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KNEE FUNCTION AND MUSCLE STRENGTH FOLLOWING DISTAL ILEOTIBIAL BAND TRANSFER FOR ANTERO-LATERAL ROTATORY INSTABILITY

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In a prospective study, 60 consecutive patients underwent a distal iliotibial band transfer for anterolateral knee instability. Knee function was evaluated with a score system, static stability tests and a standardized test including thigh muscle measurements, a one-leg-jump-test and a figure-of-8 running test. At the 40-month follow-up there was a significant increase in the mean knee score. The quadriceps in the treated leg was significantly weaker than in the non-operated leg, and the quadriceps strength was significantly correlated to the knee score. The functional outcome after operation was generally unsatisfactory. Few patients attained normal values in all tests, primarily because of poor restoration of stability.

Key words: ileotibial tract; instability; knee; knee function test; score.

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The aim of knee ligament surgery is to re-establish joint stability. Instability may be static or functional. Static instability can be tested manually or mechanically (Jacobsen 1976, 1978, Kennedy & Fowler 1971, Levén 1977, Markolf et al. 1978, Sylvin 1975). Functional instability is experienced by the patient during different activities and the effects can be registered in a scoring scale. However, the patient's activity level is a factor that can significantly influence the score. If, for example, activity is reduced after operation the patient could overestimate his knee function and thereby achieve a falsely high score. To examine this hypothesis, we studied patients after a distal ileotibial band transfer for antero-lateral instability. The resulting scores were compared with the performance in static stability tests and a standardized knee function test in which muscle strength and the patient's ability to run and jump were measured.

MATERIAL AND METHODS

Patients

Sixty consecutive patients, 16 women and 44 men (range 19–45 years), underwent extra-articular reconstructive surgery for chronic antero-lateral rotatory knee instability with positive pivot-shift and Slocum signs. Thirty-six of them also showed antero-medial rotatory instability and two had antero-lateral as well as postero-lateral rotatory instability.

The modified Ellison procedure was carried out within 12 months of the initial injury in 13 patients, and after more than 3 years in 27 patients.

Treatment

Arthroscopy was done in all patients to evaluate joint cartilage, menisci and ligaments. Procedures done in association with transfer of the distal iliotibial band included postero-medial capsular reefings (35 patients), medial collateral ligament reconstruction (12 patients), lateral collateral ligament reconstruction (one patient), Trillat procedure (Trillat 1978) (three patients), total medial meniscectomy (six patients), partial medial meniscectomy (four patients), total lateral meniscectomy (four patients), partial lateral meniscectomy (one patient), and suture of the medial meniscus (10 patients).

Procedure

The type of antero-lateral stabilization performed was similar to that used by Fox et al. (1980). Part of the ileotibial tract was rerouted under the lateral collateral ligament in order to create a static stabilizer (Odensten et al. 1983).

Follow-up

The patients were reviewed on the average 40 (27–73) months after operation. Physical examination was done preoperatively and at follow-up. A knee function score (Lysholm & Gillquist 1982) was obtained for each patient on both occasions. The maximum score is 100 points. The score emphasizes symptoms and signs of instability and pain during walking, running and jumping. A score of over 91 points was rated as excellent, and a score of 90–77 points as good. The reproducibility was ± 2.8%.

At follow-up, each patient did a knee function test which included the following:

A. Measurements of quadriceps and hamstring strength in both legs using an isokinetic dynamometer (Cybex II, Lumex Inc., New York). Isometric strength was measured at a knee flexion angle of 60° (straight = 0°). Concentric strength was recorded over the whole range of motion at an angular velocity of 30° per second. Three attempts were allowed, and the peak value was used (Moffroid et al. 1969). The strength ratio between flexors and extensors (H/Q ratio) was calculated as the ratio between the peak values.

B. One-leg-jump test. Three attempts were made with each leg, and the distance was measured in cm. The jump distance ratio between the treated and non-operated leg was calculated. The normal value for the test is 0.95 ± 0.04.

C. Figure-of-eight-running test. A figure-of-eight was run twice against time (total distance 40 m). The normal values for this test were 11.0 ± 0.3 s (men) and 12.9 ± 0.8 s (women).

RESULTS

At the follow-up, eight patients had undergone yet another operation with reconstruction of the anterior cruciate ligament owing to persistent severe instability. The follow-up included 43 patients. Nine patients did not participate for various reasons.

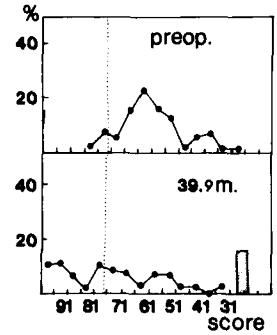

Figure 1. Distribution of scores in 60 patients after distal iliotibial band transfer procedure preoperatively and at follow-up 40 months postoperatively. At the follow-up, eight patients had had a new procedure with reconstruction of the anterior cruciate ligament because of persistent severe instability. The dotted line indicates 77 points, the border line between excellent/good and fair/poor.

Score

The mean preoperative score was 59 ± 12 points. At 40 months, a significant increase in the mean score was noted (73 ± 19 points, $P < 0.001$) (Figure 1). Preoperatively 5% (3) of the patients achieved over 77 points, (all in the category "good"), and 40 months after operation 35% achieved over 77 points ($P < 0.001$) (Figure 1) eight patients (13.3%) had a lower score at 40 months than before operation. The mean preoperative score among these patients was 63 ± 15, and at 40 months 54 ± 15 points. The scores for the items instability and pain were closely correlated to the total score ($r=0.81$, $P<0.001$; $r=0.81$, $P\pm$ 0.001).

Muscle strength measurements

The quadriceps in the treated leg was weaker than in the non-operated leg, as measured both isometrically and isokinetically (229 ± 63 and 251 ± 55, $P < 0.05$; 206 ± 62 and 243 ± 59, $P < 0.005$). There were no significant differences in mean knee flexor strength between the treated and non-operated legs.

Patients with isokinetic quadriceps strength above 90% in the treated leg had a significantly higher score than the other patients (88 ± 12 compared with 66 ± 18; $P < 0.001$). Isokinetic

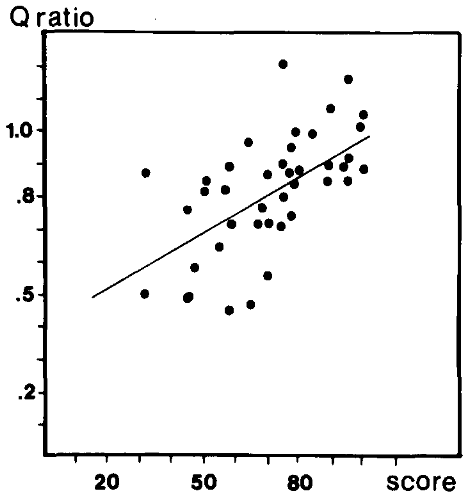

Figure 2. Correlation between isokinetic quadriceps' ratio between treated and non-operated leg and score in 43 patients after distal iliotibial band transfer 40 months postoperatively (r = 0.62, P < 0.001).

and isometric muscle strengths were significantly correlated to the score (r = 0.47, $P < 0.001$; r = 0.35, $P < 0.02$). The quadriceps ratio treated/non-operated leg was also correlated to the score (isokinetic r = 0.62, $P < 0.001$ (Figure 2), isometric r = 0.51, $P < 0.001$).

Table 1. Table showing the thigh muscle strength, jump test and running test results in patients over and under 77 score points after a distal iliotibial band transfer 40 months postoperatively

	Group I Score > 77 (20 pat)	Group II Score < 77 (23 pat)
Q isokin. op. leg	225±42.5 Nm	188±71.9 Nm $P < 0.05$
H/Q ratio isokin op leg	0.63±0.11	0.76±0.21 $P < 0.02$
Q ratio op/intact leg	0.96±0.12	0.74±0.18 $P < 0.001$
H ratio op/intact leg	1.08±0.12	0.94±0.13 $P < 0.001$
Jump distance op leg	141±22 cm	120±44 cm $P < 0.05$
Jump ratio op/intact leg	0.98±0.16	0.86±0.16 $P < 0.02$
Running	12.2±1.15	13.0±1.65 $P < 0.05$

The patients were divided in two groups according to the score. Group 1 (> 77 points, excellent-good), included 20 patients, and Group 2 (< 77 points fair/poor) 23 patients.

Patients in Group 1 showed significantly greater quadriceps strength and had a lower H/Q-ratio in the treated leg than did Group 2 patients. Both quadriceps and hamstring ratios between treated and non-operated legs were significantly higher in Group 1 (Table 1).

Jumping and running

There was a significant difference in mean jump distance between the treated and non-operated legs (130 ± 36 cm and 148 ± 25 cm; $P < 0.01$). The mean ratio between the treated and non-operated legs was 92 ± 17%. The Group 1 patients with a score exceeding 77 points achieved a significantly longer jump with the treated leg than did the Group 2 patients (141 ± 22 cm compared with 120 ± 44 cm; $P = 0.05$. There were no significant differences in jump distance with the non-operated leg. Group 1 patients also showed a significantly higher jump ratio between treated and non-operated legs than did the Group 2 patients (98 ± 16% compared with 86 ± 16%; $P < 0.02$).

The jump ratio (treated/non-operated legs) showed a significant correlation to the score (r = 0.38, $P < 0.02$).

The mean running time was 13 ± 2 s. Patients with a score of over 77 points needed a significantly shorter running time than the others (12 ± 1 compared with 13 ± 2, $P < 0.05$). Running time was significantly correlated to quadriceps and hamstring muscle strength in both treated and non-operated legs (r = 0.34–0.54, $P < 0.05$–0.001).

Joint stability

Before operation all patients showed knee joint instability, with a positive pivot-shift and/or Slocum sign. At follow-up, the joint was stable in 25 patients and unstable in 18 as judged by these tests. Patients with stable joints showed significantly greater quadriceps muscle strength measured isokinetically than patients with unstable joints (218 ± 63 and 184 ± 60 Nm; $P < 0.05$). In the stable group the isokinetic quadriceps strength of the treated leg was 90 ± 17% of that in the non-operated leg, whereas in the unstable group it was only 74 ± 14% ($P < 0.01$). The mean score at follow-up was 79.2 ± 18.0 in the stable group and 65.2 ± 17.9 in the unstable group ($P < 0.02$). However, there was no significant difference between the stable and unstable groups in the one-leg-jump test or figure-of-eight running test.

The patients were subdivided into three sets in accordance with the Venn diagram evaluation system published by Bauer et al. (1969). The first comparison (Figure 3) involved a normal jump capacity (jump ratio > 91%), normal quadriceps ratio (> 90%), and a total score exceeding 77 points. This score set includes patients with no symptoms or with symptoms only during athletic activities. Fifteen patients had normal quadriceps muscle strength, 20 a score above 77, and 27 a normal jump ratio. Eleven patients were abnormal in all these respects. The subset, where all criteria were normal, comprised only 11 patients; most of them had a high score (mean 91.5 ± 8.5).

Only three patients had a score of more than 77, other criteria being abnormal; two of them had scores close to 80, i.e. borderline values. Raising the borderline for the score set to 91 points did not change the picture significantly

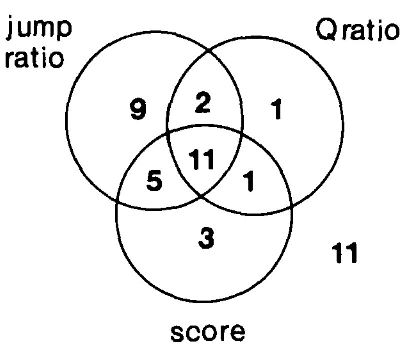

Figure 3. Venn-diagram showing the distribution of 43 patients after distal iliotibial band transfer procedure 40 months postoperatively in jump ratio (operated/non-operated leg > 91%), quadriceps' ratio measured isokinetically (operated/non-operated leg > 90%), and score over 77 points.

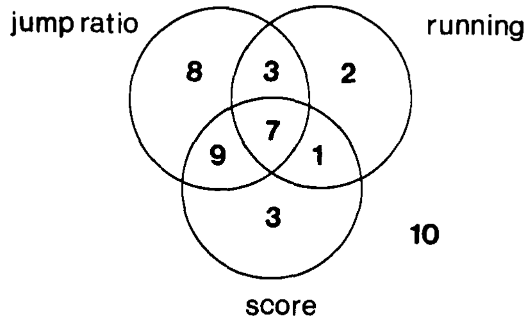

Figure 4. Venn-diagram showing the distribution of 43 patients after distal iliotibial band transfer 40 months postoperatively in the items jump ratio (operated/non-operated leg > 91%), running in a figure-of-8 (> the normal running time + 1 S.D., 11.3 sec. men and 13.7 sec. women) and score (> 77 points).

apart from the exclusion of these three patients.

Eleven patients had a normal jump-test but low score; only two of them had a normal quadriceps ratio.

Patients with unstable knees were commoner outside the three sets than in the central subset where all criteria were normal (7/11 and 1/11, $P < 0.01$). The central subset also included fewer patients with unstable knees than did the other subsets ($P < 0.05$).

When the quadriceps ratio was substituted by running (Figure 4), ten patients were excluded from all three sets. In only seven patients were all three criteria normal. Running excluded more patients from the subsets than did jumping. There were significantly more patients with one or two normal criteria that showed normal jumping but abnormal running ($P < 0.005$). Most patients with a normal quadriceps ratio could also jump or run or had a high score. There was only one patient with a normal quadriceps ratio in whom no other criterion was within normal limits.

DISCUSSION

Several authors have reported reduced muscle strength in previously injured legs or after knee ligament surgery (Arvidsson et al. 1981, Grimby et al. 1980, Teitge et al. 1980). Smillie (1978) suggested that quadriceps muscle atrophy is closely correlated to the overall function of the knee joint. Measurements of muscle strength using the Cybex II device were therefore included.

Forty months after operation, significant improvement in knee function was indicated by the increase in mean score, although this remained below 77 points. Thus, most patients had significant symptoms during day-to-day activities, and the results are not very encouraging.

There was reduced mean quadriceps strength in the treated leg, but the mean hamstring strength was unaffected – results which tally with those of Teitge et al. (1980). Muscle strength was dependent on knee-joint stability, as most patients with stable joints regained normal quadriceps strength. On the other hand, patients with unstable knees only regained 77% of normal strength.

Quadriceps muscle strength influenced the symptoms in daily life (score) as well as performance in the test. A good result in score and test was usually achieved by patients with normal quadriceps strength. Most patients with a low score had clinically unstable knees, complained of significant symptoms of instability, and were less well rehabilitated since both quadriceps and hamstrings were weaker than in the non-operated leg. The values for absolute strength were also lower than in the group with a high score, which shows that stability and thigh-muscle strength are important factors for knee function. In general, there was close correlation between the score and the functional tests, especially the one-leg jump. Patients with a low score had a shorter jump distance and a longer running time than patients with a high score. The value of the score system in measuring overall knee function is corroborated.

In general, the score (both total and the instability item separately) and jump ratio were dependent on quadriceps strength in the *treated* leg. Running time, however, was correlated to quadriceps and hamstring strength in both legs, and was thus dependent on general muscle strength. This tallies with the higher normal value for woman runners in the test.

Normal running was more difficult to attain than normal jumping. Running probably depends not only on knee function but also on technique and general muscle strength.

The functional outcome after operation was generally unsatisfactory. Few patients attained normal values in all tests. This result was primarily due to poor restoration of stability.

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