proximal to the patella to below the tibial tubercle. The incision was gently curved to the medial side of patella. Patients undergoing a standard medial parapatellar arthroscopy had an incision extending through the periosteum of the medial tibia along the patellar tendon 1 cm medial to the patella and curving into the quadriceps tendon 1 cm lateral to the insertion of the vastus medialis (Fig 1).

Those patients undergoing a medial trivector approach had a similar skin incision with the arthroscopy extending from medial to the tibial tubercle through the periosteum and along the patellar tendon 1 cm medial to the patella. Superior to the patella, the incision continued 10 to 12 mm medial to the muscle attachment of the vastus medialis to the quadriceps tendon. This incision was carried vertically through the muscle to the underlying tendon, which was divided in a straight line 6 cm superior to the superior board of the patella. All incisions were made in flexion with closure also performed in flexion (Fig 2).

**Results**

On average, patients demonstrated independence in straight-leg raising 2 days earlier with knees that had undergone a medial trivector approach com-
pared with knees that had undergone a standard parapatellar arthroscopy ($P<.05$) (Fig 3). This was consistent with each patient. Using identical therapy protocols for each knee, range of motion was similar at discharge, 6 weeks, and 6 months (Fig 4). In addition, pain and function scores were similar at 6 weeks and 6 months for each surgical approach (Fig 5).

Isokinetic testing at 6 months revealed a trend of greater strength and concentric quadriceps contraction for the knees that had undergone a medial trivector approach ($P<.058$) (Fig 6). Subjectively, patients reported a feeling of less discomfort and greater strength in the leg that had undergone a medial trivector approach. There were no complaints of tenderness or pain along the incision site in either knee at 6 months.

**DISCUSSION**

The choice of surgical approach in TKA should be dictated by the goals of the procedure. The exposure afforded by the surgical approach as well as the effect on postoperative function are important factors to be considered. The medial parapatellar arthroscopy affords excellent exposure of the knee and has been the standard approach for TKA for many years. The quadriceps tendon splitting portion of this incision detaches a significant portion of the medial quadriceps from the patella. While this eventually heals, the quadriceps are weakened for a period of time. The healing of a tendon/tendon repair may take longer than a muscle/tendon repair and could account for the difference in strength recorded at 6 months.

The trivector retaining arthroscopy allows similar exposure of the knee. However, there seems to be greater retained quadriceps function postoperatively as evidenced by the earlier return of quadriceps strength for straight-leg raising. While not statistically significant, the slightly greater strength at 6 months on isokinetic testing may have been significant with a larger series. The long-term benefits of this approach are unknown. Likewise,
complications of this approach are unknown at this time. However, based on the findings in this study, an evaluation of a larger group of patients is indicated.

CONCLUSIONS
The medial trivector retaining arthroplasty affords excellent exposure for TKA. It does not weaken quadriceps function or adversely affect the clinical results of TKA. Compared with the standard medial parapatellar arthroplasty, it may allow more rapid recovery of knee function and improved rehabilitation.

REFERENCES

EDITORIAL DISCUSSION
ORTHOPEDICS: What is the origin of the term "trivector"?
Fisher et al: We believe that Dr Kenneth Bramlett of Birmingham, Ala coined the term "trivector retaining arthroplasty" to describe this surgical approach to the knee. Using vector analysis, the resultant quadriceps force vector can be resolved into three components corresponding to the forces generated by the quadriceps muscles. These include medial, lateral, and superior vectors. Depending on where one incises the quadriceps mechanism, the resultant vector acting on the patella can be changed, both directionally and in magnitude. With the trivector retaining arthroplasty, a significant portion of the medial vector is retained.

ORTHOPEDICS: Do you feel that in the future, in addition to having greater numbers, it would be beneficial to study the neurohistology of the tendon and the vastus muscle where the trivector incision is made to determine if there is a different pattern of neural elements that are disturbed by the two different incisions?
Fisher et al: Certainly a study with a greater number of patients would provide a higher level of confidence. This was a pilot study but the results were compelling enough to change our surgical approach. We now have performed more than 500 TKAs using this approach and have yet to see a complication related to the surgical approach.

Because of the findings in this study, we believe it would be beneficial to study the neurohistology of the quadriceps expansion to determine any differences in the neuroreceptors within the tendon compared with the area of muscle attachment. Whether it was a decreased number of pain receptors causing less pain inhibition or greater retained resultant vector force allowing earlier functional return could not be determined by this study.