

Long Term Osteoarthritic Changes in Anterior Cruciate Ligament Reconstructed Knees

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To consolidate the indications for anterior cruciate ligament reconstruction and clarify the long term prognosis associated with current surgical and rehabilitation techniques, the incidence of osteoarthritis in arthroscopically anterior cruciate ligament reconstructed knees requires investigation. Seventy-two patients with anterior cruciate ligament ruptures who were active in sports requiring sidestepping and pivoting, or who had recurrent episodes of giving way, underwent arthroscopic bone-patellar tendon-bone anterior cruciate ligament reconstruction. These patients were evaluated for meniscal damage and osteoarthritic changes at the time of surgery and followed up for 7 years. Fifty-three patients underwent radiographic evaluation at 7 years, which included anteroposterior, lateral, skyline, and 30° posteroanterior weightbearing views. Radiographic evaluation was performed by three independent surgeons and graded as per International Knee Documentation Committee criteria. Results revealed that knees with chronic anterior cruciate ligament deficiency, even

those with intact menisci before reconstruction, suffered early osteoarthritic changes. More severe changes were seen with meniscectomy. Acute anterior cruciate ligament reconstruction with meniscal preservation was shown to have the lowest incidence of degenerative change. Controversy exists regarding the timing of anterior cruciate ligament reconstruction. This study supports early reconstruction of anterior cruciate ligament deficient knees before episodes of giving way occur in individuals intent on continuing activities that involve sidestepping and pivoting.

Anterior cruciate ligament injury is common, frequently affecting young active people with long work and sporting futures. Present reconstruction techniques^{6,12} can restore function with high success rates, but the long term association of osteoarthritis with anterior cruciate ligament reconstruction, especially in cases with meniscal injuries, has not been defined clearly. Later onset osteoarthritis resulting from this injury may have significant financial, social, and personal effects.

Practice patterns throughout the world vary in the timing of reconstruction in anterior cruciate ligament deficient knees. A debate continues regarding whether recon-

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struction should be performed early before onset of instability episodes or be delayed until the patient has shown that rehabilitation alone is insufficient to maintain knee stability. Other researchers have highlighted the importance of preserving menisci to prevent early osteoarthritis in isolated meniscal injuries.^{4,5,13,16} However, few studies have addressed the results of meniscal preservation in anterior cruciate ligament deficient or reconstructed knees.^{1,19} Many studies in this area are flawed by their retrospective nature and hindered by evaluation of outdated open reconstruction techniques. Current arthroscopic techniques require evaluation with respect to long term outcome.

The purpose of this study was to document the incidence and severity of radiographic osteoarthritic changes in anterior cruciate ligament deficient knees reconstructed using arthroscopic bone patellar tendon bone technique with and without meniscal pathology. Patients were reviewed at 1, 5, and 7 years after anterior cruciate ligament reconstruction. The study was intended to augment prognostication for long term outcome of the surgical reconstruction.

MATERIALS AND METHODS

Seventy-two patients underwent arthroscopic bone patellar tendon bone anterior cruciate ligament reconstruction from March 1 to November 30, 1989, all performed by the senior author (LAP). These patients were followed up by objective measures at 1, 5, and 7 years including International Knee Documentation Committee² evaluation, with radiographs taken at 7 years and KT 1000 (20 lb) examination (Medmetric Corporation, San Diego, CA). Arthroscopic examination was documented at the time of surgical reconstruction.

Patients with a ruptured anterior cruciate ligament diagnosed by clinical examination who were involved in activities that required cutting, pivoting, or sidestepping and those who had repeated episodes of giving way during activities of daily living were included. Patients who had anterior cruciate ligament deficient knees and did not have repeated episodes of instability or did

not intend to participate in high risk activities were excluded from this study. Patients with multiple ligamentous injuries, with the exception of an associated medial collateral ligament injury, also were excluded.

Meniscal pathology was documented in surgery reports. Arthroscopic description of articular surfaces was recorded and classified as normal or abnormal. Conditions considered abnormal included osteophytes, chondral fibrillation and flaps, and abnormal shape of the articular surfaces.

Weightbearing anteroposterior (AP), lateral, skyline, and 30° posteroanterior radiographs were taken at 7 years. These were graded by three independent orthopaedic surgeons as normal or abnormal based on the presence of osteophytes, subchondral sclerosis, change of articular surface, or joint space narrowing. The abnormal radiographs were classified additionally according to International Knee Documentation Committee recommendations.²

All reconstructions were performed by the senior surgeon using the same technique. A central third bone patellar tendon bone autograft was harvested from the ipsilateral knee and inserted through drill holes anatomically placed in the tibia and femur. Interference fixation was achieved using AO 6.5-mm fully threaded cancellous screws. If medial collateral ligament reconstruction was required, it was performed just before tibial fixation of the anterior cruciate ligament graft by advancement of the ligament followed by staple fixation.

The postoperative course consisted of intravenous flucloxacillin and gentamicin and 24 hours in a continuous passive motion machine at 30° to 90° followed by a rehabilitation brace set at 30° to 90° for 4 weeks. Patients were non-weightbearing for 4 weeks. Wound inspection and suture removal were done at 10 to 14 days postoperatively. Additional followup visits were at 6 weeks, 3 months, 6 months, and then at 1, 5, and 7 years. Aggressive physiotherapy commenced at 4 weeks to achieve full range of motion (ROM) and adequate muscle strength. Return to a competitive sport that involves jumping, sidestepping, and pivoting was allowed no sooner than 9 months after reconstruction. The postoperative routine was the same for those patients undergoing concurrent medial collateral ligament reconstruction.

Chi square statistical analysis was performed using Datadesk 3.0 software (Odesta Corporation, Northbrook, IL).

RESULTS

For 53 of the original 72 patients, 7-year followup radiographs were available for review. Thus radiographs had not been taken for 19 of the patients. Three patients were not included because of ruptures of their grafts at 28, 50, and 52 months. Eleven patients were lost to followup because they had moved too far away or could not be located. An additional five patients had been examined at 7 years, but radiographs were not obtained. All results described are those of the 53 patients with radiographs obtained 7 years postoperatively.

There were 37 males and 16 females in the current study. Twenty-nine reconstructions were acute (≤ 12 weeks; average age, 27 years), and 24 were chronic (> 12 weeks; average age, 5.6 years; range, 3–240 months; average age, 28 years). Of the 53 patients with 7-year radiographic followup, 50 underwent KT 1000 examination. The results showed no difference between the acute and chronic groups in terms of AP laxity (1.6 mm: 1.8 mm side to side difference). There was also

no difference in pivot shift, Lachman, and anterior drawer testing.

Of 29 acutely reconstructed knees, 20 (69%) had normal menisci or meniscal injuries not requiring meniscectomy, including those amenable to suture repair, stable posterior horn tears, and stable peripheral tears. The remaining nine (31%) knees required meniscectomy. All meniscectomies incorporated 50% to 100% of the meniscus. Eight (33%) of 24 chronic knee injuries had normal or stable (as above) menisci at time of reconstruction, whereas 16 (67%) of 24 required meniscectomy. There was a significantly higher proportion of chronic knee injuries (67%:31%) that required meniscectomy at the time of ligament reconstruction ($p < 0.025$).

Evaluation of the radiographs over 7 years revealed the following results (Table 1). Of the acute knee injuries with no meniscectomy, 17 (89%) of 19 knees remained normal on radiographs at 7 years, whereas only two degenerated (another had abnormal chondral surfaces at time of reconstruction). If meniscectomy was required at the time of ligament reconstruction, the knees with degenerative changes increased from one of nine to six of nine during the 7 years ($p < 0.01$). Of the chronic injuries, if no meniscectomy was re-

TABLE 1. Knee Joint Evaluation at Reconstruction and at 7 Years*

Time to Surgery	Meniscal Status	Grade	Number of Patients	
			Initial	7 Years
Acute	Normal	Normal	19	17
Acute	Normal	Abnormal	1	3
Acute	Menis	Normal	8	3
Acute	Menis	Abnormal	1	6
Chronic	Normal	Normal	5	4
Chronic	Normal	Abnormal	3	4
Chronic	Menis	Normal	6	0
Chronic	Menis	Abnormal	10	16

Menis = meniscectomy; Initial = visualization at time of reconstruction; 7 Years = 7 year radiographic followup; Acute = ≤ 12 weeks; Chronic = > 12 weeks [average 5.6 years (range, 3–240 months)].

* Values are number of knees described as normal or abnormal via arthroscopy at time of reconstruction and via radiographs at 7 year followup.

quired, the articular surface grading remained relatively unchanged (three of eight to four of eight). If meniscectomy was required, no knees at the 7-year review were normal (0 of 16) ($p < 0.01$).

The largest difference was the comparison between acutely reconstructed knees with meniscal preservation and chronically reconstructed knees with meniscectomy. At the 7-year radiographic followup, 17 of 20 acutely injured knees without meniscectomy were graded normal. In comparison, of the chronic anterior cruciate ligament injuries that underwent reconstruction with meniscectomy, 0 of 16 knees had normal appearing radiographs at 7 years. Seven of these 16 knees had marked osteoarthritic changes with joint space loss and were graded C (subchondral sclerosis, osteophytes, condylar squaring, and joint space narrowing 2–4 mm) as per International Knee Documentation Committee recommendations. Severe changes were seen only in this group. Of the six knees in this group that had normal chondral surfaces at initial arthroscopy, none retained a normal appearance at the 7-year radiologic followup.

At reconstruction, 38 (72%) of 53 knee joints had a normal chondral surface appearance, whereas 15 (28%) of 53 knees had abnormal appearing joints. Of the 29 acute injuries, 27 (93%) had normal chondral surfaces, whereas only two (7%) had abnormal changes. Of the 24 chronic injuries, only 11 (46%) had normal appearing chondral surfaces, whereas 13 (54%) had abnormal appearing joints. This was statistically significant ($p < 0.001$).

DISCUSSION

Research on the natural history of anterior cruciate deficient knees^{8,10,14,20} has described the progression of degenerative changes in unstable knees. The long term effect of anterior cruciate ligament rupture and associated meniscal pathology, along with the effect of ligament reconstruction, requires documen-

tation to provide surgeons with a rationale for treatment protocols and timing of surgery. This may help surgeons to prognosticate long term results and educate patients regarding future use of their knees.

Anterior cruciate ligament reconstruction techniques have evolved rapidly in the past few years. As a result, the majority of reconstructions are performed arthroscopically with improved fixation techniques. Advanced rehabilitation programs^{9,15,21} have been introduced to improve function and ROM postoperatively. These changes require additional research to consolidate indications for anterior cruciate ligament reconstruction and clarify the long term prognosis of current surgical and rehabilitation techniques.

This study provides one of the longest reviews of meniscectomy associated with arthroscopic anterior cruciate ligament reconstruction. Arthroscopy results were compared with 7-year radiographs. Daniel et al⁷ reported that radiographs correlate closely with arthroscopic evaluation. The radiographs in this study were graded by three independent orthopaedic surgeons to decrease subjectivity associated with interpretation of radiographs. Patients in the two groups (acute and chronic) were similar with respect to age and postoperative stability.

There was a statistically significant increase in the incidence of meniscectomy required at the time of ligament reconstruction in chronically injured knees compared with acutely injured knees. Allowing anterior cruciate ligament deficient knees to undergo repetitive trauma, whether minor translations or major giving way episodes, resulted in increased meniscal damage so that subsequent meniscectomy was required more frequently. This supports early ligament reconstruction before episodes of giving way in patients who participate in activities that require cutting and sidestepping.

It has been shown that meniscectomy alone is related directly to osteoarthritis.^{4,5,13,16} Meniscectomy in the current study

consisted removing sufficient meniscus when 50% to 100% of the meniscus was not functional. Patients who underwent meniscal trimming of small radial and similar tears that left a functioning rim were not included in the meniscectomy group. There was an increased incidence of mild radiographic deterioration in knees reconstructed with rather than without a meniscectomy, which is consistent with the results reported by Aglietti et al,¹ Anderson et al,³ and Shelbourne and Gray.¹⁸

In contrast, the review of Sommerlath et al²⁰ that discussed primary repairs with and without meniscectomy revealed 47% abnormal knees despite meniscal preservation after 9 to 16 years followup, a higher incidence than in the current study (11%). This possibly reflects the longer period of the study of Sommerlath et al or the inadequacy of primary repairs to stabilize the knee joint as performed in that study.

Given that meniscectomy leads to osteoarthritis, prevention of meniscal damage is paramount. Delay in reconstructing unstable knees leads to increased meniscal injury and subsequent meniscectomy, as seen in the current study and others.^{11,22} However, it has not yet been shown what percentage of menisci are preserved by reconstructing the anterior cruciate ligament compared with leaving an anterior cruciate ligament deficient knee. In the current study, the knees with delayed reconstruction had increased degenerative changes, almost guaranteeing radiographic abnormalities 7 years after reconstruction, with the most severe changes existing in this group.

These results are not inconsistent with a recent article by Shelbourne and Gray.¹⁸ Their article described an 11% incidence of moderate osteoarthritic degeneration observed by joint space narrowing in the chronic anterior cruciate ligament ruptures that eventually had ligament reconstruction. The results of the current study had a higher rate of moderate degenerate change (29%, seven of 24), but this may be explained by the significantly

longer waiting period for ligament reconstruction in the chronic injuries (average, 5.6 years) than in the study by Shelbourne and Gray (average, 2.1 years). It is also unfortunate that the study of Shelbourne and Gray did not comment on milder degenerative changes such as subchondral sclerosis, marginal osteophytes, and change in articular surface, which in the current study were interpreted as early degenerative changes in accordance with International Knee Documentation Committee recommendations.

Recently, Noyes and Barber-Westin¹⁷ published results of anterior cruciate ligament reconstructions on chronically ligament deficient knees. Unfortunately, that article did not describe whether 30° to 45° posteroanterior weightbearing radiographic views were taken, which may be the most sensitive views for determining osteoarthritic change, especially for joint space narrowing. The article stated that no radiographic deterioration occurred, but with the short followup (average, 27 months) and no specified radiographic views, it is necessary to wait for a longer followup and weightbearing radiographs for satisfactory comparison.

The aforementioned articles and this one support the view that early anterior cruciate ligament reconstruction can delay or prevent osteoarthritic degeneration of the knee joint. The debate remains whether progressive degenerative changes can be expected even after stabilization in a chronically injured knee.

Osteoarthritic development in anterior cruciate ligament deficient knees likely involves factors other than meniscal damage. On direct viewing, chronically injured knees without meniscectomy, when compared with acute reconstructions, manifested a significant increase in degenerative changes at the time of reconstruction, and 50% (four of eight) revealed degenerative changes at the 7-year followup. This suggested that instability without gross meniscal damage may lead to degenerative changes. Chondral damage at the time of original injury did not account for this difference because few acutely injured

knees with normal appearing joints and no meniscectomy had deteriorated by 7 years after reconstruction (two of 19). It is possible that increased translation of the tibiofemoral joint of anterior cruciate ligament deficient knees hastened the arthritic degeneration, as reported by Kannus and Jarvinen¹⁴ and Sommerlath et al²⁰ (although disputed by others¹⁶). Minimal work has been reported in the literature on this topic, but the results of the current study indicate that chronically unstable knees even without meniscectomy are at an increased risk of degenerative changes. Additional research is required.

Leaving anterior cruciate ligament deficient knees until the chronic stage for reconstruction resulted in early osteoarthritic changes even without meniscectomy. The arthritic changes were more marked if meniscectomy was performed. Acute reconstruction of the anterior cruciate ligament with meniscal preservation resulted in the lowest incidence of early degenerative change and was the optimal method in preventing long term disability from this injury in patients intending to participate in activities that require sidestepping or pivoting.

The current study provides information describing potential radiographic outcomes of arthroscopic anterior cruciate ligament reconstruction with and without meniscectomy. This may enable surgeons and patients to understand better the long term effects of anterior cruciate ligament injury and possibly aid in delaying osteoarthritic outcomes in young patients.

References

1. Aglietti P, Zaccherotti G, De Biase P, Taddei I: A comparison between medial meniscus repair, partial meniscectomy, and normal meniscus in anterior cruciate ligament reconstructed knees. *Clin Orthop* 307:165-173, 1994.
2. Anderson AF: Rating Scales. In Fu FH, Harner CD, Vince KG (eds). *Knee Surgery*. Vol 1. Baltimore, Williams & Wilkins 289-295, 1994.
3. Anderson AF, Snyder RB, Lipscomb B: Anterior cruciate ligament reconstruction using the semitendinosus and gracilis tendons augmented by the Losee iliotibial band tenodesis. *Am J Sports Med* 22:620-626, 1994.
4. Appel H: Late results after meniscectomy in the knee joint. *Acta Orthop Scand* 133(Suppl):1-111, 1970.
5. Bolano LE, Grana WA: Isolated arthroscopic partial meniscectomy. *Am J Sports Med* 21:432-437, 1993.
6. Brown CH, Steiner ME, Carson EW: The use of hamstring tendons for anterior cruciate ligament reconstruction. *Clin Sports Med* 12:723-756, 1993.
7. Daniel DM, Stone ML, Dobson BE, et al: Fate of the ACL-injured patient: A prospective outcome study. *Am J Sport Med* 22:632-644, 1994.
8. Fetto FJ, Marshall JL: The natural history and diagnosis of anterior cruciate ligament insufficiency. *Clin Orthop* 147:29-38, 1980.
9. Fu FH, Woo SLY, Irrgang JJ: Current concepts for rehabilitation following anterior cruciate ligament reconstruction. *J Orthop Sports Phys Ther* 15:270-278, 1992.
10. Giove TP, Miller SJ, Kent BE, et al: Nonoperative treatment of the torn anterior cruciate ligament. *J Bone Joint Surg* 65A:184-192, 1983.
11. Indelicato PA, Bittar ES: A perspective of lesions associated with ACL insufficiency of the knee: A review of 100 cases. *Clin Orthop* 198:77-80, 1985.
12. Jackson DW, Jennings LD: Arthroscopically assisted reconstruction of the anterior cruciate ligament using a patella tendon bone autograft. *Clin Sports Med* 7:785-800, 1988.
13. Johnson RJ, Kettelkamp DB, Clark W, Leaverton P: Factors affecting late results after meniscectomy. *J Bone Joint Surg* 56A:719-729, 1974.
14. Kannus P, Jarvinen M: Conservatively treated tears of the anterior cruciate ligaments. *J Bone Joint Surg* 69A:1007-1012, 1987.
15. Lutz GE, Stuart MJ, Sim FH: Rehabilitation techniques for athletes after reconstruction of the anterior cruciate ligament. *Mayo Clin Proc* 66:114-117, 1991.
16. McDaniel WJ, Dameron TB: Untreated ruptures of the anterior cruciate ligament: A followup study. *J Bone Joint Surg* 62A:696-705, 1980.
17. Noyes FR, Barber-Westin SD: Anterior cruciate ligament reconstruction with autogenous patellar tendon graft in patients with articular cartilage damage. *Am J Sports Med* 25:626-634, 1997.
18. Shelbourne KD, Gray T: Anterior cruciate ligament reconstruction with autogenous patellar tendon graft followed by accelerated rehabilitation: A two- to nine-year followup. *Am J Sports Med* 25:786-795, 1997.
19. Sherman MF, Warren RF, Marshall JL, Savatsky GJ: Analysis of 127 anterior cruciate insufficient knees. *Clin Orthop* 227:229-237, 1988.
20. Sommerlath K, Lysholm J, Gillquist J: The long-term course after treatment of acute anterior cruciate ligament ruptures: A 9- to 16-year followup. *Am J Sport Med* 19:256-263, 1991.
21. Stanish WD, Lai A: New concepts of rehabilitation following anterior cruciate reconstruction. *Clin Sports Med* 12:25-29, 1993.
22. Woods GW, Chapman CR: Repairable post meniscocapsular disruption in ACL injury. *Am J Sport Med* 12:381-385, 1984.