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PROSPECTIVE STRESS RADIOGRAPHIC STUDY OF KNEE LIGAMENT INJURIES IN 62 PATIENTS TREATED BY ACUTE REPAIR

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A prospective clinical and stress radiographic study comprising 62 patients was performed to assess the value of acute repair of 35 isolated collateral ligament injuries and 27 major injuries. After a follow-up period of 6 years there was no lateral or medial instability in 42 out of 46 patients. This included 31 out of 33 patients in the group with medial collateral ligament injuries. Among the patients with major injuries 16 (60 per cent) had drawer signs, but in only 6 was there significant instability (> 6 mm). In the total material it proved difficult to prevent the development of rotatory instability. This was present in 10 patients preoperatively and in 19 at follow-up. However, this instability was on the whole slight and was experienced as annoying by only 4 patients.

Measurement of passive instability showed that 55 per cent (34/62) had become completely stable, but this applied to only 30 per cent (8/27) of patients with major injuries. The functional end result was unsatisfactory in 8 patients (13 per cent). Although several patients could compensate muscularly for a marked passive instability, there was a significant correlation between instability and functional loss.

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

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The correct treatment of knee ligament injuries is still a controversial subject. If untreated, major injuries may lead to progressive instability and secondary osteoarthrosis (Alm 1974, Jacobsen 1977b). Secondary reconstructive operations have never given consistently favourable results (Ellison 1979, Fetto & Marshall 1980, Hunter et al. 1979, Jacobsen & Rosenkilde 1977, Jones 1980, Kennedy et al. 1978, Lipscomb et al. 1979), whereas active treatment in the acute stage is technically simpler and appears to afford better therapeutic results (O'Donoghue 1955, Liljedahl et al. 1965). In Scandinavia, Palmer, as early as 1938, advocated acute repair of total collateral ligament injuries and injuries involving the cruciate ligaments. However, he realized that even acute ligament repair would give rise to problems: The vascular and nervous supply of the ligaments may be damaged, and this may entail functional loss and passive instability. Because of the numerous unelucidated aspects of this problem, we felt it would be of interest to submit the results of a prospective study on patients subjected to acute repair of isolated or combined injuries to the knee ligaments. We were able to objectively investigate the passive stability before and after the operation using stress radiography.

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PATIENTS

From January 1974 to November 1975, seventy-nine consecutive patients with fresh knee ligament injuries were operated on in our Department. Of them 62 were seen at follow-up. Six were excluded because of a new traumatic injury treated by operation, two had died (cancer, avalanche accident), two had emigrated, and seven could not be persuaded to attend the follow-up. Table 1 lists age, sex, and length of follow-up period. Most of the patients were young men, as the majority of injuries occurred during football or similar contact sports. The injuries were classified into minor injuries, viz. injury only to the collateral ligaments, and major injuries which could be isolated cruciate ligament injuries or combined ligament injuries. Table 2 gives the distribution of the various ligament injuries. The medial collateral ligament was injured in 35 cases, including 15 with total rupture. Of the 20 patients with partial injuries, 9 had a total rupture and 6 a partial rupture of the superficial part, while the deep part was intact. Conversely, 5 patients had a total rupture of the deep part with an intact superficial part of the ligament. Only 5 patients had isolated cruciate ligament injuries, all of the anterior cruciate ligament. Three were partial, one total, and one an avulsion from the tibia. All other cruciate injuries were combined with injuries to the collateral ligament, and all were total. Only one patient in the whole series had rupture of a meniscus. The remainder had pure ligament injuries, although a number had instability of the menisci because of injury to the collateral ligament and simultaneous injury to the capsule.

All the operations were performed within 2 weeks of the trauma (1–12 days, median 4 days) by the same surgeon (K. J.). All the injuries were carefully exposed and sutured with silk or wire. Arthroscopy was not performed. Postoperatively the patients wore a high circular plaster cast in which they were mobilized without support for 6 weeks, whereupon active exercises and training were instituted.

Table 1. Age, sex and observation time of 62 patients

Number of patients	62	(51♂ 11♀)
Age (years)	13–67 25	(range) (median)
Observation time (years)	5.0–6.8 6.0	(range) (median)

Table 2. Type of injury diagnosed in 62 patients at operation

Site of injury	Number
MCL	35
ACL	5
ACL+MCL	13
PCL+MCL	3
PCL+LCL	2
ACL+PCL+MCL	3
ACL+PCL+MCL+LCL	1
Total	62

MCL: Medial collateral ligament, LCL: Lateral collateral ligament, ACL: Anterior cruciate ligament, PCL: Posterior cruciate ligament.

METHOD

Stress radiographic measurements were carried out preoperatively and at follow-up using a gonylaxometer as previously described by Jacobsen (1976, 1977a, 1978). Medial and lateral instability was measured on a-p views with the knees in 20° flexion (neutral position 160°) and a 9 kg stress (abduction and adduction) on both knees at the same time. Drawer signs and rotatory instabilities were measured with 90° flexed knees and the foot fixed in the neutral position pointing straight forward (neutral position 90°) during 30 kg stress. By this means, eight different types of instability could be measured 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 (PMRI), antero-lateral (ALRI), and postero-lateral rotatory instability (PLRI). Abnormal instability was taken to be present 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 taken to be present 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 instabilities. So-called complex rotatory instability was defined as a rotation of more than 3 mm combined with a more than 3 mm drawer sign (Jacobsen 1978).

In the further evaluation of the final operative result at the end of the follow-up period, we used a non-equidistant rank scale with 17 subgroups and a score ranging from 0 to 128 points (modified after Kettelkamp & Thompson 1975). This scale had primarily been developed for assessing osteoarthrotic knees. Therefore, most emphasis was on functional loss during weight-bearing while walking, while passive instability resulted in relatively less loss of points. Nevertheless, we found that this accepted scale was applicable to our material of young, active persons in whom loss of function on weight-bearing and during direction changing while running was considered of importance.

The patients' opinion of the results was divided into: Excellent (no complaints, completely normal function),

good (minor sensation of instability, occasionally pain on weight-bearing, slight functional loss), and poor (pain and instability restricting function, considerably reduced strength). For each of these three groups the median score was calculated. Lastly, the sum of the "total" instabilities measured was correlated with the Kettelkamp score in order to assess the role of passive instability on knee function.

RESULTS

Table 3 gives the types of instability as measured by stress radiography in patients with minor injuries. Thirty-three patients had preoperative valgus instability of from 3 to 9 mm. The least marked instability was found in patients with isolated injury to the deep part of the medial collateral ligament and the most marked in patients with total, distal injuries to the superficial part at the site of the insertion beneath the pes anserinus. Proximal, epicondylar injuries were rare – there were only five – and the instability amounted to only about 6 mm in these cases. Only 4 patients had rotatory instability, but of moderate severity, and none was complex. All 4 had total rupture of the medial collateral ligament and a tear of the posterior oblique ligament. At follow-up nearly all the patients had acquired medial/lateral stability, only two having persistent ML, but of a negligible amount (4 mm). On the other hand, 9 patients had rotatory instability, as against 4 preoperatively. Two patients had AMRI (4 and 5 mm) as sequelae to rupture of the superficial part of the medial collateral ligament. Seven patients developed PMRI, a peculiar instability in these isolated injuries to the medial collateral ligament. However, these rotatory instabilities were very slight – only up to 5 mm. Only 4 patients in this group with minor injuries did not achieve a top score on the Kettelkamp scale.

Table 3. Type of instability in 35 isolated MCL injuries

Type*	Preop.	Follow-up
ML	33 (3–9 mm)	2 (4 mm)
LL	0	0
AMRI	3 (<4 mm)	2 (4 mm, 5 mm)
PMRI	1 (4 mm)	7 (<5 mm)

*See text.

Table 4. Type of straight instability in 27 major injuries

Type*	Preop.	Follow-up
ML	13 (6–18 mm)	2 (3 mm, 6 mm)
LL	2 (4 mm, 21 mm)	0
AD	9 (all ≥ 6 mm)	10 (4 ≤ 5 mm, 2 = 6 mm, 4 > 6 mm)
PD	7 (5 ≥ 6 mm)	6 (2 > 6 mm)

*See text.

Table 4 sets out the drawer signs as well as the valgus/varus instabilities in patients with major injuries. Preoperatively one-third (9/27) had a marked AD (> 6 mm). At follow-up the AD had disappeared in 2, decreased in 7, while 3 with no drawer sign preoperatively had developed a minor AD (< 5 mm). All the patients with AD had had injuries to the anterior cruciate ligament plus injury to at least one additional ligament (6 medial collateral ligament, 2 posterior cruciate ligament + lateral collateral ligament, 1 posterior cruciate ligament + medial collateral ligament).

Out of the 5 patients with isolated anterior cruciate ligament injuries none had preoperative AD. Only one had ALRI which is otherwise considered characteristic of isolated anterior cruciate ligament injury. This was the only one of the 5 patients who was not symptom-free at follow-up, having developed a tendency to anterolateral subluxation ("jerk").

PD was a constant phenomenon in the 9 patients with injuries to the posterior cruciate ligament. This was an injury invariably combined with others (cf. Table 2). These instabilities were considerable – up to 15 mm. Although they had subsided somewhat at follow-up – in 2 patients completely – more than half (5/9) had complaints of instability and pain on weight-bearing.

ML and LL were usually marked preoperatively – up to 18 mm ML and 21 mm LL. However, as in the group of minor injuries, satisfactory correction of the lateral and medial instabilities was achieved, only 2 patients having a minor residual instability (ML 3 and 6 mm).

Rotatory instability was more difficult to

Table 5. Type of rotatory instability in 27 major injuries

Type*	Preop.	Follow-up
AMRI	1 (4 mm)	4 (4 mm)
PMRI	1 (5 mm)	1 (same, 6 mm)
ALRI	2 (5 mm)	2 (4 mm)
PLRI	2 (6 mm)	3 (5, 6, 9 mm, heavy inj.)

*See text.

handle (Table 5). Preoperatively it was present in almost one-quarter of the patients (6/27) and at follow-up in more than one-third (10/27). Of the 4 patients with AMRI only one was symptom-free. The other 3 had, apart from the AMRI, also AD – i.e. complex AMRI – as sequelae to ruptures of the medial collateral ligament + anterior cruciate ligament. The only patient having PMRI – after an injury to the medial collateral ligament + posterior cruciate ligament – was symptom-free at follow-up and had no other types of instability. ALRI was found in 2 patients, one of whom was the patient mentioned above with a jerk phenomenon after isolated anterior cruciate ligament injury. The other one had ALRI + PLRI as sequelae to injury to the medial collateral ligament + anterior and posterior cruciate ligaments, which entailed annoying instability. All the patients with PLRI were in an unfortunate situation, as this instability occurred only after rupture of three or more ligaments; in other words, the knee had been dislocated at the moment of the trauma. The patient having rupture of all four ligaments developed a permanent peroneal palsy as a result of the dislocation.

Table 6 presents the clinical result of the operations in relation to the score. Forty-two patients had no complaints at all (68 per cent), and indeed the median for this group was high, viz. the maximum score of 128. The lowest score, viz. 95, was found in a patient with injury to three ligaments. However, this patient was symptom-free, although his score was low on account of marked passive instability.

The next group of patients, in whom the result was designated "good", had varying degrees of minor complaints, such as intermittent pain on weight-bearing and a sensation of laxity. Their median score was 115.

Finally, 8 patients had a poor end-result. Their median score was 97, due to pain, instability, subluxation, and reduced strength. However, one patient of this group achieved a score of 122, thanks to full stability and strength (MCL rupture), but her activity was inhibited by pain which was presumably a sequel to deep venous thrombosis.

On the whole, patients with stable knees achieved good function, although there were ex-

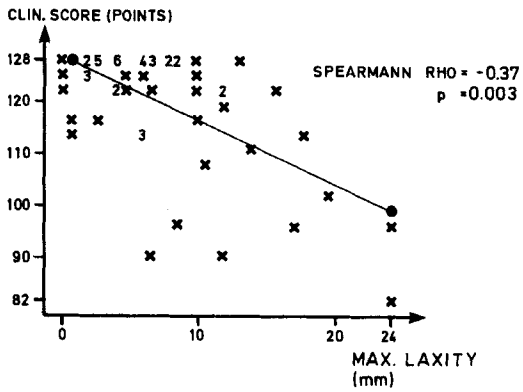

Figure 1. Scatter diagram showing the correlation between clinical score and maximal laxity.

Table 6. The subjective results related to clinical score

	0–105		106–121		122–128	Total
Excellent	1		6	128 (median)	35	42
Good	1	115 (median)	9		2	12
Fair	97 (median) 5		2		1	8

ceptions. Conversely, several patients were able to compensate muscularly for a marked passive instability. Nevertheless, there was a significant correlation between instability and score (Figure 1, non-parametric correlation test).

DISCUSSION

Only 8 out of 62 patients (13 per cent) exhibited such marked dysfunction in the knee that the result had to be designated "poor". Measurement of passive instability showed that 34 (55 per cent) had become completely stable. True, this included only 8 of the 27 patients with major injuries. The medial collateral ligament injuries were rewarding therapeutic objects – healing with only minor instability or none at all. On the other hand, minor rotatory instabilities had arisen, presumably because of weakened capsule and ligaments in the posteromedial corner. This area, including the semitendinosus insertion, may be difficult to inspect at the operation, unless an unreasonably large exposure is made. Empirically too, minor ligament laxities have a tendency to increase in the course of a 5- to 6-year follow-up period. Moreover, PMRI is a form of rotatory instability which has not yet received much attention in the literature. It may easily be imagined to be more common than observed so far.

Drawer signs were almost constant sequelae to major injuries, viz. those involving the cruciate ligaments. In our material a drawer sign persisted in 60 per cent (16/27), but only 6 of them exceeded 6 mm, approximately the limit at which complaints occur (Jacobsen 1977a). When bearing in mind that about 90 per cent of the resistance to drawer instability in an intact knee is due to the cruciate ligaments (Butler et al. 1980), even a very slight posttraumatic atrophy may result in drawer instability. Among our 5 patients with isolated anterior cruciate injury only one developed AD (5 mm), and he was symptom-free. A large proportion of the patients with combined ligament injuries developed rotatory instability, particularly marked after injuries to the posterior cruciate ligament and the postero-lateral corner. As these structures contribute by about 60 per cent to the total stability-preserving strength (Butler et al. 1980), it is obvious that insufficient healing may lead to instability. The explanation for the instabilities may be a too early and too violent training programme after too short a time in a plaster cast. Injured ligaments require about 3 months to regain their full strength, so that long-term plaster casts must be recommended after major ligament injuries in the knee joint. Hinge plaster casts, permitting a 20–60° mobility, are reported to be a good type of bandage (Helbing & Burri 1980).

Within the total material (Tables 3 and 4) only 9 per cent (4/46) had a slight residual laxity (ML) at follow-up. Jonasch (1958) found the same percentage of ML in similar measurements in his follow-up on 453 patients treated conservatively (3–6 months in a plaster cast). Jonasch did not measure drawer signs, but clinically 34 per cent of his patients had persistent drawer instability at follow-up. By comparison, our measurements showed 26 per cent (16/62) with drawer signs, but these were major (> 6 mm) in only 10 per cent (6/62). Thus, operation appears to offer an advantage over conservative treatment, but not as striking as might be expected.

We must conclude that primary repair of acute knee ligament injuries results in a functionally favourable result in 85 per cent. Annoying rotatory instability often developed after injuries to the cruciate ligaments + one or more collateral ligaments.

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