

# Trends in Decreased Hospitalization for Anterior Cruciate Ligament Surgery: Double-Incision Versus Single-Incision Reconstruction

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**Summary:** Over a 4-year period, hospital charges of 151 consecutive anterior cruciate ligament (ACL) reconstructions were retrospectively evaluated. Eighty-one patients who underwent a two-incision ACL central third autogenous patellar bone tendon bone reconstruction were compared with 72 patients who had a single-incision endoscopic reconstruction with a similar graft. Charges were adjusted for inflation. There was a statistically significant difference in hospital days ( $2.8 \nu 1.57$ ,  $P = .0001$ ), total hospital charges ( $\$15,063 \nu \$13,520$ ,  $P = .0001$ ), as well as operating room/hospital ward charges ( $P = .0001$ ), pharmacy charges ( $P = .035$ ), and physical therapy charges ( $P = .001$ ). No statistical difference was observed for anesthesia or laboratory charges. A matched comparison of patients from each group who were in the hospital for 2 days showed a statistically significant reduction in operating room/hospital ward charges ( $P = .037$ ), but no significant reduction in total costs. There was a trend in both groups toward shorter hospital stays in each successive year. The reduction in charges observed for the endoscopic procedure correlated with a reduction in postoperative hospital days.

**Key Words:** Anterior cruciate ligament reconstruction—Hospital charges.

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Charges for commonly performed elective operations have come under intensive scrutiny as health costs continue to increase. Anterior cruciate ligament (ACL) reconstruction, a procedure that has evolved rapidly over the past decade, will most likely be one of those operations that will be evaluated for its cost-effectiveness.

The purpose of this study was to retrospectively compare two popularly performed arthroscopy-assisted ACL techniques to determine if there were any differences in hospitalization charges.

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## MATERIALS AND METHODS

This report describes the comparison of patient hospital charges for two methods of ACL reconstruction. An arthroscopy-assisted double-incision technique (group 2) and endoscopic single-incision technique (group 1), using autogenous bone tendon bone central third patellar tendon substitution, were compared. The surgical techniques for these procedures are described elsewhere.<sup>1,2</sup> Revision ACL reconstructions, allograft ACL reconstruction, ACL reconstruction using hamstrings, or reconstructions that required associated procedures (meniscal repairs, extra-articular procedures) were excluded.

One hundred fifty-one consecutive patients operated on by two different surgeons (B.R.B. and C.B.-J.) between June 1989 and November 1992 comprised our study group. Standard surgical techniques and perihospitalization protocols were used by the surgeons. Seventy-two patients underwent a single-incision endoscopic procedure (group 1). Eighty-one patients

**TABLE 1.** Hospital Days Frequency

Number of Days	Endoscopic (Group 1)	Two-Incision (Group 2)
1	45 (62.5%)	0
2	20 (27.8%)	21 (25.9%)
3	7 (9.7%)	52 (64.2%)
4	0	8 (9.9%)

underwent an arthroscopy-assisted two-incision reconstruction (group 2). The double-incision technique was used until mid-1991, at which time we prospectively embarked upon the single-incision technique. All patients were admitted to the hospital on the day of surgery. Two patients had staged bilateral reconstructions (a minimum of 6 weeks apart). Approximately 70% of the patients had chronic ACL deficiency (>1 month after injury). A delayed acute reconstruction was performed on the remaining patients after adequate preoperative range of motion was obtained. An intra-articular hemovac drain was placed in all patients and removed on the first postoperative day. Patients were placed on continuous passive motion machines while hospitalized, and this was discontinued after discharge.

A retrospective analysis of these patients' hospital charges was performed by extracting data from the Patient Condensed Bill Files from the Rush-Presbyterian-St. Luke's Healthcare Finance Department database. An SAS Institute extraction program was designed to find pertinent billing information and to sort it into preselected categories designated as cost centers. This was applied to the fiscal year 1990 through 1993 databases.

Cost centers were grouped into categories to facilitate comparison. Operating ward charges included operating room time, supply and instrument charges, postoperative brace, and hospital room charges. Anesthesia charges consisted of anesthesia time and anesthetic agents. Laboratory charges were those incurred for preoperative testing as well as any postoperative laboratory work. It was unusual to obtain postoperative blood studies in this healthy population. Pharmacy charges were those that were incurred while the patient was in the recovery room and in the hospital room. Physical therapy billing were defined as charges while hospitalized. Surgeon's fees were excluded from this study because they are identical for each procedure.

Several cost center's charges, such as radiographs, were deleted from the analysis. These were taken intraoperatively or immediately postoperatively in 42 of the 153 patients. These radiographs were infrequently obtained in group 2 and more commonly ordered intra-

operatively in the early phase of our prospective group 1 patients. As another example, pathology charges were omitted as well. In this group, the only charges that were incurred were evaluation of partial meniscectomy specimens in 60 of the 153 operations.

Adjustments of charges were performed to facilitate comparison and to allow for relevant comparison. To compensate for inflation over the past 3 years, each year was individually adjusted for inflation, using an estimated inflation rate of 8% per year, which reflected the average increase per year in the Chicago area.

An SPSS statistics software package (SPSS, Inc, Chicago, IL) was used to perform a Student's *t*-test and nonparametric Mann-Whitney U-Wilcoxon analyses of variance. All statistical analysis in this report are based on Student's *t*-test values unless otherwise noted. Comparisons were performed between each group's entire population charges as well as between those patients in each group who stayed for 2 postoperative hospital days. Statistical significance was established at  $P < .05$ .

## RESULTS

The mean hospital stay for group 1 was 1.47 days, versus 2.84 days for group 2. Table 1 shows the distribution of each group. No group 1 patient stayed longer than 3 postoperative days, and no group 2 patient was discharged on the first postoperative day.

Sixty-two percent of group 1 patients were discharged on the first postoperative day, whereas the majority of group 2 patients were hospitalized for 3 postoperative days (64%). There was a statistically significant difference in hospitalization length ( $P = .0001$ ) between these groups.

A trend was observed in both groups' hospital stay lengths. Both groups showed a trend for decreasing length of stay from year to year (Table 2). In the year in which both two-incision and endoscopic procedures were performed, an average of 1.5 versus 2.3 days was found in groups 1 and 2, respectively.

**TABLE 2.** Average Hospital Days by Year

Year	Endoscopic (Group 1)	Two-Incision (Group 2)
1992	1.3 (n = 24)	-
1991	1.5 (n = 48)	2.3 (n = 10)
1990	-	2.8 (n = 34)
1989	-	2.9 (n = 37)

**TABLE 3.** Summary of Hospital Charges

	Endoscopic (Group 1)*	Two-Incision (Group 2)†	P Value
Operating room/ward	9,585 (6,887-14,287)	11,079 (7,165-15,794)	.0001
Anesthesia	1,246 (1,053-3,072)	1,219 (1,014-1,459)	.355
Laboratory	471 (292-915)	448 (204-1,143)	.342
Pharmacy	1,063 (248-1,749)	1,146 (642-1,708)	.035
Physical therapy	271 (0-716)	369 (0-1,127)	.001
Total charges	13,519 (10,349-21,131)	15,063 (10,612-19,423)	.0001

NOTE. Charges listed are in U.S. dollars; mean (range).

\* n = 72.

† n = 81.

### Unmatched Comparison (All Patients)

After inflation adjustment, an analysis of data from each group with all patients in each group, without regard for hospital days, showed the following results, which are summarized in Table 3.

Operating room/ward charges, which included daily hospital room charges, averaged \$9585 (range \$6,887 to \$14,278) for group 1 and \$11,079 (range \$7,165 to \$15,794) for group 2. There was a significant decrease in group 1 charges ( $P = .0001$ ). Anesthesia ( $P = .355$ ) and preoperative and postoperative laboratory ( $P = .342$ ) charges were not significantly different in either group. Physical therapy charges ranged from \$0 to \$716 and \$0 to \$1127 in groups 1 and 2 respectively. Several of the patients did not require physical therapy for crutch training and thus had no charges in this category. CPM (continuous passive motion) use while hospitalized contributed to the wide variations in physical therapy charges.<sup>9,10</sup> Pharmacy charges ( $P = .035$ ) were statistically significant between groups, with group 1 being the lower of the two. A reduction in total hospital charges for group 1 ( $P = .001$ ) was strongly statistically significant (Table 3).

### Matched Comparison (2 Hospital Days)

A direct comparison of the subgroups comprised of those patients in group 1 (n = 21) and group 2 (n = 20) who stayed for 2 postoperative days showed no statistical difference in operating room/ward, anesthesia, laboratory, pharmacy, physical therapy, or total charges. Table 4 summarizes this data.

## DISCUSSION

In this analysis, charges, not costs, were analyzed. No data were reviewed to determine the actual reimbursement or net profit/loss of each cost center. Although charges may not proportionately reflect reim-

bursement, these charges should generally reflect the cost to each respective cost center. Actual costs can only be determined by examining each cost center's capital expenditures and operating expenses.

As financial considerations of health care delivery become more prominent in our society, a critical appraisal of charges and costs becomes an important factor. Other investigators have examined the charges of surgical procedures.<sup>3-6</sup>

In a review of hospital charges of patients undergoing prostatectomy, Litwin et al. found that charges related to this procedure were not significantly changed by comorbid diseases. The only factor that was found to be statistically significant was the length of hospital stay.<sup>4</sup> Barber and Healy,<sup>3</sup> in a comparison of hospital costs for total hip arthroplasty, determined that between 1981 and 1990, a portion of the hospital costs had decreased because of decreasing postoperative hospital stays.

A trend toward shorter hospital stays has also come from economic pressures to decrease the hospitalization. Reports of outpatient ACL reconstruction with minimal complication rates have been presented.<sup>5-8</sup> Our experience with our ACL reconstructions has been that

**TABLE 4.** Mean Hospital Charges for 2-Day Hospital Stays

	Endoscopic (Group 1)*	Two-Incision (Group 2)†	P Value
Operating room/ward	9,436	10,268	.094
Anesthesia	1,308	1,230	.413
Laboratory	450	457	.894
Pharmacy	1,086	1,124	.517
Physical therapy	354	345	.844
Total charges	13,587	14,122	.373

NOTE. Charges listed are in U.S. dollars.

\* n = 21.

† n = 20.

patients are being discharged earlier. Hospital days in this report were decreased yearly as noted in Table 2. Subsequent to this study, all patients reconstructed endoscopically have been discharged on either an outpatient basis or by the first postoperative day.

The decrease in hospital days is the strongest factor in decreasing hospital charges, as shown by the matched comparison of each group's patients who stayed 2 postoperative days. Our transition to the endoscopic single-incision technique did not clearly contribute to lowering hospital charges.

Physical therapy charges also correlated with length of hospital stay. However, if therapy is prescribed for a patient, it is likely that the patient will be seen for his or her entire hospital stay. Patients who undergo ACL reconstruction require crutch ambulation instruction, guidance regarding flexion and extension, correct teaching of straight and bent knee leg raises, patellar mobilization, and cryotherapy usage instruction.

Postoperative pain reduction and reduction of narcotic analgesics has been a theoretical advantage of the endoscopic technique because there is only one incision and the posterior capsule is not violated. A direct comparison of pharmacy charges between patients in both groups who stayed for 2 postoperative days did not support this hypothesis. Pharmacy charges were only greater in the entire group 2 population. On an average, this group stayed in the hospital longer than group 1 patients. To address this issue directly, a formal review of narcotic use would have been a more accurate determination of analgesia required.

Recent advances in anesthesia, notably epidural anesthesia or Diprivan (propofol; Stuart Pharmaceuticals, Wilmington, DE) for general anesthesia, have allowed for easier recovery from anesthesia as well as for fewer anesthetic-related complications.<sup>11</sup> Intramuscular Toradol (ketorolac tromethamine; Syntex Laboratories Inc, Palo Alto, CA), a nonsteroidal anti-inflammatory medication, appears to contribute to reduced early postoperative discomfort.<sup>8</sup> The prevention of pain in the early postoperative period may greatly diminish pain in the acute postoperative course.<sup>7</sup>

Malek reported on a review of inpatient surgery on two groups of 15 patients each who underwent central third patellar tendon arthroscopy-assisted ACL reconstruction with the two-incision technique and the single-incision endoscopic technique.<sup>6</sup> These groups were compared with 10 patients who underwent outpatient endoscopic ACL reconstruction. The inpatient groups had total average charges of \$12,711 and \$9,132, respectively. Total outpatient ACL reconstruction charges averaged \$7,645. The investigators observed

that despite the lower overall charge for the endoscopic outpatient procedure, the two-incision inpatient procedure charges were less when charge per hours in the hospital were figured.

Losee et al. reviewed a series of outpatient arthroscopy-assisted ACL reconstructions using autograft central third patellar tendon in 182 patients and semitendinosus in 135 patients.<sup>5</sup> Ten patients had allograft reconstructions. Intra-articular hemovac drains were placed. No patients required postoperative intravenous or intramuscular narcotics or readmission for pain relief or wound complications. Other complications were comparable with those of inpatient ACL reconstructions. The investigators estimated that at their institution, a savings of \$5,900 per patient was achieved using an outpatient protocol.

Anterior cruciate ligament reconstruction, in the absence of any synthetic augmentation or prosthesis, does not have proportionately large implant costs, such as are found with knee and hip prosthetic arthroplasty. An increase in implant charges and costs was thus not a factor in this analysis. Barber and Healy,<sup>3</sup> in their review of hospital cost for total hip arthroplasty in 1981 and 1990, noted that decreasing hospitalization offset the cost of rising implant costs.

Control of charges for ACL reconstruction appears to be best served by decreasing the hospital days. A gradual trend toward outpatient surgery, as well as "23-hour surgical units," has evolved in the face of rising concerns over health care costs. Visiting nurse/home health care may also be a viable alternative in the management of this population of otherwise healthy patients. Although this nonrandomized retrospective study suggests that the endoscopic group can be discharged sooner postoperatively, we do not believe that the surgical technique alone contributes to this reduced hospitalization. Improved preoperative education (surgeon, nursing, anesthesia), clear definitions of patient expectations, implementation of postoperative cryotherapy units, and improved perianesthetic medication (e.g., Diprivan, Toradol), we believe, contributed to the ability to reduce hospitalizations over time.

## SUMMARY

A comparison of hospital charges for arthroscopy-assisted ACL reconstruction via a two-incision and a single-incision technique showed several results. (1) There was a trend in both groups progressively for shorter hospital stays as time went on. (2) In an unmatched comparison of both groups (not matching hospital days), there was a statistically significant differ-

ence in inflation adjusted hospital charges for hospital days and for operating room/ward, pharmacy, and physical therapy charges. (3) When patients from both groups who had a 2-day postoperative hospital days were compared, there was no statistical difference in hospital charges. (4) The above findings suggest that a charge reduction in ACL surgery may depend more on trends to reduce the length of hospital stay rather than on the procedure performed for ACL reconstruction.

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