Acta orthop. scand. *54*, 119–125, 1983

PROSPECTIVE STRESS RADIOGRAPHY IN 38 OLD INJURIES OF THE LIGAMENTS OF THE KNEE JOINT

NIELS HEJGAARD, HENRIK SANDBERG, ADAM HEDE & KLAUS JACOBSEN

Department of Orthopaedic Surgery T-3 and Department of Diagnostic Radiology, Gentofte Hospital, University of Copenhagen, Denmark

In a prospective clinical and stress radiographic study comprising 38 patients, the course of chronic ligament injuries in the knee joint was evaluated. All but five patients had isolated ligament injuries, 16 of which affected the anterior cruciate ligament. The operations were performed from 18 days to 20 years after the injury had occurred. In 13 patients primary suture could be carried out, 12 patients underwent exploratory arthrotomy, and the remainder had relevant ligament repair. After a follow-up period of 7 years the instability had been cured in all patients with medial laxity and in one of two patients with lateral laxity. Nineteen patients had a drawer sign preoperatively. The anterior drawer sign disappeared in practically all patients, while a posterior drawer sign was a constant sequel to injury affecting the posterior cruciate ligament. It was difficult to prevent the development of rotatory instability – which was present in six preoperatively and in 14 at follow-up – and the rotatory instabilities were predominantly marked (>6 mm). Nevertheless, only a few patients had an annoying sensation of instability. By means of ligament reconstruction, it was possible to reduce the preoperative instability appreciably. Passive instability had completely subsided in 40 per cent (15/38). The subjective result was good, only 16 per cent (6/38) having troublesome loss of function.

Key words: gonylaxometry; injuries; instability; knee joint; ligament repair; stress radiography

Accepted 26.vii.82

Acute ligament injuries to the knee joint are a gratifying object for treatment, as simple primary suture affords encouraging results (Hejgaard et al. 1982, Lysholm et al. 1982, O'Donoghue 1959, Palmer 1938). On the other hand, old, neglected ligament injuries pose many therapeutic problems (Chick et al. 1981, Ellison 1979, Fetto & Marshall 1980, Ireland & Trickey 1980, Jones 1970, Kennedy et al. 1974, Nicholas 1973). The reconstructive procedures are often comprehensive and technically difficult and, most important of all, the operative indications are often poorly defined. The latter is due particularly to deficient elucidation of the spontaneous course of untreated or insufficiently treated ligament injuries. According to some authors, however, the course is not as unfavourable as previously assumed (Balkfors 1982, Dandy & Pusey 1982, McDaniel & Dameron 1980). With the aid of an accurate, prospective stress radiographic measuring technique we have been able to describe the long-term course of old ligament injuries to the knee joint, with a particular view to changes in passive instabilities.

PATIENTS

From January 1974 to November 1975 56 consecutive patients with old ligament injuries of the knee joint were treated in our Department. Of the 56 patients, 38 were included in the follow-up study, six were excluded because of new traumas requiring operation, three had emigrated, one had died, and eight could not be persuaded to attend the follow-up. Table 1 presents the age distribution, sex ratio, and follow-up periods. All but one patient had sustained the injury during athletic performances. The distribution of the various ligament injuries is given in Figure 1. Isolated ligament injuries predominated in this material of old ligament injuries. The medial collateral ligament had ruptured partially in four patients, showed a partial injury in the superficial part and total rupture of the entire deep part in four; in five patients there was total rupture of all layers proximally, and one patient had rupture of all layers + injury to an old semitendinosus tenodesis. Nearly half the patients had isolated injuries to the anterior cruciate ligament, most often manifesting themselves in a lax, atrophic ligament. The only injury to the posterior cruciate ligament was 7 months old. It was a distal tear with so much substance preserved that primary suture was possible. Four patients also had meniscal injuries, two in the medial and two in the lateral meniscus. In three patients it was combined with rupture of the ACL and in one with injury to the MCL. Table 2 lists the operative procedures. *Exploratory arthrotomy was performed on 12 patients* with varying instability of the knee on suspicion of internal derangement. In two cases it revealed an injury to a meniscus, which was removed. The therapy delay in this group was 30 days to 12 years, median 1 year. The next group of *13 patients underwent primary suture or reefing* of a weak ligament/capsule. These were predominantly medial structures, there being only two ACL and one PCL injury. In this group the therapy delay was from 18 days to 16 years, median 40 days. Lastly, *13 patients were treated by ligament reconstruction* because of annoying laxity. Medially the method was the simple McMurray semitendinosus tenodesis (McMurray 1919). Centrally the patellar ligament was used (Jones 1970) and in one case the semitendinosus tendon (Cho 1975); this patient had rupture of a Jones reconstruction done 2 years previously. Laterally a modified Ellison reconstruction was performed (Ellison 1979) and a biceps transposition in one case. Two patients had in addition lateral meniscectomy. In this group of reconstructions the therapy delay was from 35 days to 20 years, median 5 years. All the patients were operated on by the same surgeon (K.J.).

Table 1. Age, sex and observation time of 38 patients

No. of patients	38	(32♂ 6♀)
Age (years)	15–51 25	(range) (median)
Observation time (years)	6.1–7.5 6.9	(range) (median)

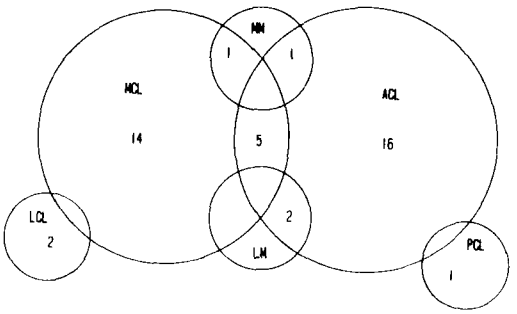

Figure 1. Venn-diagram showing the type of injury diagnosed in 38 patients at operation. MCL: Medial collateral ligament. ACL: Anterio cruciate ligament. MM: Medial meniscus. LCL: Lateral collateral ligament. PCL: Posterior cruciate ligament. LM: Lateral meniscus.

METHOD

The stress radiographic measurements were carried out preoperatively and at follow-up by using a gonylaxometer as described previously by Jacobsen (1981). Medial and lateral instability was measured on anteroposterior films with the knee in 20° flexion and with a 88 newtons stress (abduction + adduction). Drawer sign and rotatory instability were measured in

Table 2. The various operative procedures

Operative procedure	Lesion	*n*
Explorative arthrotomy	MCL 6, ACL 8	12
Suture/reefing	MCL 9, ACL 3, PCL 1	13
Ligamentous reconstruction		13
MCL (McMurray tenodesis)	3	
ACL (Jones, Cho)	8	
LCL (Modif. Ellison)	2	
Total		38

Table 3. Knee scoring scale

	Points		Points
Activity level	0–5	Flexion in degrees	0–2
Pain with activity	0–26	Anterior drawer	0–7
Shoes and socks	0–6	Posterior drawer	0–9
Stairs	0–22	Rot. instability	0–4
Gait	0–2	Collat. lig. stability	0–8
Rough ground	0–4	Pain w. flex/ext.	0–6
Distance walked	0–6	Pain on rotation	0–8
Synovitis	0–4	Varus-valgus	0–1
Flex. contracture	0–8		
Total points			128

90° flexion of the knee and the foot pointing straight forward with 294 newtons stress. By these procedures it was possible to measure eight different types of instability on the X-ray films: Medial "valgus" laxity (ML), lateral "varus" laxity (LL), anterior drawer sign (AD), posterior drawer sign (PD), antero-medial rotatory instability (AMRI), postero-medial rotatory instability (PMRI), anterolateral (ALRI) and postero-lateral rotatory instability (PLRI). Abnormal instability was diagnosed, if the relative laxity (the injured less the uninjured knee) exceeded the following critical levels: 2 mm for ML and LL, 3 mm for AD and PD. Medial rotatory instability was diagnosed if the medial tibial condyle was displaced 3 mm or more forwards or backwards in relation to the lateral condyle, and correspondingly for lateral rotatory instability. For the clinical evaluation of the final result we used a non-equidistant rank scale (Table 3) with 17 sub-groups and a score from 0 to a maximum of 128, modified after Kettelkamp & Thompson (1975). The patients' opinion of the result was graded as EXCELLENT (no complaints, normal function), GOOD (minor sensation of instability and occasional pain), and FAIR (pain and instability restricting function, considerably reduced strength). For each of these three groups the median score was calculated. To be able to assess the therapeutic gain in the three different treatment groups, we measured the median, total abnormal laxity before and after treatment.

RESULTS

Valgus/varus instabilities and drawer signs are shown in Table 4. ML was found preoperatively in nine patients, with a laxity of from 3–7 mm. The maximum laxities were found in patients with rupture of previous ligament reconstruction (one McMurray, one Jones) or with the "unhappy triad" (one patient). The remainder had only minor laxity as a sequel to partial rupture, predominantly proximally, in the MCL. All ML had disappeared at follow-up. Only two patients had LL, and in one the laxity had disappeared after a modified Ellison repair. AD was a constant finding in all patients with ACL rupture and was found also in two patients with MCL injuries and clinically intact ACL. At follow-up only four had significant drawer signs (>6 mm). AD disappeared completely in 10, improved in four, and developed in five who had previously been AD stable (two MCL and three ACL ruptures). PD was found preoperatively only in the one patient with a PCL injury. At follow-up it had become aggravated from 9 to 12 mm. Three patients de-

Table 4. Type of straight instability in 38 patients

Type*	Preop.	Follow-up
ML	9 (3–7 mm)	0
LL	2 (3 mm)	1 (5 mm)
AD	18 (10 ≥ 6 mm)	14 (6 = 3 mm, 4 = 5 mm, 4 ≥ 6 mm)
PD	1 (9 mm)	4 (4 mm, 4 mm, 12 mm, 18 mm)

* See text.

Table 5. Type of rotatory instability in 38 patients

Type*	Preop.	Follow-up
AMRI	2 (4 mm, 5 mm)	8 (4 ≥ 6 mm)
PMRI	1 (4 mm)	4 (5 mm, 7 mm, 8 mm, 10 mm)
ALRI	3 (3 mm, 5 mm, 6 mm)	1 (4 mm)
PLRI	1 (3 mm)	1 (6 mm)

* See text.

veloped PD in the course of the follow-up period of 7 years: two after a Jones repair and one (18 mm) after an "unhappy triad".

Table 5 presents the *rotatory instabilities*. Six patients had rotatory instability preoperatively, equally distributed between medial and lateral instability. Five of these patients had become stable at follow-up (three after conservatively treated ACL ruptures, one after a Jones repair, and one after an LCL repair). Fourteen patients had rotatory instabilities at follow-up. In other words, these instabilities had developed over the years in 13 patients, including 10 with old cruciate injuries. In eight patients the rotatory instability was marked, >6 mm. PMRI was in all cases a sequel to MCL ruptures.

Fifteen out of 38 patients (40 per cent) were completely stable at follow-up.

The clinical result in relation to the score is given in Table 6. Only six out of the 38 patients (16 per cent) had a poor result with annoying loss of function. The median was low – 97 – caused by pain (meniscal symptoms in two patients, chondromalacia/osteoarthritis in four patients) and laxity (four patients: one Jones, one Cho, one modified Ellison, and one ACL suture). Eighteen patients obtained a good final result with a high median score (128 points). Seven of these patients had marked medial rotatory instability (PMRI in four and AMRI in three patients), and the only patient with PD after posterior cruciate ligament injury also belonged to this group.

Table 7 sets out the relationship between the clinical result and the laxity for the three treatment groups. The median total abnormal laxity is stated before and after treatment. It is apparent that the reconstruction group was – in fairness – characterized by considerable preoperative laxity as compared with the other groups. Appreciable reduction of the total laxity was obtained, but in a number of the patients the price paid for the stability has been the development of complaints due to chondromalacia. The alterations of the median total laxity in the three groups were +3 mm, +2 mm and −5 mm, respectively. However, the difference between the groups was not significant ($P > 0.05$, Mann-Whitney U-test).

The spontaneous course of untreated ligament injuries was, as might be expected, increased laxity, but of no major significance in the majority of cases. In the group treated by suture the development of laxity was also marked, but only one patient had a poor result (5-week-old ACL rupture).

Table 6. The subjective results related to clinical score

	0–105	106–121	122–128	Total
Excellent	0	3 128 (median)	15	18
Good	1 115 (median)	11	2	14
Fair 97 (median)	3	3	0	6

Table 7. The clinical results related to the maximum laxity (mean value) in the three therapeutical groups

Group	Good results	Score (points)	Laxity (mm) Preop.	Follow-up
Explor. arthrotomy	11/12	120	5	8
Suture/reefing	12/13	126	4	6
Reconstruction	9/13	117	9	4

DISCUSSION

The present material of old ligament injuries in the knee joint is predominated by isolated injuries. The explanation is that isolated ligament injuries usually cause but few and not very alarming symptoms and are therefore apt to be overlooked, also in the event of total ruptures. This applies particularly to the anterior cruciate ligament, as the intact lateral ligaments may prevent the demonstration of abnormal laxity if the examination is not done with the necessary stress (Butler et al. 1980) or in a sufficiently relaxed patient (Jacobsen 1981).

It has been demonstrated experimentally that ligament suture within 10 days of the trauma affords optimal healing (Kappakas et al. 1978). Therefore, acute repair seems definitely indicated in injuries to the knee ligaments. Indeed, the results after acute repair are good, with complete stability in 55 per cent of the patients (Hejgaard et al. 1982). In the present material 15 patients (40 per cent) were rendered completely stable, but among these were only two from the untreated group.

Straight instabilities were predominantly minor and of no major clinical significance. This was presumably due to a well-preserved function of the collateral ligaments as well as the central ligaments and the reconstructions, all of which are decisive to the valgus/varus and drawer instability (Butler et al. 1980, Grood et al. 1981).

As in acute ligament injuries to the knee, the development of rotatory instabilities is an inevitable sequel, especially after insufficiency of the central ligaments. The role of the collateral ligaments, however, is important as well. Hertel (1980), pointing out the importance of the medial structures, including the posterior oblique ligament, concluded that injuries to these structures are frequently overlooked, as the superficial part of the MCL may be intact. The consequence is said to be abnormal external rotation of the tibia (AMRI). This could not be confirmed by us either in the present or in previous studies (Hejgaard et al. 1982). On the contrary, we found PMRI to be the most common isolated instability after injury to the MCL. Indeed, this seems logical, as the ligament fibres in the posteromedial corner follow an oblique course backwards and distally.

The correct treatment of injuries to the cruciate ligaments has been a matter of much discussion. Acute suture is recommended by several authors (Fetto & Marshall 1980, Hejgaard et al. 1982, Lysholm et al. 1982, O'Donoghue 1959, Palmer 1938), but the results do not differ much from those of conservative treatment (Balkfors 1982, Dandy & Pusey 1982, McDaniel & Dameron 1980). Because of the rapid onset of atrophy in injuries to the mid-substance of the ACL, resection of the cruciate ligament has been recommended (Kennedy et al. 1974), while surgeons in sports medicine recommend acute reconstruction using a modified Jones procedure (Eriksson 1976). In our material there were only minor drawer signs in patients with untreated ACL ruptures, and a marked improvement in stability was obtained on reconstruction of the ligament. Thus, by secondary reconstruction it is possible to obtain a good effect upon the passive instability. However, the clinical result is not consistently good, as several patients developed troublesome chondromalacia after the operation.

In our material it was striking that even marked medial rotatory instabilities were almost symptom-free. The explanations are presumably good quadriceps function in these young athletes and the extensive use of meniscus-preserving surgery.

As the three therapeutic groups are not comparable, we are unable to draw any definite conclusion concerning the treatment of old ligament injuries in the knee joint. However, the course of untreated ligament injuries is better than previously assumed, especially if the menisci are preserved. Simple reefing of medial structures or the simple McMurray tenodesis appear to be effective and gentle methods for correcting valgus instabilities, whereas marked, total instabilities are best treated by central ligament reconstruction. However, uncritical use of major ligament reconstructions should be avoided.

An important item is the indication for ligament reconstruction. For several years, it has been in vogue to carry out a pes anserinus transfer in any troublesome laxity of the knee joint. As pointed out by Chick et al. (1981), medial reconstruction will never afford a good result if there is, at the same time, an (overlooked) insufficiency of the anterior cruciate ligament. In their material not less than 97 per cent of the patients had cruciate ligament insufficiency with consequent instabilities (AD, ALRI). In other words, these patients would have been better off with central or lateral reconstruction.

To be able to decide upon an accurate indication for ligament reconstruction, we therefore recommend an accurate mapping of the instability type preoperatively. For this purpose, gonylaxometry is of inestimable value.

REFERENCES

Balkfors, B. (1982) *The course of knee ligament injuries.* Thesis. University of Lund, Sweden.

Butler, D. L., Noyes, F. R. & Grood, E. S. (1980) Ligamentous restraints to antero-posterior drawer in the human knee. A biomechanical study. *J. Bone Joint Surg.* **62**-A, 259–270.

Chick, R. P., Collins, H. R., Rubin, B. D., Kerlan, R. K., Jobe, F. W., Carter, V. S., Shields, C. L. & Lombardo, S. J. (1981) The pes anserinus transfer. A long-term follow-up. *J. Bone Joint Surg.* **63**-A, 1449–1452.

Cho, K. O. (1975) Reconstruction of the anterior cruciate ligament by semitendinosus tenodesis. *J. Bone Joint Surg.* **57**-A, 608–612.

Dandy, D. J. & Pusey, R. J. (1982) The long-term results of unrepaired tears of the posterior cruciate ligament. *J. Bone Joint Surg.* **64**-B, 92–94.

Ellison, A. E. (1979) Distal iliotibial-band transfer for anterolateral rotatory instability of the knee. *J. Bone Joint Surg.* **61**-A, 330–337.

Eriksson, E. (1976) Reconstruction of the anterior cruciate ligament. *Orthop. Clin. North Am.* **7**, 167–179.

Fetto, J. F. & Marshall, J. L. (1980) The natural history and diagnosis of anterior cruciate ligament insufficiency. *Clin. Orthop.* **147**, 29–37.

Grood, E. S., Noyes, F. R., Butler, D. L. & Suntay, W. J. (1981) Ligamentous and capsular restraints preventing straight medial and lateral laxity in intact human cadaver knees. *J. Bone Joint Surg.* **63**-A, 1257–1269.

Hejgaard, N., Sandberg, H., Hede, A., Skive, L. & Jacobsen, K. (1982) Prospective stress radiographic study of knee ligament injuries in 62 patients treated by acute repair. *Acta Orthop. Scand.* **53**, 285–290.

Hertel, P. (1980) Zur funktionellen Anatomie und Pathophysiologie des Kniebandapparates. *Unfallheilkunde* **83**, 381–388.

Ireland, J. & Trickey, E. L. (1980) MacIntosh tenodesis for anterolateral instability of the knee. *J. Bone Joint Surg.* **62**-B, 340–345.

Jacobsen, K. (1981) Gonylaxometry. Stress radiographic measurement of passive stability in the knee joints of normal subjects and patients with ligaments injuries. Accuracy and range of application. Thesis. *Acta Orthop. Scand.* **52**, Suppl. 194.

Jones, K. G. (1970) Reconstruction of the anterior cruciate ligament using the central one-third of the patellar ligament. *J. Bone Joint Surg.* **52**-A, 1302–1308.

Kappakas, G. S., Brown, T. D., Goodman, M. A., Kikuike, A. & McMaster, J. H. (1978) Delayed surgical repair of ruptured ligaments: A comparative biomechanical and histological study. *Clin. Orthop.* **135**, 281–286.

Kennedy, J. C., Weinberg, H. W. & Wilson, A. S. (1974) The anatomy and function of the anterior cruciate ligament. As determined by clinical and morphological studies. *J. Bone Joint Surg.* **56**-A, 223–235.

Kettelkamp, D. B. & Thompson, C. (1975) Development of a knee scoring scale. *Clin. Orthop.* **107**, 93–99.

Lysholm, J., Gillquist, J. & Liljedahl, S.-O. (1982) Long-term results after early treatment of knee injuries. *Acta Orthop. Scand.* **53**, 109–118.

McDaniel, W. J. & Dameron, T. B. (1980) Untreated ruptures of the anterior cruciate ligament. A follow-up study. *J. Bone Joint Surg.* **62**-A, 696–705.

McMurray, T. P. (1919) The operative treatment of ruptured internal lateral ligament of the knee. *Br. J. Surg.* **6**, 377–381.

Nicholas, J. A. (1973) The five-one reconstruction for anteromedial instability of the knee. Indications, technique, and the results in fifty-two patients. *J. Bone Joint Surg.* **55**-A, 899–922.

O'Donoghue, D. H. (1959) Injuries to the knee. *Am. J. Surg.* **98**, 463–476.

Palmer, I. (1938) On injuries to the ligaments of the knee joint. A clinical study. Thesis. *Acta Chir. Scand.* **81**, suppl. 53.

Correspondence to: Dr. Niels Hejgaard, 27, Henriettevej, DK-2920 Charlottenlund, Denmark.