

Patella Baja in Anterior Cruciate Ligament Reconstruction of the Knee

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Twenty-nine consecutive arthroscopic assisted anterior cruciate ligament (ACL) reconstructions of the knee were retrospectively studied to evaluate the incidence of patella baja and the correlation of the finding with patellofemoral pain after the ligament surgery. The central one third of the patellar ligament was used and positioned isometrically. The patellar ligament defect was sutured closed. The incidence of patellar chondromalacia at the time of surgery was 24%. The incidence of medial femoral condyle chondromalacia was 59%. The incidence of symptoms of patellofemoral pain after surgery was 14%. Patella baja occurred in 76% of the ligament reconstructions. Two knees showed unexplained patellar tendon lengthening. There was no statistical difference in the results between the knees with and without baja. Postoperative symptoms of patellofemoral pain correlated best with chondromalacia of the patella or the medial femoral condyle at the time of the surgical procedure. Use of the central one third of the patellar tendon with closure of the defect does lead to baja; however, the presence of this radiographic finding does not correlate with patellofemoral pain.

Surgical approaches to disruption of the anterior cruciate ligament (ACL) of the knee have become more common in the past decade. Kenneth Jones stated, "The knee of an

active patient that has a deficiency of one or both cruciate ligaments is, and will remain, an unstable knee until surgically corrected."⁸

Primary repairs of the ligament have not been very successful; thus, reconstructions are presently the most viable alternative.⁹ Synthetic replacements have a limited longevity¹⁰; allografts have the risk of disease transmission³; extraarticular reconstructions address the primary problem in an indirect way¹¹; and autografts sacrifice another structure to replace the injured ligament.¹⁴

In 1963 Jones proposed the patellar ligament as a substitute for the ACL.⁶ The procedure was performed with an arthrotomy and postoperative immobilization. The results were acceptable in terms of stability, range of motion, infection, and length of time to return to full activity.⁷ Noyes subsequently demonstrated that the bone-patellar tendon-bone complex (as he harvested it) was the strongest of all of the autografts.¹²

In the mid-1980s the procedure was converted to an arthroscopically assisted surgery.¹ Ligament placement was refined, motion was instituted immediately, and the complications were decreased.

As the results were followed, the range of motion returned to normal and stability became reliably predictable. Symptoms from the patellofemoral joint became more noticeable with time, however. Some investigators thought that the surgery on the patella itself led to the symptoms; others thought that the compromise of the patellar ligament led to anterior knee pain.¹⁷

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Burks studied the surgery in dogs and showed that the patellar ligament shortened 10% after the central third was removed whether the defect was left opened or sutured closed.² O'Brien investigated eighty ACL reconstructions using the central third of the patellar ligament performed through an arthrotomy approach and showed that the incidence of patellar tendon shortening was 55% with a range of shortening from 10% to 50%.¹⁵ The patella baja appeared logical with respect to the anatomy of the surgical procedure; however, the question remained as to whether the ligament shortening correlated with subsequent anterior knee pain.

O'Brien noticed a trend of increased shortening leading to increased pain; however, he did not take into account the patellar surface condition at the time of surgery.¹⁵ Noyes reported a statistical correlation between the patellar surface changes and the postoperative pain, but he did not comment on the relationship of the symptoms to patellar height.¹¹ Other investigators have shown that there is no correlation between patellar surface changes in general and clinical symptoms of pain.⁴ This study was instituted to evaluate the relationship of patellar surface changes at the time of surgery and the postoperative change of the patellar height with the symptoms of patellofemoral pain that are seen after arthroscopic ACL reconstruction, using the central one third of the patellar ligament.

MATERIALS AND METHODS

Twenty-nine consecutive arthroscopic-assisted ACL reconstructions of the knee were evaluated with a minimum of two- and a maximum of four-years' follow-up interval.

The hospital charts, office records, operative reports, and radiographs of the knee joint were reviewed for each patient. The patients were interviewed, examined, and evaluated using the Cincinnati Sportsmedicine and Orthopaedic Center Evaluation Form (CSOE).¹³

The surgical procedure harvested the central one third of the patellar ligament with bone blocks on either end measuring 20 mm in length and 9 to 12 mm in width. Fourteen ligaments were 9.0 mm

in width; one ligament was 9.5 mm in width; were 10.0 mm in width; and one was 12 mm in width. The ligament was then positioned arthroscopically using the Kinematic Guide (Dyonics, Andover, Massachusetts). The position of the guidewires for the drill holes was accepted if the total excursion through the full range of motion of the knee was less than 2 mm. The graft was secured by tying the sutures from the blocks through plastic buttons and then securing the sutures beneath a screw and washer. The patellar tendon defect was closed with interrupted absorbable sutures (Fig. 1).

Seventeen patients (60%) had had previous meniscectomy. Seventeen patients (60%) required partial meniscectomy at the time of the ACL surgery. There were no other associated ligament injuries. After surgery, a simple hinged knee brace was applied and the knee was placed on a continuous passive motion machine overnight. The patient was discharged on the first postoperative day and given instructions for partial weight bearing with crutches. Full range of motion was permitted from the day of surgery. After two weeks, full weight bearing was allowed without supportive devices.

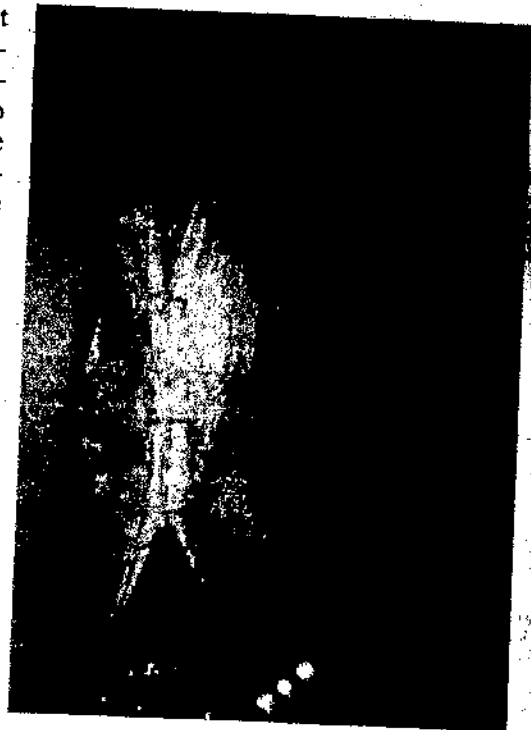


FIG. 1. Closure of the patellar defect with interrupted absorbable sutures.

ament was 9.5 mm in width; 13 mm in width; and one was 12 mm in width. The graft was then positioned arthroscopically using the Kinematic Guide (Dyonics, Boston, Massachusetts). The position of the drill holes was accepted if the graft covered the full range of motion of the knee within 2 mm. The graft was secured with sutures from the blocks through the patellar tendon and then secured the sutures behind the patellar tendon de-washer. The patellar tendon de-washer with interrupted absorbable sutures (60%) had had previous meniscectomies (60%) required par-tial ACL surgery. After associated ligament injuries, a simple hinged knee brace was placed on a continuous machine overnight. The patient was discharged on the first postoperative day and for partial weight bearing with a brace. After two weeks, full weight bearing was permitted without supportive devices or

braces. Progressive resistive exercises were instituted five weeks after surgery. Limited braced sports were permitted three months after surgery, if the patient obtained full range of motion and a Cybex^R (Division of Lumex, Ronkonkoma, New York) testing showed less than 10% difference between the hamstring/quadiceps group versus the contralateral normal side.

The status of the patellofemoral joint at the time of surgery was determined by reviewing the Outerbridge changes reported in the operative findings of the dictated operative note.¹⁶ Seven knees showed patellar chondromalacia. There was one Grade I change, three Grade II, three Grade III, and no Grade IV changes.

The radiographs were measured using the lateral view of the knee with the Insall-Salvati patellar tendon/patella ratio.⁵ The preoperative radiographic ratio was compared to the postoperative ratio, a minimum of one year after the surgery (average, 1.8 years). Patella baja was defined as a decrease in the ratio of 10% or more between the two radiographs.

RESULTS

Twenty-six of the ACL reconstructions were performed for a chronic ACL deficiency (defined as three or more months after the initial injury) and three were performed for an acute injury. There were 17 males and 12 females. The average age was 25. No patient complained of patellofemoral symptoms prior to the reconstruction. All of the patients with chronic deficiency complained of me-

TABLE 1. Cincinnati Sportsmedicine Orthopaedic Evaluation Scores

Overall preoperative	54
Overall postoperative	88
Patients with chondromalacia at the time of surgery	81
Patients without chondromalacia at the time of surgery	92
<i>p</i> = 0.002	
Patients with patellofemoral pain after surgery	87
Patients without patellofemoral pain after surgery	91
<i>p</i> = 0.74	
Patients with patella baja	89
Patients without patella baja	90
<i>p</i> = 0.99	

TABLE 2. Patellar Chondromalacia versus Postoperative Patellofemoral Pain

	Pain	No Pain
Chondromalacia	3/7 (43%)	4/7 (57%)
No chondromalacia	1/22 (5%)	21/22 (95%)

p < 0.04; Fisher's exact 2-tail test.

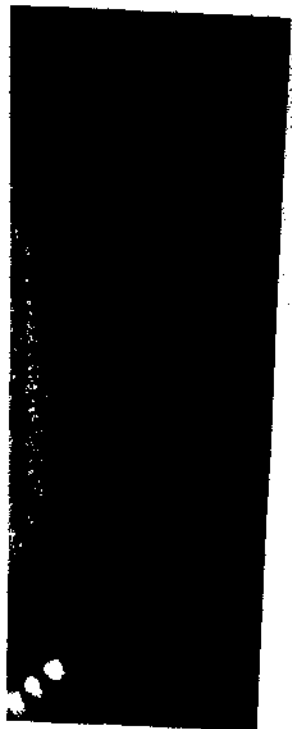
chanical instability. The average preoperative CSOE score was 54 and the average postoperative score was 88. Twenty-six of the 29 patients had a score of 80 or above. One scored in the seventies and two scored in the sixties (Table 1).

One knee developed a 10° flexion contracture requiring arthroscopic lysis of adhesions and manipulation with subsequent restoration of full extension. There were no spontaneous ligament ruptures. There was one traumatic rupture associated with sports twelve months after surgery despite the use of a protective brace. There were no cases of infection or phlebitis.

The overall incidence of patellofemoral pain was 14% (4/29 knees). Patellar chondromalacia was documented at the time of the surgery in seven knees (24%), three of which subsequently developed patellofemoral pain (3/7 knees, 43%). Twenty-two knees showed no chondromalacia changes and one developed patellofemoral pain postoperatively (1/22, 5%). This difference is statistically significant using the Fisher's exact two-tail test (*p* < 0.04) (Table 2).

The average score for patients with patellar chondromalacia at the time of surgery was 81, and for those without chondromalacia it was 92 (difference statistically significant using the Student's *t*-test with *p* = 0.002).

The other surfaces of the knee joint were also evaluated and the chondromalacia changes correlated with the postoperative scores. Seventeen knees demonstrated chondromalacia changes of the medial femoral articular surface (59%). The average score of these patients was 87. The average score of



the patellar defect with in-sutures.

the patients without changes on the medial condyle was 94 (statistically significant with $p = 0.03$). Surface changes on the medial tibial plateau, the lateral femoral condyle, and the lateral tibial plateau occurred with less frequency and were not statistically significant.

The average score for patients with patellofemoral pain after surgery was 87 and for those without patellofemoral pain it was 91 (difference not statistically significant with $p = 0.737$) (Table 1).

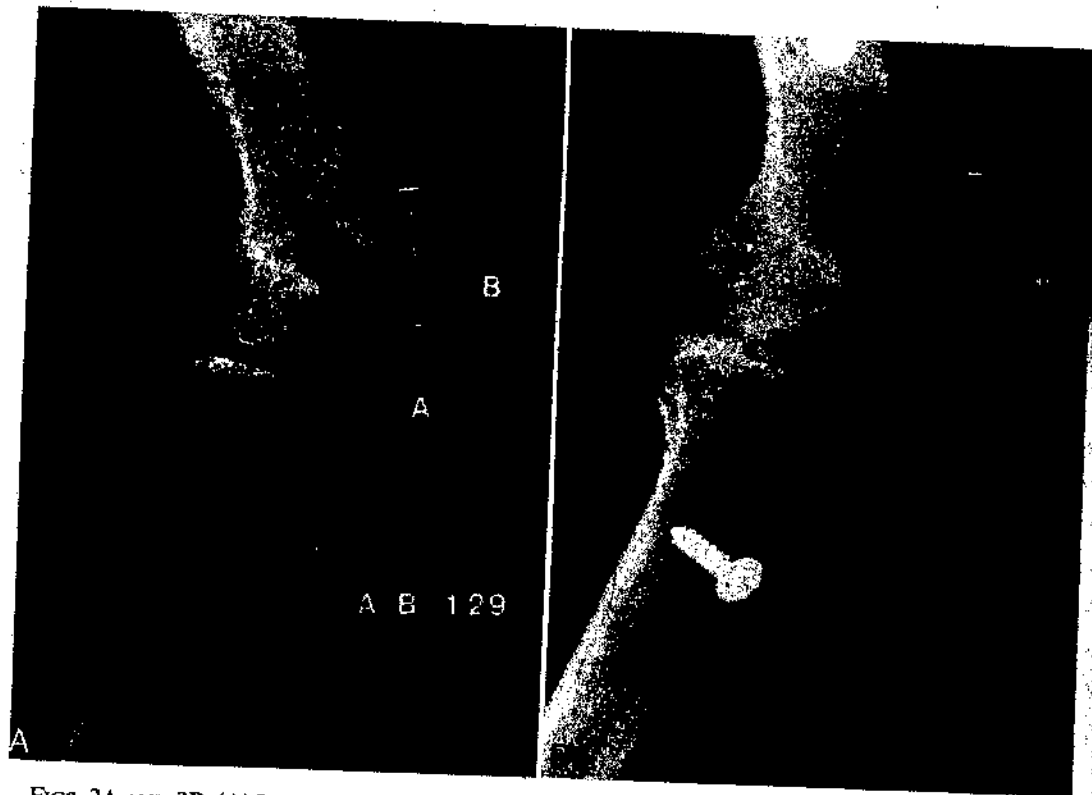
Twenty-two of the 29 knees (76%) had patellar ligament shortening. Thirteen knees (45%) had shortening less than 10% and nine knees (31%) had shortening greater than 10% (relative patella baja) (Fig. 2). Six knees (21%) had lengthening of the ligament with two greater than 10%. One knee (3%) showed no patellar ligament change. The width of the

bone blocks and the male/female incidence of each group was not significant.

Using the assumption that the patellar tendon length would not change from the preoperative to the postoperative measurement statistical analysis of the results using the paired t -test rejected the hypothesis with $p < 0.0002$ (Fig. 3).

The average score for the patients with relative patella baja was 89 and for those without baja it was 90 ($p = 0.99$). Seven of the nine patients with baja were free of pain; two were symptomatic. Eighteen of the twenty patients without baja were free of pain; two were symptomatic. The difference between the two groups was not statistically significant ($p = 0.57$) (Table 3).

Because the definition of baja is somewhat artificial, the average change in length of the

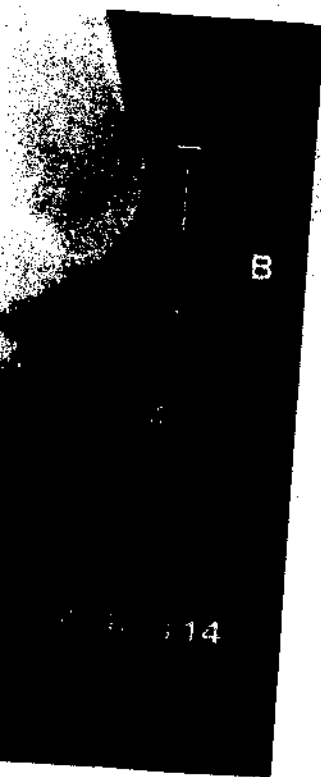


FIGS. 2A AND 2B. (A) Lateral radiograph of the knee before surgery. (B) Lateral radiograph of the knee after surgery, demonstrating patella baja.

and the male/female incidence p was not significant. The assumption that the patellar tendon would not change from the preoperative postoperative measurement. Analysis of the results using the rejected the hypothesis with $p < .05$.

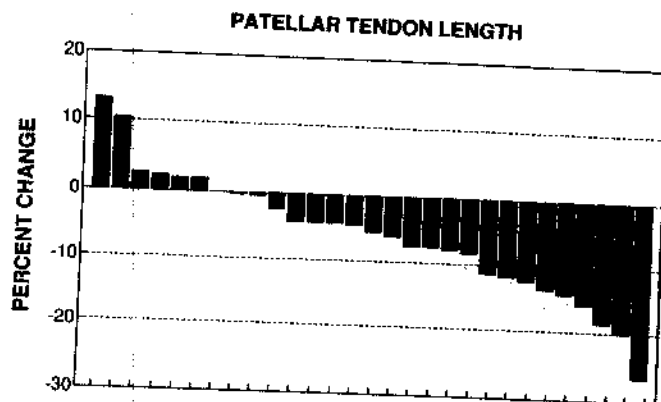
Score for the patients with patellofemoral pain was 89 and for those without was 92 ($p = 0.99$). Seven of the nine knees with patella baja were free of pain; two were not. Eighteen of the twenty patients with patellofemoral pain were free of pain; two were not. The difference between the two groups was not statistically significant ($p = 0.3$).

The definition of baja is somewhat subjective. The average change in length of the



Lateral radiograph of the knee

FIG. 3. Percentage change in the patellar length of each of the 29 knees.



$P < .0002$ paired t-test

patellar tendon was compared for the group of patients with and without patellofemoral pain. Those patients without pain showed an average change of -0.5 ; those patients with pain showed an average of -0.11 . The difference is not statistically significant with $p = 0.67$.

DISCUSSION

Repair and or reconstruction of the ACL remains a controversial subject in orthopaedic surgery. An ideal solution for the problem does not exist. Thus, any approach represents a compromise. The central one third bone-patellar ligament-bone complex is the strongest construct available. The authors admit that this is somewhat controversial because of the width of the complex Noyes chose to test.¹²

Removal of the segment from the extensor mechanism and closure of the ligament defect should shorten the patellar tendon and lead to a patella baja. It may also lead to overall weakening of the quadriceps. Thus, some investigators are concerned with subsequent patellofemoral symptoms after the surgery.

This study looks at a group of patients who had arthroscopic assisted ACL reconstruction using the central one third of the patellar ligament. The data presented indicate short-

ening of the ligament in 76% of the knees; however, this shortening does not correlate with patellofemoral symptoms or with the size of the bone block removed. The authors were unable to explain the fact that two knees showed lengthening of greater than 10%.

Changes of patellar chondromalacia at the time of surgery correlated best with the symptoms of pain after the surgery. The score of 81 for the knees with chondromalacia was statistically different than the score of 92 for the knees without chondromalacia ($p = 0.002$). Surface changes in other areas of the knee were also evaluated and only changes on the medial femoral condyle were found to be statistically significant ($p = 0.03$).

The data suggest that chondromalacia changes on the medial femoral condyle or the facets of the patella compromise the results of anterior cruciate ligament reconstruction using the central one third of the patellar ligament.

TABLE 3. Patella Baja versus Patellofemoral Pain

	Pain	No Pain
Patella baja	2/9 (22%)	7/9 (78%)
No patella baja	2/20 (10%)	18/20 (90%)

$p = 0.57$.

Although patella baja represents an aberration from the normal, it does not correlate with patellofemoral pain. Anterior cruciate ligament reconstruction using the central one third of the patellar ligament does lead to ligament shortening; however, the clinical significance of this radiographic finding remains unclear.

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