Outcomes of Anterior Cruciate Ligament Reconstruction in Patients With Workers’ Compensation Claims

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Summary: A general perception exists that outcomes of orthopaedic procedures in patients with Workers’ Compensation claims fare worse than those of patients without such claims. We retrospectively reviewed the outcomes of anterior cruciate ligament (ACL) reconstruction in patients who have Workers’ Compensation claims. This minimum 2-year follow-up study analyzed the occupational, functional, and objective results of patients who underwent arthroscopic-assisted anterior cruciate ligament (ACL) reconstruction. Twenty-two patients with Workers’ Compensation claims representing 5% of patients who underwent ACL reconstruction at our institution between 1987 and 1995 were included in the current study. All reconstructions were performed by the senior author (B.R.B.) using arthroscopic-assisted techniques (single and double-incision) with bone-patellar tendon-bone autografts followed by an accelerated rehabilitation protocol. Postoperative follow-up physical examinations revealed a negative anterior drawer in 19 patients (91%), a negative Lachman in 15 patients (68%), and a negative pivot shift in 21 patients (96%). The KT-1000 arthrometric evaluation at follow-up showed a mean maximum manual difference of 1.9 mm with 15 patients (68%) having a maximum manual difference of ≤3 mm and 7 patients (32%) from 3 to 5 mm. The mean postoperative scores for the Hospital for Special Surgery scoring scale was 86, Noyes Sports activity scale 81, Noyes ADL score 36, Noyes Problem with Sports 75, Noyes Sports Function score 87, Lysholm score 82, and the Tegner score 5.9. The Noyes Occupational rating system increased from preoperative 48 to 60 postoperatively and the Noyes Job Title rating system score remained at 5 after surgery. Functional testing revealed mean deficits of no more than 9% between the reconstructed and normal knees. SF-36 testing revealed significantly higher scores in the Role Physical and General Health categories and a significantly lower score in the Mental Health category when compared with United States norms. Subjective evaluation revealed that 95% of the patients would undergo a similar procedure if faced with a similar injury to the contralateral knee in the future. The results of the current study show that ACL reconstruction leads to predictable functional and occupational results in those patients with work-related injuries. All of our patients were able to return to work. The hypothesis that Workers’ Compensation compromises the results of ACL reconstruction was not observed in this study. Key Words: ACL reconstruction—Workers’ Compensation claims.

"The employer shall provide and pay for all the necessary first aid, medical and surgical services, and all the necessary medical, surgical, and hospital services thereafter incurred, limited, however, to that which is reasonably required to cure or relieve from the effects of the accidental injury..." [The General and Permanent Laws of Illinois 305/8 Amount of Compensation-Nonfatal Cases.] The sports medicine literature is replete with information documenting the success of anterior cruciate ligament (ACL) reconstruction with respect to stabilization of the ACL-deficient knee, the return to preinjury levels of athletic activity, and patient satisfaction. Most of the studies analyze the young, active patient who typically is injured during an athletic event. Previous work from our own institution has had...
predictable results following ACL reconstruction for both double-incision (DI) and endoscopic ACL reconstruction using patellar tendon autograft at short-term and intermediate follow-up evaluations, as well as middle aged patients who undergo ACL reconstruction.2-5,12

There is a subpopulation of ACL-deficient patients who are injured during work activities. Evidence in the literature on spine and upper extremity injuries shows that patients with Workers' Compensation claims have a much slower rehabilitative period with less predictable results.17-26 We have previously reviewed the results of open distal clavicle resection and noted a significant difference in the subjective results, but not objective results in comparison Workers' Compensation versus non-Workers' Compensation patients.27 Unfortunately, these patients often have secondary issues that cloud the orthopaedic management and eventual outcomes from their initial work-related injury. There is little information in the literature concerning the outcome for patients who undergo ACL reconstruction secondary to work-related injuries.

The purpose of the current study was to investigate the results of ACL reconstruction in patients with Workers' Compensation claims. Our perception before this study was that the Workers' Compensation population appeared to respond well to ACL reconstructive surgery in contrast to our observations of surgery about the shoulder region. Our goal was to challenge the notion that Workers' Compensation in itself comprises the results of ACL reconstruction. Clinical, functional, and objective analyses were performed as well as occupational scoring to test our hypothesis.

MATERIALS AND METHODS

The study group included patients with Workers' Compensation claims who underwent endoscopic or arthroscopic-assisted ACL reconstruction using patellar tendon autograft performed by the senior author (B.R.B.) between January 1987 and December 1995. Patients were selected for ACL reconstruction based on their preinjury activity level, desire to return to that level, and postinjury symptoms of instability. No patients were excluded from having an ACL reconstruction based upon their Workers' Compensation status. The patients were identified from a computerized database maintained by the senior author at Rush-Presbyterian-St. Luke's Medical Center. During this time period, a total of 449 ACL reconstructions were performed. Twenty-two reconstructions were performed in 22 patients with Workers' Compensation claims. Inclusionary criteria for the current study included patients who underwent ACL reconstruction and who had a Workers' Compensation claim. Exclusionary criteria for the current study included patients with less than 2 years of minimal follow-up, bilateral reconstructions, multiligament reconstruction, allograft ACL reconstruction or revision ACL reconstruction. All 22 patients comprising the study group were personally evaluated and none were lost to follow-up. Historical controls based on our previously reported results of DI and single-incision ACL reconstructions were used for comparison.

Surgical Technique and Rehabilitation

Before October 1991, patients underwent a DI arthroscopic-assisted technique without extra-articular augmentation as described by Bach et al.2 Thereafter, a single-incision endoscopic procedure as described by Haiden et al. was performed.28 Regardless of the operative technique employed, the principles of graft harvesting, adequate notch preparation, tunnel placement, graft orientation, and rigid interference screw fixation with the knee in extension were used for all patients. Surgery was delayed until patients had regained near normal range of motion and had minimal or no knee effusion. This study group included both types of procedures as our previously reported studies showed no significant differences between the techniques.3-5

Postoperative physical therapy was started immediately after surgery with gait training, straight leg raising, prone heel hang, and range of motion exercises. The DI group patients were progressed to full weight bearing by 6 weeks, whereas the endoscopic group patients were allowed immediate full weight bearing following surgery. Both groups used a hinged knee brace for 6 weeks after surgery. A formal rehabilitation program was instituted during the first postoperative week. This program allowed stationary bicycling by week 2, stairsteppers by weeks 4 to 6, straight ahead jogging by weeks 12 to 16, and gradual return to sports by 4 to 6 months. A custom orthosis was used from 6 weeks to 6 months for activities of daily living and was used for sports from 6 months to 1 year postoperatively.

Questionnaire

A detailed questionnaire was developed so that the modified Tegner, Lysholm, Hospital for Special Surgery, Noyes Sports Activity, Noyes Sports Function, Noyes Cincinnati, Noyes Occupational rating (Table 1), and Noyes Job Title (Tables 2 and 3) rating scales could subsequently be determined.29-33 All question-
naires were completed by the patient to eliminate interviewer or surgeon bias. These were completed at final follow-up.

Subjective Assessment

Subjective patient satisfaction was evaluated using several methods. They were asked to categorize their satisfaction level as "completely," "mostly," or "some what" satisfied, or "dissatisfied." Patients were also asked to respond with a simple yes or no if they would consider having the procedure repeated on the opposite knee if faced with similar circumstances. Finally, patients were asked to graphically diagram their level of satisfaction using a visual analog scale on a ruled 10-cm scale.

Physical Examination

Physical examination of the both knees was performed by the sports medicine fellow independently of the treating physician. This included supine range-of-motion measured with a goniometer, prone heel height differences measured to the nearest centimeter, thigh circumference measurements and evaluation of patellofemoral compartment crepitation. Patellofemoral crepitation was graded as 0 (absent), 1+ (mild), 2+ (moderate), or 3+ (severe). Varus/valgus stability at 0° and 30°, Lachman, anterior and posterior drawer, and pivot shift tests were performed. Ligamentous laxity was graded as 1+, 2+, or 3+ (O to 5 mm, 6 mm to 10 mm, >10 mm). The pivot shift phenomenon was graded as 1+ (slip), 2+ (jump), and 3+ (transient lock) in the position of thigh abduction and external rotation, which maximizes the pivot shift phenomenon.

Functional Examination

Bilateral functional knee testing, which included timed single-leg 6-m hop, measured single-leg hop, and single-leg vertical jump, was performed by an experienced athletic trainer (J.B.). All patients underwent 3 trials of each functional test on each leg, which were then averaged and reported as side-to-side percentage differences.

Arthrometric Examination

Each knee was tested preoperatively and postoperatively with the KT-1000 arthrometer by an experienced independent examiner (J.B.). Testing was performed as described by Daniel et al. Anterior maximum manual and maximum manual side-to-side differences.
TABLE 3. Factor Occupational Rating System Work Level

<table>
<thead>
<tr>
<th>Work Level</th>
<th>Scale Points*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disabled</td>
<td>0</td>
</tr>
<tr>
<td>Very light</td>
<td>1-20</td>
</tr>
<tr>
<td>Light</td>
<td>21-40</td>
</tr>
<tr>
<td>Moderate</td>
<td>41-60</td>
</tr>
<tr>
<td>Heavy</td>
<td>61-80</td>
</tr>
<tr>
<td>Very Heavy</td>
<td>&gt;80</td>
</tr>
</tbody>
</table>

*Based on the total points multiplied times 2 from the Factor Occupational Rating System Scale (Table 3).

(MMD) were calculated. An arthrometric failure was described as MMD >5 mm.

Statistics
All data were recorded on computerized scantron sheets to allow automatic input into a computer program. Descriptive statistics, analysis of variance testing (ANOVA), χ-square analysis, and linear regression analysis were employed using the EXCEL software package (Microsoft, Redmond, WA). Significance was reported at $P < .05$.

RESULTS

Patient Demographics
The Workers' Compensation ACL reconstruction study group was comprised of 22 patients (17 men, 5 women) whose average age was 33 years (range, 23 to 51 years; SD, 8.3). The left knee was involved in 9 patients and the right knee in 13. The mean time interval from injury to reconstruction was 50 months (range, 4 weeks to 240 months; median, 29 months; SD, 64). There were 3 acutely reconstructed knees (defined as less than 6 weeks following injury) and 19 chronic knees (>6 weeks). The mean interval from surgery to follow-up was 55 months (range, 24 months to 98 months; SD, 23). Eleven patients (50%) had a previous surgical procedure performed on the affected knee with 1 patient (4.5%) having more than 1 prior procedure. The injury occurred acutely on the job in 9 patients (41%) and represented an aggravation of a pre-existing condition in 13 patients (59%).

Surgical Findings and Associated Procedures
Ten knees (45%) had reconstructions performed using an arthroscopic-assisted DI technique and 12 knees (55%) were reconstructed using a single-incision arthroscopic technique. At the time of ACL reconstruction, 6 patients underwent meniscal repair (3 medial, 3 lateral) and there were 10 partial menisectomies (7 medial, 3 lateral). At surgery, chondromalacia patella was noted in 8 patients (36%) with varying grades of chondromalacia found on the medial femoral condyle (32%), on the lateral femoral condyle (71%), on the lateral tibia plateau (45%), and on the medial tibia plateau (32%).

Physical Examination
Results of physical examination findings are listed in Table 4. Preoperatively, the Lachman test was graded as negative in 1 patient (5%), as 1+ in 4 patients (20%), as 2+ in 9 patients (45%), and as 3+ in 6 patients (30%). Two patients had abnormal Lachman tests, but were not specifically graded. The preoperative anterior drawer test was graded as negative in 3 patients (17%), 1+ in 13 patients (72%), and as 2+ in 2 patients (11%). Four patients did not have a preoperative anterior drawer grade recorded. The preoperative pivot shift test was graded as negative in 5 patients (26%), 1+ in 6 patients (32%), 2+ in 7 patients (37%), and as 3+ in 1 patient (5%). Three patients did not have a preoperative pivot shift score recorded. The pivot shift test performed under anesthesia was abnormal in all patients. Varus laxity was present in 1 patient, grade 1 valgus laxity was present in 2 patients, and grade 2 valgus laxity was present in 1 patient.

At follow-up evaluation, 15 patients (68%) had a negative Lachman. Seven patients (32%) had a grade 1 Lachman with a firm end point, which we consider normal. Nineteen patients (91%) had a negative anterior drawer and 2 patients (9%) had a grade 1 anterior drawer at follow-up. One patient did not have a postoperative anterior drawer recorded. The postoperative pivot shift test, performed in the office setting, was positive in only 1 patient (4%) who had a grade 1 pivot.

<table>
<thead>
<tr>
<th>Test</th>
<th>Preoperative No. of Pts (%)</th>
<th>Postoperative No. of Pts (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior Drawer</td>
<td>0  3 (17%)</td>
<td>19 (91%)</td>
</tr>
<tr>
<td>1+</td>
<td>13 (72%)</td>
<td>2 (9%)</td>
</tr>
<tr>
<td>2+</td>
<td>2 (11%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Lachman</td>
<td>0  1 (5%)</td>
<td>15 (68%)</td>
</tr>
<tr>
<td>1+</td>
<td>4 (20%)</td>
<td>7 (32%)</td>
</tr>
<tr>
<td>2+</td>
<td>9 (45%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>3+</td>
<td>6 (30%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Pivot Shift</td>
<td>0  5 (26%)</td>
<td>21 (96%)</td>
</tr>
<tr>
<td>1+</td>
<td>6 (32%)</td>
<td>1 (4%)</td>
</tr>
<tr>
<td>2+</td>
<td>7 (37%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>3+</td>
<td>1 (5%)</td>
<td>0 (0%)</td>
</tr>
</tbody>
</table>
whereas the remainder of the 21 patients (96%) had a negative pivot shift. The postreconstruction reductions in the Lachman, anterior drawer, and pivot shift grades at follow-up were statistically significant ($P < .0002$).

The postoperative mean range of motion measured $1^\circ$ of hyperextension (range, 10$^\circ$ of hyperextension to 10$^\circ$; SD, 3.9) to 136$^\circ$ of flexion (range, 120$^\circ$ to 150$^\circ$; SD, 1.4). The mean postoperative prone heel height difference was 1.8 cm with 10 patients having less than 1 cm, 17 patients less than 2 cm, and 5 patients greater than 3 cm. Thigh girth atrophy was noted in 50% of the patients (mean, 1 cm; range, 0 to 3 cm; SD, 1.1). Seven patients (32%) had patellofemoral crepitation on active flexion-extension, 6 of whom had minimal to mild crepitation.

**Subjective Results**

Twenty-one patients (95%) indicated that they would undergo the procedure again given similar circumstances or recommend the procedure to a friend. Patient satisfaction was assessed on a scale of 1 to 4 (1, completely satisfied; 2, mostly satisfied; 3, somewhat satisfied; 4, dissatisfied). The mean score was 1.6 with 91% of the patients being completely or mostly satisfied. A visual analog scale was used to assess overall satisfaction. The average score for this scale was 7.5 (range, 5 to 10; SD, 1.4). Eleven patients (50%) ranked their knee from 8 to 10 whereas the remaining patients rated their knee from 5 to 7. All patients returned to work: 19 patients (86%) returned to work at the same activity level, 2 patients (9%) returned to work at a lower activity level, and 1 patient (5%) returned at an increased activity level.

**KT-1000 Arthrometry**

Arthrometric results are in Table 5. Preoperatively, the mean maximum manual translation of the affected leg was 12.5 mm (range, 5 to 21 mm; SD, 4.4). The mean maximum manual difference (MMD) was 6.9 mm (range, 1.5 to 13 mm; SD, 3.4), and the MMD was greater than 3 mm in 95% of the patients. The preoperative maximum manual translations between injured and uninjured knees were found to be statistically significant ($P < .0001$).

At postoperative follow-up, the mean maximum manual translation was 6.7 mm (range, 2.5 to 11 mm; SD, 2.3). The mean MMD was 1.9 mm (range $-1.5$ to 5 mm; SD, 2.1). Fifteen patients (68%) had a mean MMD less than 3 mm, and 7 patients (32%) had a MMD greater than 3 mm and less than 5 mm. Significant reductions in maximum manual values in the affected knee from preoperative to postoperative levels ($P < .0001$) were noted. There were no significant differences between the postoperative reconstructed knee and the normal contralateral knee. The reduction in the MMD from preoperative to postoperative evaluation was significant ($P < .0001$).

**Rating Scales**

Average rating scale scores are listed in Table 6. The mean retrospective Tegner preinjury rating was 7.1 (range, 5 to 9; SD, 0.9). The mean Tegner postinjury rating was 3.9 (range, 1 to 7; SD, 1.8). The mean Tegner rating at follow-up evaluation was 5.9 (range, 2 to 9; SD, 1.7). The Tegner rating changes from preinjury to postinjury, and postinjury to postoperatively were statistically significant ($P < .0001$).

The mean postoperative Lysholm score was 82 (range, 43 to 100; SD, 14). The mean postoperative modified HSS score at follow-up was 86 (range, 72 to 100; SD, 7.5). This scoring system defines an excellent result as 90 to 100, good as 80 to 89, fair as 70 to 79, and poor as <70. There were 82% good and excellent results with 18% fair results and no poor results.

The mean postoperative Noyes Sports Activity scale

**Table 5. KT-1000 Arthrometric Data**

<table>
<thead>
<tr>
<th>Test</th>
<th>Preoperative</th>
<th>Postoperative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Max Manual</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Translation</td>
<td>12.5 mm (SD 4.4)</td>
<td>6.7 (SD 2.3)</td>
</tr>
<tr>
<td>Mean MMD*</td>
<td>6.9 mm (SD 3.4)</td>
<td>1.9 mm (SD 2.1)</td>
</tr>
<tr>
<td>MMD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\leq$3 mm</td>
<td>2 patients</td>
<td>15 patients</td>
</tr>
<tr>
<td>3.5 to 5 mm</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>$&gt;$5 mm</td>
<td>11</td>
<td>0</td>
</tr>
</tbody>
</table>

*MMD, maximum manual difference.
at follow-up was 81 (range, 0 to 99; SD, 22). The mean postoperative Noyes ADL score was 36 (range, 30 to 40; SD, 4.0). The mean postoperative Noyes Sports Function score was 87 (range, 67 to 100; SD, 9.7). The mean postoperative Noyes Problems with Sports score was 75 (range, 30 to 100; SD, 12.0). The mean retrospective Noyes Occupational Factor score was 48 (range, 22 to 96; SD, 24), while the postoperative mean Occupational Factor score was 60 (range, 30 to 96; SD, 21). The changes in the Occupational score revealed a statistical improvement following surgery ($P < .05$). The mean retrospective Noyes Job Title rating score was 5.14 (range, 1 to 8; SD, 2) before injury and 5.18 (range, 1 to 8; SD, 2) after surgery ($P = .94$). The following are the number of patients at each title rating score: 1 at level 1, 1 at level 2, 4 at level 3, 3 at level 4, 2 at level 5, 6 at level 6, and 5 at level 8. One patient at level 3 decreased to level 1, 1 patient at level 5 decreased to level 4, and 1 patient at level 2 increased to level 6. The average time to return to work was 17.36 weeks (SD, 13.09). Although the average time to return to work in patients with Noyes Job Title Rating levels of 1-5 was significantly less than those patients with level of 6-8 (9.7 weeks v 25 weeks, $P = .013$), linear regression analysis did not show a positive correlation ($r = .46, r^2 = .21$).

The SF-36 Questionnaire scores are shown in Table 7. These values were compared with the norms for the general United States population. Compared with the norms, the Workers' Compensation group had significantly higher scores in the Role Physical and General Health categories, but a significantly lower score in the Mental Health category.

**Functional Testing**

The functional parameters that were measured included the timed single-leg 6-m hop, the single-leg hop for distance, and the vertical jump. The reconstructed knee showed a mean 7% deficit (range, +9 to 56; SD, 14) compared with the contralateral knee on the timed single-leg hop, a mean 6% deficit (range, +29 to 23; SD, 11) for the single leg hop for distance, and a mean 9% deficit (range, +42 to 19; SD, 15) for the vertical jump.

**Complications**

There were 3 patients (14%) who required reoperation. One patient slipped on ice while walking and sustained a patellar tendon rupture that required a direct repair with hamstring augmentation; however, he still was able to return to work at 6 months as a police officer. A second patient suffered a twisting injury and subsequent locked knee that required an arthroscopic subtotal lateral meniscectomy. A third patient had complaints of painful hardware, which was removed.

**DISCUSSION**

The results of the current study show that ACL reconstruction patients with Workers' Compensation claims in our practice had objective, functional, subjective, and occupational results that exceeded our expectations.

The shoulder and spine subspecialties literature has shown that patients with Workers' Compensation claims have a higher likelihood of poorer outcomes regarding the orthopaedic management of the injury and the eventual return of the patient to work. Frieman and Fenlin reported that patients with Workers' Compensation claims who underwent anterior acromioplasties had a statistically longer time to return to work than the "standard" patient (7 times as long to return to work). Hawkins et al. reviewed the treatment of patients after failed acromioplasties for impingement syndrome. They noted that the lack of improvement in the Workers' Compensation patients with any form of treatment was striking and that future surgery in this population of patients should be approached cautiously.

Weisel et al. performed a prospective investigation
of more than 5,300 workers over a 10-year period. They found excessive time off from work and an unacceptably high operation rate with poorer outcomes compared with national averages in regard to spine surgery. Frymoyer\(^\text{19}\) reported that psychosocial factors and work environment factors are better prognostic indicators of low back pain than are physical findings. Similarly, Waddell et al.\(^\text{25}\) have reported on the need to approach the patient with occupational low back pain from a biopsychosocial model.

Katz et al.\(^\text{37}\) reported that a Workers' Compensation claim was the strongest predictor of poor outcome in patients following arthroscopic partial medial meniscectomy. Patients with Workers' Compensation who undergo ACL reconstruction represent a unique population in that there is minimal literature reporting on this relationship. Noyes and Barber-Westin\(^\text{38}\) reviewed their experience with ACL reconstruction and Workers' Compensation. Their series of 19 Workers' Compensation patients had no significant difference from matched controls with respect to knee stability, subjective variables, complications, overall rating, and patient perceived outcome. However, the Workers' Compensation patients had statistically more time lost from employment, both before and after reconstruction. Noyes and Barber-Westin surmised that many factors contributed to this time lost from work, such as inadequate diagnosis and lack of timely treatment, and adversarial issues at the workplace.

In our study group, the objective and subjective results were not significantly different from our previously reported results of DI and single-incision ACL reconstruction evaluated at 2 to 4 year follow-up evaluations, of DI ACL reconstruction data evaluated at 4 to 9 year follow-up, or of a similar sized cohort of "middle aged" (>35 years old) patients (Tables 8, 9, and 10). In each study, objective stability (Lachman, pivot shift, KT-1000), functional testing, scoring scales (Tegner, Lysholm, Noyes, HSS), and subjective satisfaction did not differ to any great degree.

Most of the rating systems that are currently used to evaluate knee ligament reconstruction are based on the young active individual and analyze the type and intensity of sports activities in which they participate.\(^\text{29}\) These scoring systems often neglect occupational factors and fail to show the effect of treatment on work activities. The current article includes many of the standard reporting methods for the athletic individual but also includes an occupational scoring system, and reports on the return to work activities. This methodology allows for comparison of the current series with our historical controls.

All patients in this study returned to work. Our aggressive approach to rehabilitation following surgery may help to motivate patients during their postoperative rehabilitation. The team approach of the treating medical staff, including physicians, athletic trainers, physical therapists, and nurses (including the Workers' Compensation nurse case manager), emphasizes and encourages patients to return to their preinjury condition. This philosophy begins with our preoperative teaching program, which clearly emphasizes that the goal of surgery is to return the worker back to the work force. This positive framework in which the patients interact may play a role in developing the proper psychosocial environment for patients to return to work. Our protocol for returning patients to work is similar to our athletic activity protocol. We allow patients to return to full athletic activity between 4 and 6 months after surgery, and similarly, patients with heavily demanding work activities (category I) are allowed to return to work without restriction between 4 to 6 months after surgery.

The average age of our Workers' Compensation

### Table 8. Patient Demographic Comparisons Between Current Study and Previous Studies

<table>
<thead>
<tr>
<th>Technique</th>
<th>No.</th>
<th>Mean Age at Surgery</th>
<th>Interval to Reconstruction</th>
<th>Postop Follow-up</th>
<th>Previous Surgery</th>
<th>Postreconstruction Reoperation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bach(^3)</td>
<td>DI</td>
<td>62</td>
<td>27 (16-45)</td>
<td>37 (27-51)</td>
<td>26 (40%)</td>
<td>6 (10%)</td>
</tr>
<tr>
<td>Bach(^4)</td>
<td>endo</td>
<td>105</td>
<td>26 (10-53)</td>
<td>36 (24-55)</td>
<td>45 (44%)</td>
<td>15 (15%)</td>
</tr>
<tr>
<td>Bach(^5)</td>
<td>DI</td>
<td>97</td>
<td>26 (12-53)</td>
<td>79 (66-113)</td>
<td>46 (47%)</td>
<td>25 (26%)</td>
</tr>
<tr>
<td>Current study</td>
<td>DI/Endo</td>
<td>22</td>
<td>33 (23-51)</td>
<td>55 (24-98)</td>
<td>11 (50%)</td>
<td>3 (14%)</td>
</tr>
</tbody>
</table>

### Table 9. Postoperative Physical Examination and KT-1000 Comparisons

<table>
<thead>
<tr>
<th>Study</th>
<th>0/+ Lachman</th>
<th>Negative Lachman</th>
<th>Pivot</th>
<th>MMD</th>
<th>KT ≤3</th>
<th>KT &gt;3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bach(^3)</td>
<td>60 (96%)</td>
<td>57 (92%)</td>
<td>0.3 (−6−16)</td>
<td>92%</td>
<td>4%</td>
<td>4%</td>
</tr>
<tr>
<td>Bach(^4)</td>
<td>101 (98%)</td>
<td>94 (91%)</td>
<td>1.1 (−6−7)</td>
<td>83%</td>
<td>14%</td>
<td>3%</td>
</tr>
<tr>
<td>Bach(^5)</td>
<td>95 (98%)</td>
<td>81 (84%)</td>
<td>1.0 (−11.5−7)</td>
<td>70%</td>
<td>26%</td>
<td>4%</td>
</tr>
<tr>
<td>Current study</td>
<td>22 (100%)</td>
<td>21 (90%)</td>
<td>1.9 (−1.5−5)</td>
<td>68%</td>
<td>32%</td>
<td>0%</td>
</tr>
</tbody>
</table>
population (mean age, 33 years) was slightly higher than most reported series on ACL reconstruction. However, the results of the postoperative physical and arthrometric examination in this series compare favorably with most series reported in the literature. All but 1 of our patients had a negative pivot shift (95%), all patients had a negative or 1+ Lachman test, and 91% of the patients had a negative anterior drawer test. The KT-1000 arthrometer provides another objective parameter of knee stability. There were no arthrometric failures (MMD >5 mm) in this series.

The results of the knee scoring systems compare favorably with series reported in the literature.1,3-6,9,11,16,39 The postoperative Tegner activity score in this series was slightly less than the mean retrospective preinjury Tegner score, although not significant. This may be attributable to the fact that our patient population is an older one and that patients may have decreased their activity level for reasons other than those related to knee stability (e.g., time considerations, family responsibilities, work responsibilities). This observation has been noted in our other ACL follow-up studies.3,5

The Noyes Occupational score allows for comparison of the patients’ ability to function in the workplace.32 The mean improvement in this score from preoperative to postoperative of 12 points indicates that patients were able to return to the workplace at increased levels of work activity. The fact that all patients were able to return to work (1 patient with an increase in work activity level and 2 patients with a decreased work activity level) suggests that ACL reconstruction in the Workers’ Compensation population is effective from an occupational viewpoint. Although we did not see a significant correlation between the Job Level rating and return to work, a trend was noted that patients with more strenuous jobs tended to take longer to return to work.

The SF-36 is a self-administered questionnaire that queries patients concerning their health in 8 different dimensions: physical functioning, role limitations due to physical problems, bodily pain, general health perception, energy/fatigue, social functioning, role limitations due to emotional problems, and mental health.34 Health status measurements like the SF-36 have potential value in evaluating the complex issues of work-related disability.17,23,40 In our study, the SF-36 scores of our Workers’ Compensation patients were similar to the general population of the United States and in fact were significantly higher in the Role Physical and General Health categories. Interestingly, the Workers’ Compensation patients also scored significantly lower in the Mental Health category. Psychosocial distress from job difficulties contributes greatly to lower Mental Health scores.34 As Noyes and Barber-Westin38 alluded to in their study on ACL reconstruction in the Workers’ Compensation population, much of the subjective dissatisfaction seen in the Workers’ Compensation population may be secondary to the adversarial mechanisms inherent in the process as well as the oftentimes delayed and poor initial treatment.38 This would certainly be reflected in lower Mental Health scores.

The patients’ subjective satisfaction with the ACL reconstruction treatment protocol was extremely high. Ninety-five percent of the patients stated that they would undergo a similar procedure if faced with identical circumstances and 91% of the patients were mostly or completely satisfied. This high satisfaction level is comparable with that of our other reported studies, and clearly different than what has been reported in the spine and shoulder Workers’ Compensation literature. One major difference between these populations is that ACL reconstruction is generally performed for instability and mechanical symptoms rather than pain. In the spine and shoulder Workers’ Compensation literature, the operations that have been evaluated, such as spinal fusion and rotator cuff repair, are generally performed to relieve pain. It is quite possible that this pain issue is what contributes to favorable results in ACL reconstruction. In this study, the Workers’ Compensation patients’ scores in the Bodily Pain category of the SF-36 was not significantly different than those of the general United States

### Table 10. Postoperative Rating Scale Comparisons

<table>
<thead>
<tr>
<th>Study</th>
<th>Preinjury</th>
<th>Prereconst</th>
<th>Postop</th>
<th>Tegner</th>
<th>Lysholm</th>
<th>Modified HSS</th>
<th>Noyes Knee Sport Act</th>
<th>Noyes Knee Sport Act</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bach¹</td>
<td>7.6 (6-10)</td>
<td>2.1 (0-10)</td>
<td>6.3 (1-9)</td>
<td>88 (52-100)</td>
<td>88 (65-99)</td>
<td>86 (30-100)</td>
<td>90 (50-100)</td>
<td></td>
</tr>
<tr>
<td>Bach²</td>
<td>7.3 (4-9)</td>
<td>3.5 (0-7)</td>
<td>6.5 (2-9)</td>
<td>89 (43-100)</td>
<td>90 (72-100)</td>
<td>88 (0-100)</td>
<td>90 (33-100)</td>
<td></td>
</tr>
<tr>
<td>Bach³</td>
<td>7.1 (4-9)</td>
<td>3.5 (0-9)</td>
<td>6.3 (2-9)</td>
<td>87 (34-100)</td>
<td>87 (72-100)</td>
<td>87 (0-100)</td>
<td>89 (27-100)</td>
<td></td>
</tr>
<tr>
<td>Current study</td>
<td>7.1 (5-9)</td>
<td>3.9 (1-7)</td>
<td>5.9 (2-9)</td>
<td>82 (43-100)</td>
<td>86 (72-100)</td>
<td>81 (0-99)</td>
<td>87 (67-100)</td>
<td></td>
</tr>
</tbody>
</table>
population, and in the Role Physical category, the
clearly educated our patients that they would not be

Acknowledgment: The authors acknowledge the assist-
ance of former sports medicine fellows Drs. Matthew Levy
and Steven Tradonsky who participated in the clinical
of their pre-existent condition” (n = 13).

In summary, our retrospective review of ACL surgi-
series presents the general orthopaedic practitioner
with information that may prove helpful in evaluating
and treating the Workers’ Compensation patient who
has an ACL-deficient knee.

These results raise an important question—why did
these patients do well postoperatively, particularly in
contrast with the studies of other orthopaedic condi-
tions? There may be a selection bias based on the
surgeon; unfortunately, we do not have accurate data to
indicate what percentage of our ACL-deficient Work-

population, and in the Role Physical category, the
patients actually scored significantly higher. This sug-

The limitations of the current study are several. This
is a retrospective study with historical controls. How-
ever, using our previously reported studies, which
included patients who underwent reconstruction using
the same techniques during the same time frames,
strengthens our observations. One could argue that a
prospective design that included a nonoperative con-
control group might yield better insight. This study
represents a small group of patients and perhaps a
larger study group may have resulted in different
observations. It is problematic to include a nonopera-
tive control group in this type of study because of the
demands of the workplace environment. These types
of patients need a stable knee in order to function on
the job (e.g., climbing ladders, carrying heavy ob-
jects). The magnitude of our patients were construc-
tion workers, fire fighters, police officers, and heavy
laborers. One could also argue that age-matched
patients who underwent ACL reconstruction could
be used as a control group; however, the analysis might
be confusing due to the comparison of athletes and
workers. The benefit of a prospective study is that it
would allow for the determination of pretreatment and
posttreatment scores for the various knee rating scales.

The results reported here contradict the general
trend of outcomes from the Workers’ Compensation
spine and upper extremity population and refute the
notion that Workers’ Compensation claims in patients
undergoing ACL reconstruction are doomed to less
than optimal outcomes. Unfortunately the label of
Workers’ Compensation may influence the treating
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