Concomitant partial meniscectomy worsens outcome after arthroscopic anterior cruciate ligament reconstruction

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Submitted 00-11-02. Accepted 01-12-19

ABSTRACT – In this multi-center study involving 412 patients, we assessed the influence of concomitant partial meniscal resection on the medium-term clinical results after anterior cruciate ligament reconstruction. We performed a resection of minimum one-third of the medial or lateral menisci in 137 patients (group M) and found intact menisci in 275 patients (group NM). Those who had undergone previous meniscal surgery, subsequent meniscal surgery or a re-rupture of the anterior cruciate ligament graft during the follow-up were not included.

After a median of 3 (2–6) years, the patients were re-examined by independent observers. Group M patients had more pain, swelling and laxity than those in group NM; they also had a worse classification according to the IKDC system, lower Lysholm scores and a greater proportion of patients with loss of motion.

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The commonest concomitant intra-articular lesion seen during anterior cruciate ligament (ACL) reconstruction involves the menisci which are affected in about 40–70% of patients (Noyes and Barber-Westin 1997, Stapleton 1997, Karlsson et al. 1999, Wiger et al. 1999). Meniscal pathology seems to increase with the amount of time that elapses between the injury and reconstruction (Jomha et al. 1999b, Karlsson et al. 1999). It has also been reported that radiographic signs of arthrosis increase after partial meniscectomies alone or in conjunction with ACL reconstruction and that intact menisci are important for function of the knee (Lynch et al. 1983, Sommerlath et al. 1991, Aglietti et al. 1994, Küllmer et al. 1994, Roos et al. 1994, 1995, 1998, Jomha et al. 1999a, Kartus et al. 1999, Shelbourne and Gray 2000).

We compared the medium-term clinical results in patients who, at the time of arthroscopic ACL reconstruction, underwent concomitant partial meniscal resection with those who had intact menisci. Our hypothesis was that the former patients would have a worse functional outcome than the latter.

Patients and methods

It is routine practice in the 4 participating institutions to collect data prospectively on all patients undergoing ACL reconstruction. However, this study was designed and implemented retrospectively.

At follow-up, patients were divided into 2 study groups depending on whether they had undergone substantial meniscal surgery (group M, removal of at least 1/3 of the medial or lateral meniscus; group NM, intact menisci) at the time of the ACL reconstruction. The study groups were comparable in terms of age, reconstructive technique and pre-injury activity level (Table 1).

To minimize initial confounding factors, the inclusion criteria were:

All patients had undergone an arthroscopic ACL reconstruction using a central third patellar tendon or hamstring tendon autograft and interference screw fixation.

All patients were living in the Sydney metropolitan area in Australia or the catchment area of 3 Swedish hospitals at the time of reconstruction.

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No patient had undergone meniscal surgery before the ACL reconstruction.

A reconstruction was performed on a pain-free mobile joint between 3 weeks and 6 months after the ACL rupture, before resuming sports and before any major episode of instability had recurred.

No patient had had meniscal sutures at the time of ACL reconstruction.

No patient underwent subsequent meniscal surgery during the follow-up.

The follow-up ranged between 20 and 73 months.

The patients suffered no re-rupture of the reconstructed ACL during the follow-up.

The patients had a normal contralateral ACL before the index operation and sustained no contralateral ACL rupture during the follow-up.

Table 1. Demographics of the patients

	Group M (n 137)	Group NM (n 275)	P-value
Gender			
Female	47 (34%)	123 (45%)	0.04
Male	90 (66%)	152 (55%)	
Age (years)	26 (14–63)	25 (14–53)	0.1
mean	28 (SD 10)	26 (SD 7.9)	
Preinjury activity level			
Strenuous	110 (80%)	229 (83%)	0.5
Moderate	21 (15%)	36 (13%)	
Light	5 (4%)	9 (3%)	
Sedentary	1 (1%)	1 (1%)	
Reconstructive technique			
Patellar tendon	71 (52%)	152 (55%)	0.5
Hamstring tendons	66 (48%)	123 (45%)	
Articular surface damage at reconstruction	30 (22%)	21 (8%)	<0.0001

The inclusion criteria were fulfilled by 460 of 3,468 patients who had undergone primary ACL reconstruction in all 4 institutions. Follow-up examinations were done in 412/460 (90%); 48 declined to attend the follow-up, could not be located, or lived too far away to attend. As regards the demographics, the patients who were lost to follow-up were similar to those fulfilling the inclusion criteria. Group M comprised 137 patients and group NM 275.

The patients underwent arthroscopic ACL reconstruction using a patellar tendon autograft (Rosenberg 1991) or combined semitendinosus and gracilis autograft (Corry et al. 1999). Interference screw fixation was used in all patients both on the tibial and femoral sides (Kurosaka et al. 1987, Corry et al. 1999). Stability of the joint was confirmed at the end of the procedures by performing the Lachman and anterior drawer test.

At the index operation, there were significantly more male patients in group M than in group NM. In group M, 45 (33%) patients required surgical treatment of the medial meniscus, 67 (49%) of the lateral and 25 (18%) required treatment of both the medial and the lateral menisci. Articular surface damage was more often found in group M than in group NM (Table 1).

We used an accelerated rehabilitation program permitting immediate full range of motion and full weight bearing. Range of motion exercises were directed towards achieving full extension. Closed kinetic chain (axial load bearing) exercises with proprioceptive training were started within the first postoperative week. Return to a competitive sport was not permitted until at least 6 months after surgery and only after knee stability was reconfirmed on clinical examination.

Five physiotherapists and one research assistant who were not involved in the rehabilitation of the patients performed all the follow-up evaluations. Before the study, all observers were given instruction with a view to minimizing intra-observer variations. At re-examination, the observers were blinded as regards the meniscal status at the index operation.

We used the modified Lysholm knee score (Tegner and Lysholm 1985) and completed it by a self-questionnaire, as described by Höher et al. (1997).

We also used the International Knee Documentation Committee (IKDC) classification, as described by Hefti et al. (1993). This score is based on a subjective evaluation of knee function, including activity level and symptoms. Independent examiners assessed the range of motion (ROM) and ligament laxity. The results were graded as A (normal), B (nearly normal), C (abnormal) or D (severely abnormal). The worst grading in each subgroup determines the subgroup grading and the worst subgroup grading is decisive for the final evalu-

ation, which is reported in the section on results. The activity level was classified as strenuous, moderate, light and sedentary, according to the IKDC classification system (Hefti et al. 1993).

The patients performed the one-leg hop test by jumping and landing on the same foot with their hands behind their back (Tegner et al. 1986). Three attempts were made for each leg and the longest jump was registered for each leg separately. A quotient (%) between the index and uninjured leg was calculated. The result was classified as normal (100–90%), nearly normal (89–76%), abnormal (75–50%) or severely abnormal (< 50%), as suggested by the IKDC classification.

We used the instrumented KT-1000 test (MEDmetric Corp., San Diego, CA, USA) to evaluate the amount of anterior sagittal laxity of the index knee as compared with the uninjured knee using a force of 89 N. All six observers who performed KT-1000 tests had experience with this method. The manual Lachman test was performed with the knee in 30° of flexion with the patient on an examination couch. It was graded as 0, +1, +2 and +3 compared with the uninjured contralateral side. The pivot shift test was graded according to the IKDC classification as 0, + (glide) and ++ (clunk).

The ROM was measured with a goniometer to the nearest 3°. Any loss of motion compared with the normal contralateral side was registered; for example, if full hyperextension equal to the contralateral side was not regained, the patient was classified as having a loss of extension. The patients were then categorically classified as having an extension deficit or not. The same procedure was used for the flexion measurements.

We paid particular attention to the evaluation of pain and swelling on activity. The highest possible pain-free activity level was registered and classified as strenuous, moderate, light or sedentary, according to the IKDC classification system (Hefti et al. 1993). The highest possible activity level without swelling was classified in a similar way.

Statistics

Median (range) values are reported unless means and standard deviations (SD) are indicated. For comparisons between the study groups, the Mann-Whitney non-parametric U-test was used for ordinal and interval scale variables and Fisher's exact test for dichotomous variables.

To avoid possible confounder effects of gender, age, articular surface damage at reconstruction and preinjury activity level, a control group to group M was selected from group NM to make the marginal distributions of the confounding variables as identical as possible. To make the distributions of articular surface damage at reconstruction equal in the study groups, we could only include the first 10 patients of 30 in group M with this type of injury. This placed 117 patients in group M'. Next, we selected a control group for group M' from group MN individual by individual by minimizing the maximal t-values between the two groups over the above variables for all patients in group NM not yet included in the control group. The procedure was stopped when the maximal t-value started to increase substantially and placed 223 in group NM' matched for the marginal distributions. In the statistical analysis involving group M' and group NM'; confounding bias was eliminated by this procedure.

For the main result variables, we performed a complementary multivariate logistic regression analysis on all patients adjusted for the baseline variables. Due to non-normality of the Lysholm score, even after transformation, the score was analysed as the explained variable in the multivariate logistic regression analysis and the group was analyzed as the dependent variable (O'Brien 1988).

All significance tests were two-tailed and done at the 0.05 significance level.

Results

At the follow-up examination, we found a lower Lysholm score and worse classification according to the IKDC system in group M than in group NM (Table 2). The patients in group M had more pain and swelling with activity, and a greater proportion showed loss of motion than those in group NM (Table 2). The KT-1000 laxity test and pivot shift tests were similar in the study groups; however, using the manual Lachman test, the patients in group M were found to have an increase in laxity (Table 3). In terms of the activity level and one-leg-hop test, we noted no differences between the study groups (Table 3).

The distributions of gender, age, articular surface damage at reconstruction and preinjury activity level were almost identical in the selected group M' and its matched controls in group NM' (Table 4).

In the statistical analyses of group M' and its matched controls in group NM', the former still had lower evaluation scores, more swelling with activity, more loss of motion and greater laxity than the latter (Table 5).

In the complementary multivariate analyses adjusted for all baseline variables, we still found differences between the groups for the most important outcome variables, the Lysholm score (p = 0.0003), loss of extension (p = 0.0003) and loss of flexion (p = 0.02).

Table 2. The results of the Lysholm score, final IKDC evaluation, maximum pain-free activity level, maximum activity level without swelling and loss of motion before confounder adjustment

	Group M (n 137)	Group NM (n 275)	P–value
Follow–up period (months)	37 (20–68)	46 (22–73)	
mean	38 (SD 13)	44 (SD 15)	
Lysholm score (points)	90 (35–100)	95 (45–100)	<0.0001
Final IKDC evaluation			
Normal	30 (22%)	117 (42%)	0.003
Nearly normal	75 (55%)	118 (43%)	
Abnormal	28 (20%)	32 (12%)	
Severely abnormal	4 (3%)	8 (3%)	
Maximum pain-free activity level			
Strenuous	82 (60%)	208 (76%)	0.001
Moderate	35 (26%)	42 (15%)	
Light	14 (10%)	17 (6%)	
Sedentary	6 (4%)	8 (3%)	
Maximum activity level without swelling [a]	(n 130)	(n 268)	
Strenuous	84 (65%)	220 (82%)	0.0001
Moderate	37 (28%)	39 (15%)	
Light	7 (5%)	8 (3%)	
Sedentary	2 (2%)	1 (0%)	
Loss of extension	35 (26%)	32 (12%)	0.0006
Loss of flexion	44 (32%)	55 (20%)	0.01

[a] 14 missing values

Discussion

Our principal finding was that the medium-term results were worse in patients who underwent concomitant partial meniscal resection at the time of ACL reconstruction than in those who had intact menisci. An advantage of our study is that the evaluations were done by blinded observers who had no knowledge of the meniscal status of the patients and were not involved in their treatment. Furthermore, the study groups were large, a follow-up rate of 90% was achieved and efforts to minimize confounding factors were made.

A potential weakness is that patients in group M may have had a severer initial injury or a meniscal tear before the ACL rupture and therefore had a less favorable outcome. It is also possible that group NM had meniscal lesions which were not detected at arthroscopy and therefore not registered.

When we planned our study, we decided that the main aim was to evaluate the effect of concomitant partial meniscal resection on the results after ACL reconstruction. Therefore, we avoided analyses between subgroups based on variables such as gender, graft type, institution and whether the meniscal tears were medial or lateral.

Both the analysis of the matched subgroups, where the influence of the baseline variables of age, gender, preinjury activity level and articular surface damage were eliminated, and the multivariate analyses of the main variables adjusted for the baseline variables strengthen the view that concomitant partial meniscectomy is detrimental for knee function in the long run.

Due to the nearly identical distributions of the baseline variables in group M' and its matched controls in group NM', we achieved a good internal validation in terms of confounding bias.

One analysis was confined to subgroup NM' out of the original group NM, to match group M' in terms of the baseline variables (Table 5). This suggests a somewhat higher age and higher proportion of males and articular surface damage in group NM' than in the original group NM. One should bear this in mind when generalizing the results. Despite the loss of patients in the proposed restricted analysis, the statistical power is probably higher, due to the large number of patients in the groups, compared to a stratified analysis, where the numbers in the strata are often very few

Table 3. The results in terms of stability, activity level and the one-leg hop test before confounder adjustment

	Group M (n 137)	Group NM (n 275)	P-value
KT-1000 test [a]	(n 128)	(n 263)	
(mm)	1 (-2–9)	1 (-5–10)	
mean	1.4 (SD 1.8)	1.3 (SD 1.8)	0.8
Lachman 0	87 (64%)	216 (78%)	0.001
Lachman +1	47 (34%)	55 (20%)	
Lachman +2	3 (2%)	4 (2%)	
Pivot shift 0	128 (93%)	258 (94%)	0.8
Pivot shift +	9 (7%)	17 (6%)	
Pivot shift ++	0 (0%)	0 (0%)	
Activity level			
Strenuous	68 (50%)	135 (49%)	0.7
Moderate	31 (22.5%)	56 (20%)	
Light	31 (22.5%)	69 (25%)	
Sedentary	7 (5%)	15 (6%)	
One-leg hop test [b]	(n 136)	(n 273)	
Normal	107 (79%)	232 (85%)	0.1
Nearly normal	25 (18%)	32 (12%)	
Abnormal	4 (3%)	6 (2%)	
Severely abnormal	0 (0%)	3 (1%)	

[a] 21 missing values
[b] 3 missing values

and distributed in a skewed way between the two groups.

The proposed method also has the advantages that appropriate statistical methods for these types of variables could be used and estimates given for the matched subgroups.

Our findings are similar to those of Aglietti et al. (1994); they found that patients who underwent partial medial meniscectomy in conjunction with an ACL reconstruction had more pain than those who had a normal medial meniscus. However, their conclusion was based on a comparison of only 39 patients. Küllmer et al. (1994), in a study of 77 patients with an artificial ACL graft, found that there was a correlation between meniscal injuries and the development of degenerative changes on radiographs after a follow-up of 41 months. McConville et al. (1993) studied 64 patients and reported that those who underwent meniscal surgery in conjunction with an arthroscopically-assisted ACL reconstruction had significantly more pain and giving way than those with normal menisci. Shelbourne and Gray (2000) showed in a follow-up of 482 patients, 5–15 years after open ACL reconstruction, that patients with meniscal damage at the index operation did worse in terms of subjective and arthrometric evaluation than those who had intact menisci. Comparisons with our study are difficult, because they classified patients who had meniscal sutures at the index operation as having intact menisci and they also included those who underwent multiple meniscal procedures before as well as after the index operation. Furthermore, their conclusions were based on a follow-up rate of only 39%.

Table 4. The distributions of gender, age, articular surface damage at reconstruction and preinjury activity level after marginal adjustment for these variables

	Group M' (n 117)	Group NM' (n 223)
Gender		
Female	41 (35%)	78 (35%)
Male	76 (65%)	145 (65%)
Age (years)	26 (14–54)	26 (14–52)
mean	27 (SD 8.8)	27 (SD 7.3)
Preinjury activity level		
Strenuous	95 (81%)	181 (81%)
Moderate	19 (16%)	34 (15%)
Light	2 (2%)	8 (4%)
Sedentary	1 (1%)	0 (0%)
Articular surface damage at reconstruction	10 (9%)	19 (9%)

Lynch et al. (1983), Roos et al. (1995, 1998), Sommerlath et al. (1991), McConville et al. (1993) and Jomha et al. (1999a) have all found that the degenerative changes on radiographs increase in the long-term after meniscal surgery. During the planning of our study, we considered a radiographic evaluation, however, we found it extremely difficult to perform consistent radiographic evaluations of more than 400 patients in a multi-center study.

Our findings and those of Karlsson et al. (1999) and Jomha et al. (1999b) support the view that patients who want to participate in pivoting sports should undergo reconstruction as soon as possible after the acute symptoms have subsided. We suggest that when the results of ACL reconstructions are reported, the amount of meniscal pathol-

Table 5. Main results after adjustment for possible confounders

	Group M' (n 117)	Group NM' (n 223)	P-value
Lysholm score (points)	95 (45–100)	90 (35–100)	<0.0001
Final IKDC evaluation			
Normal (A)	27 (23%)	98 (44%)	0.0004
Nearly normal (B)	65 (55%)	93 (42%)	
Abnormal (C)	23 (20%)	25 (11%)	
Severely abnormal (D)	2 (2%)	7 (3%)	
Maximum pain-free activity level			
Strenuous	76 (65%)	164 (74%)	0.1
Moderate	27 (23%)	36 (16%)	
Light	9 (8%)	16 (7%)	
Sedentary	5 (4%)	7 (3%)	
Maximum activity level without swelling [a]			
Strenuous	75 (68%)	183 (83%)	0.002
Moderate	28 (26%)	32 (14%)	
Light	6 (5%)	5 (2%)	
Sedentary	1 (1%)	1 (1%)	
Loss of extension	31 (26%)	23 (10%)	0.0003
Loss of flexion	36 (31%)	42 (19%)	0.02
Lachman 0	71 (60%)	183 (82%)	
Lachman +1	43 (37%)	37 (17%)	
Lachman +2	3 (3%)	3 (1%)	<0.0001
One-leg hop test			
Normal	92 (79%)	197 (88%)	0.02
Nearly normal	21 (18%)	21 (10%)	
Abnormal	4 (3%)	3 (1%)	
Severely abnormal	0 (0%)	2 (1%)	

[a] 9 missing values

ogy and surgery should be described, unless this is done, comparisons with other studies will be difficult.

This study was supported by grants from the Australian Institute of Musculo-Skeletal Research, Göteborg Medical Society, Göran Bauer Foundation, Swedish National Centre for Research in Sports and the Department of Research and Development at Norra Älvsborg/Bohus County Council. Furthermore, we also thank Ninni Sernert, Kristina Köhler, Eva Faxén and Janeth Larsson for examining the Swedish patients.

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