

Correlation of Patellar Articular Lesions with Results from Anteromedial Tibial Tubercle Transfer

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ABSTRACT

This retrospective study determined that the outcome from anteromedialization of the tibial tubercle correlates well with the location of patellar articular lesions. Detailed descriptions of patellar articular cartilage lesions were obtained from the operative reports of 36 patients who had anteromedialization performed between February 1984 and March 1994. The patterns fell into four distinct groups. Ten patients with type I (distal) patellar lesions and 13 patients with type II (lateral facet) patellar lesions had 87% good to excellent subjective results, and 100% of these patients said they would have the procedure done again. Nine patients with type III (medial facet) lesions had 55% good to excellent results, and 5 patients with type IV (proximal or diffuse) lesions had only 20% good to excellent results. Patients with type I or II lesions were significantly more likely to have good or excellent results than those with type III or IV lesions. Central trochlear lesions were associated with medial patellar lesions and all patients with central trochlear lesions had poor results. There was no significant correlation between the Outerbridge grading of the patellar lesion and the overall results. Workers' compensation issues diminished the likelihood of a satisfactory outcome by 19%; however, this was not statistically significant. This is the first study to correlate the patellar articular cartilage lesion with outcome after tibial tubercle transfer.

Anteromedial tibial tubercle transfer has been successful in patients with lateral patellar tilt or lateral tracking

(subluxation) associated with articular cartilage degeneration. Tubercle transfer helps to realign the extensor mechanism while decreasing patellofemoral joint-reaction force.⁷ The purpose of this study was to see if the pattern of the patellar articular cartilage lesion affects the outcome after anteromedial tibial tubercle transfer.

Reider et al.¹¹ emphasized the importance of selecting the correct surgical treatment appropriate for a specific patellofemoral disorder. A careful history and physical examination; appropriate radiographic studies, including an axial Merchant view⁹; and, when necessary, a CT scan¹² have been most helpful in selecting the appropriate patients for anteromedial tibial tubercle transfer. Another important factor to consider, however, is the extent and location of the accompanying patellar articular cartilage lesion or lesions. In most patients, malalignment leads to articular cartilage breakdown.^{2,3} The particular pattern of articular cartilage breakdown relates directly to the type of malalignment or injury in most cases. Because cadaveric studies and our direct observations reveal that the patellar contact area is shifted proximally and medially after anteromedial tibial tubercle transfer,⁷ we hypothesized that the location and possibly the extent of the patellar articular cartilage degeneration may be important in determining the outcome after an anteromedial tibial tubercle transfer.

MATERIALS AND METHODS

Patients were selected for this retrospective study if they had undergone an anteromedial tibial tubercle transfer and a detailed description of the patellar or trochlear articular lesion was available from the operative report. Fifty knees met the selection criteria for the study. Thirty-six patients returned detailed questionnaires on 37 knees. The questionnaire evaluated the patient's present function and compared this with preoperative function. The follow-up period ranged from 1 to 8 years, with an average

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followup of 46.8 months. There were 31 women and 5 men with an average age at time of surgery of 29 years (range, 16 to 54). This group of patients included 10 workers' compensation patients. Sixty-eight percent of the patients (30 of 36) had previous surgery, and the average number of previous procedures was 1.9. The most common procedures previously performed were lateral release (68%) and arthroscopic debridement of loose articular cartilage (24%). Fifty-seven percent of the patients (20 of 36) had had complete patellar dislocations and, of these, 86% (17 patients) reported recurrent dislocations (>2 previous dislocations). All patients had failed results with more than 6 months of comprehensive nonoperative care or had failed to improve with their previous operative care.

Although we have previously used CT scans to evaluate patellar alignment, we now rely more on clinical assessment, radiographic studies (particularly Merchant and lateral knee films), and intraoperative arthroscopic evaluation.⁵ Only in cases where there is still questionable malalignment do we obtain a CT scan before surgery, and few patients in this study required preoperative CT scans. All patients undergoing anteromedialization in this study had either lateral subluxation or symptomatic patellofemoral arthrosis.

All patients underwent an arthroscopic examination followed by a lateral release and anteromedial tibial tubercle transfer performed by the senior author (JPF) using a technique previously described.^{3,6,7} Patellar lesions were addressed by simple arthroscopic debridement of any loose and unstable fragments. If bone was exposed (grade IV Outerbridge lesion), arthroscopic drilling into the subchondral bone was performed. From detailed operative descriptions, including the specific lesion location (medial, lateral, superior, inferior), the lesions were categorized into four groups based on the location of the articular lesion on the patella⁵ (Fig. 1). Type I lesions were distal midpatellar lesions in Ficat's critical zone. Ten patients had this pattern. There were 13 type II lesions (involving the lateral facet), 9 type III lesions (involving the medial facet), and 5 type IV lesions (involving the proximal patella).

Type IV patellar lesions were further subdivided into type IVA (proximal only) and type IVB (proximal and

at least 80% of the overall patella). The depth and size of the articular cartilage lesion was also classified using the Outerbridge system.¹⁰

Postoperatively, patients' legs were placed in knee immobilizers for 4 weeks and the patients were allowed limited weightbearing on crutches. Daily range of motion exercises were started on the 1st postoperative day, with a goal of full range of motion by 4 to 8 weeks. Full active quadriceps muscle strengthening started after the osteotomy had healed sufficiently (callus formation).

Patient followup included a detailed questionnaire with visual analog scales and a modified Lysholm scale.⁸ The modified Lysholm scale was adapted for patellofemoral pain and instability to give a functional measure of normal knee activity.⁷ A patient had an excellent result if the modified Lysholm score was 95 to 100, a very good result if the score was 90 to 94, a good result if the score was 80 to 89, a fair result if the score was 70 to 79, and a poor result if the score was less than 70.

Subjectively, patients were asked to evaluate their conditions compared with preoperative status with regard to pain, activity level, satisfaction with level of sports participation, and overall satisfaction with the procedure. They were also asked whether they would agree to the procedure again. Patient subjective assessment of overall results from tubercle transfer are based predominantly on pain. An excellent result was no pain with prolonged periods of strenuous exertion, a good result was occasional mild pain, a fair result was frequent pain with activities of daily living, and a poor result was constant pain with minimal activity.

RESULTS

Overall, 33 (92%) patients said they would have the procedure done again. Sixty-three percent of the patients ($N = 23$) were satisfied with their current levels of sports participation and 72% ($N = 26$) thought that their level of sports activity had improved after the surgery. Of all the patients who had tubercle transfers, 22 reported participating in high-level activities (skiing, soccer, jogging, running, volleyball, and tennis), 25% biked regularly, and 21% regularly participated in aerobics classes. The more stringent modified Lysholm scale rated the overall results as 46% good to excellent and 54% fair to poor.

Comparing the outcome of anteromedial tibial tubercle transfer with the pattern of articular cartilage damage gave some interesting results. Subjectively, 9 of 10 patients with type I (distal) lesions reported good to excellent results; 11 of 13 patients with type II (lateral facet) lesions reported good to excellent results; 5 of 9 patients with type III (medial facet) lesions reported good to excellent results; and only 1 of 5 patients with type IV (proximal or diffuse) lesions reported good to excellent results (Fig. 2). A statistical analysis using Fisher's exact test revealed that patients with type I and II lesions were statistically more likely to have a good or excellent result than patients with type III and IV lesions ($P = 0.008$). All patients (100%) with type I and II lesions said they would have the procedure again. Using the Armitage-Mantel trend test

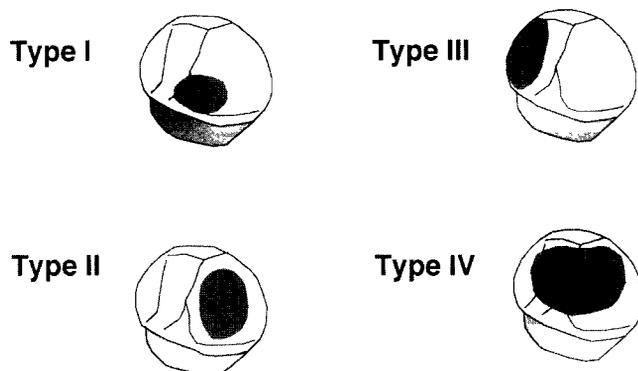


Figure 1. Grading system based on location of patellar lesion. See text for details.

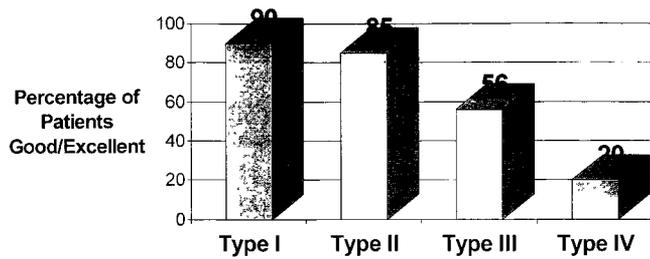


Figure 2. Location of patellar articular lesion correlated with subjective results of anteromedial tibial tubercle transfer ($P = 0.003$).

(Stat Xact software, Cytel Corporation, Cambridge, Massachusetts), we demonstrated a highly significant trend toward worse results from the type I through type IV lesions ($P = 0.003$),¹ based on subjective findings.

The modified Lysholm scale showed large differences between the outcomes in patients with different types of patellar lesions (Fig. 3). Fifty-seventy percent (13 of 23) of the patients with type I and II lesions achieved a score equal to or greater than 80 by this strict rating scale, although 100% expressed satisfaction with the outcome. Only 29% (4 of 14) of the patients with type III and IV lesions achieved a score equal to or greater than 80.

Although there is clearly a trend of worsening results from type I to type IV lesions (Fig. 3), this did not achieve statistical significance ($P = 0.30$) based on Lysholm scores. The modified Lysholm scale did, however, correlate with overall results. The patients with subjective excellent results had an average Lysholm score of 88 (range, 77 to 100). Patients with good subjective results had an average Lysholm score of 74 (range, 53 to 95). Fair results gave an average score of 46 (range, 38 to 54), and poor results objectively gave a score of 33 (range, 14 to 61).

Patients also rated their pain on a visual analog scale from 1 to 10, comparing their current pain with a preoperative pain level of 10. The patients with type I lesions reported an average pain index of 2.9 (range, 1 to 8), with a median of 2.5 and standard deviation of 2.18. Patients with type II lesions had an average pain index of 2.92 (range, 1 to 7), with a median of 3 and standard deviation of 1.80. Patients with type III lesions had an average pain index of 4.28 (range, 1 to 10), with a median of 3 and a standard deviation of 3.47. Patients with type IV lesions

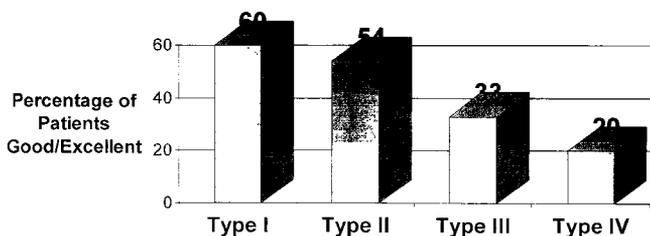


Figure 3. Location of patellar articular lesion correlated with results of modified Lysholm scale ($P = 0.30$).

had an average pain index of 6.8 (range, 3 to 10), with a median of 8 and a standard deviation of 3.11.

Statistical analysis of the pain results using the one-way analysis of variance demonstrated an overall P value of 0.0324. The two-sample t -test for type I and II versus type III and IV lesions demonstrated the significant P value of 0.01. Comparing type IV lesions with all other types showed a highly significant increase in pain in type IV patients ($P = 0.007$).

Eighty-three percent of patients with type I and II lesions (19 of 23) were satisfied with their postoperative levels of sports participation, whereas only 21% of the patients with type III and IV lesions (3 of 14) were satisfied. It is reasonable to expect an enhanced activity level after anteromedial tibial tubercle transfer if a lateral or distal articular lesion is noted. Patients with diffuse or proximal lesions, however, may not achieve satisfactory improvement in physical activity.

There was no correlation between the grade of the patellar lesion using the Outerbridge classification and the overall results (Fig. 4). Seventeen knees had grade IV (exposed bone) Outerbridge changes, and 12 of these had good to excellent subjective results. There were 11 knees with grade III (fibrillation >0.5-inch diameter) Outerbridge changes and 7 of these had good to excellent subjective results. Four of five knees with grade II (small fibrillated area) Outerbridge changes had good to excellent results. All three patients with diffuse grade IV Outerbridge changes did poorly. Applying the Armitage-Mantel trend test demonstrated the highly nonsignificant correlation between the Outerbridge classification and the patients' results ($P = 0.86$).

Ten patients had trochlear lesions at the time of tubercle transfer. All three patients with lateral trochlear lesions at the time of anteromedialization had good or excellent results. The seven patients with central trochlear lesions had poor results. Six of the seven knees with central trochlear lesions also had medial patellar lesions.

Of the 37 surgeries, there were 3 significant complications (8%). There were no cases of compartment syndrome, skin slough, neurovascular complication, or deep venous thrombosis. The first complication was a nondisplaced tibial fracture that occurred 5 days after surgery while the

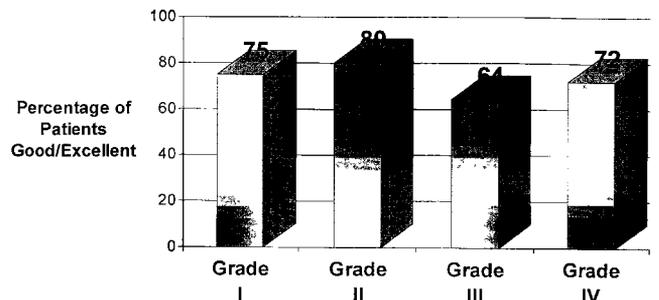


Figure 4. Outerbridge classification showing no correlation with subjective results ($P = 0.86$).

patient was toe-touch weightbearing. The patient was treated in a long leg cast for 2 months and the fracture healed. This patient later developed reflex sympathetic dystrophy and had a poor outcome with a Lysholm score of 14, the lowest in the series. The second complication was a traumatic wound dehiscence that occurred 2 weeks after surgery after the patient fell down four steps and landed directly on the treated knee. The wound was irrigated and debrided in the operating room and the wound closed over a drain. The patient was discharged 2 days later and healed without sequelae. Her subjective outcome was excellent and her Lysholm score was 77. The third complication was arthrofibrosis. This patient had a questionable nickel allergy and 2 months after surgery she had her screws changed to titanium screws. She subsequently developed arthrofibrosis and required a manipulation 5 months after surgery, which improved her motion satisfactorily. Overall, her subjective result was fair and her Lysholm score was 54.

Seventy-five percent (27 of 36) of the patients had their screws removed. Besides removal of hardware, there were nine patients who required further procedures. There were four patients who required arthroscopic debridement of the patella. One patient required arthroscopic debridement and vastus medialis obliquus advancement for continued symptoms of lateral subluxation. All of the patients who had patellar debridement had symptoms of mechanical catching with flexion and extension of the knee. After the debridement, all of the patients improved subjectively; however, a repeat Lysholm score was not obtained. One patient had iliotibial band scar tissue debrided. Another patient had revision of the surgical scar. A third patient had hardware replaced with titanium screws and then, 3 months later, manipulation under anesthesia for arthrofibrosis. One patient with Outerbridge grade IV changes had a poor result and later went on to have a patellectomy.

There were 10 patients involved in workers' compensation cases. Four of these patients had poor results; two, fair; two, good; and two, excellent. Of the 11 patients who had poor or fair outcomes after tubercle transfer, 6 were involved in workers' compensation cases. If the workers' compensation cases are removed from this series, the overall good to excellent rating is 95% for types I and II and 50% for type III and IV. Although there was a difference of 19 percentage points between workers' compensation and nonworkers' compensation cases (40% versus 59% good to excellent results, respectively), the small number of workers' compensation patients in this study did not achieve statistical significance ($P = 0.46$). Of interest is the fact that despite only 40% (4 of 10) workers' compensation patients achieving good or excellent results, 100% responded that they were pleased with the surgery and would have the procedure again.

DISCUSSION

Anteromedial tibial tubercle transfer has been successful in many patients with patellofemoral arthrosis and malalignment problems. Improving patient selection, however, offers the possibility of even better results. In our

attempt to correlate the location of patellar lesions with overall outcome, we categorized the lesions into four groups. The lesions were categorized at the time of surgery, independently of the patients' eventual outcomes. As with any attempt at categorization, not all lesions fit neatly into specific categories, but four general patterns were identified. This is the first study to correlate the location of the patellar articular lesion with the outcome of tibial tubercle transfer, and we believe it is an important addendum to our previous indications for treating patellofemoral malalignment.

In this patient population, the location of the lesion correlated better with outcome after tibial tubercle transfer than the depth and extent of the lesion as described by the Outerbridge classification.¹⁰ Patients with type I (distal) and type II (lateral) lesions were statistically more likely to have good or excellent results than those with type III (medial), type IVA (proximal), or type IVB (diffuse) lesions ($P = 0.008$). In fact, three of four patients with diffuse involvement of the patella had poor outcomes, and the one patient with a type IVA (proximal) lesion had a poor result.

The overall results in terms of pain relief significantly correlated with the location of the patellar articular lesion(s). Patients with type I and II distal or lateral lesions had significantly less pain. In patients with type IV proximal or diffuse lesions, anteromedial tibial tubercle transfer may not offer a good chance of improvement; 80% (4 of 5) of such patients had fair or poor results. Also, patients with type IV lesions had significantly more pain postoperatively ($P = 0.007$). We would consider doing an alternative procedure to anteromedialization if the initial arthroscopic examination demonstrated a type IV lesion of the patella.

In this study, central trochlear lesions were associated with medial patellar lesions (six of seven). All seven central trochlear lesions resulted in poor outcomes of anteromedial tibial tubercle transfer. The three patients with lateral trochlear lesions had associated lateral patellar lesions. The patients with lateral trochlear lesions all had good or excellent results. The central trochlear lesion appears to be a contraindication to anteromedial transfer of the tibial tubercle.

Although workers' compensation results were worse overall (40% good or excellent results versus 59% for nonworkers' compensation), this result was not statistically significant. And although only 40% (4 of 10) of the workers' compensation patients achieved good or excellent results, a full 100% thought they were helped by the surgery and would have the procedure again. Workers' compensation is not a contraindication to performing tibial tubercle transfer.

One must explain to surgical candidates that completely normal knee function after this procedure may not occur, but they may experience improvement in pain, stability, activities of daily living, and possibly an increase in level of sports participation. Patients should be reminded also that they will have difficulty kneeling and that 75% will eventually have to have the screws removed. The Lysholm scores indicate that the majority of patients do not have

normal knees postoperatively, yet 92% said they would have the procedure done again. Anteromedial tibial tubercle transfer, particularly in properly selected patients, yields high patient satisfaction, but many patients continue to have objective signs of limited function. Relief of pain is the most evident benefit of this procedure, and the majority of patients with type I and II lesions are satisfied with their sports and other physical activity.

Anteromedial tibial tubercle transfer is a very good procedure for properly selected patients, but it should be used with extreme caution in patients with proximal or diffuse patellar changes or in patients with central or medial trochlear lesions. We recommend performing a routine arthroscopic examination before the tibial tubercle transfer to evaluate the patellar articular surface. By restricting the use of this operation to patients with type I (distal) and II (lateral) lesions, one may anticipate 87% good to excellent pain relief overall, 95% good to excellent results (when there is no workers' compensation case involved), and extremely high patient satisfaction (100% in this series).

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