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Posterior cruciate ligament injuries

We have studied 48 patients with posterior cruciate ligament injury and 14 knees from fresh frozen cadavers. A diagnosis of posterior cruciate ligament injury was made by the sag and posterior drawer signs and stress x-ray films, the latter being useful in the grossly swollen and multiple ligament-injured knee. For avulsion injury, surgical management gave the best results. Other isolated posterior cruciate ligament injuries did well conservatively. When posterior cruciate injury is part of a multiple ligament injury, the nature of the associated ligament injury and that of the posterior cruciate determine the type of treatment; the posterior cruciate ligament is not more important than other knee ligaments.

Key words: posterior cruciate ligament.

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Contradictory observations have been recorded regarding: 1) the importance of the posterior cruciate ligament; 2) the existence of isolated posterior cruciate ligament injuries; 3) the diagnosis of the injury; 4) its prognosis; and 5) the morphology of the ligament.

Kennedy & Grainger (1967), Hughston (1969) and Kennedy et al. (1977) attribute the role of primary stabiliser of the knee to the posterior cruciate ligament. Balkfors (1982), however, found the disability resulting from posterior cruciate ligament injuries to be similar to that of other knee ligament injuries.

Isolated avulsion injuries of the posterior cruciate ligament have been described by Trickey (1968), Torisu (1977) and Meyers (1975). This, however, does not preclude the existence of isolated ruptures in the substance of the ligament. Welsh et al. (1971), and Noyes et al. (1974) have shown by experimental studies that with greater strain rates the point of tendon or ligament disruption shifts from the bony attachment to the substance of the ligament itself. Hughston (1969) believes that posterior cruciate ligament injuries are always associated with injuries to other knee ligaments.

Although the sag sign and the posterior drawer sign have been described as being the most reliable for diagnosis of posterior cruciate injuries, Ellison (1977) claims that they may be masked in the acute period. Hughston et al. (1980) suggest using abduction and adduction stress in extension. Instability indicates posterior cruciate ligament injury.

Hughston et al. (1980) and Moore & Larson (1980) advocate surgical management of all posterior cruciate ligament injuries but this has been challenged (Hall 1980). There are no reports of posterior cruciate ligament injuries treated non-surgically.

Major differences exist in descriptions of the morphology and function of the posterior cruciate ligament (Brantigan & Voshell 1941, Hughston et al. 1980).

Patients and methods

Between 1971 and 1980, 65 cases with posterior cruciate ligament injury were managed at our department. Of these, 48 patients were reviewed in 1980–81. The majority were young men; 22 of the patients sustained their injuries in motor-cycle accidents and nine in sports. The mean follow-up period was 4 (1–10) years.

Twenty-five cases were first seen within 2 weeks of injury (acute) and 23 cases were seen later. In most cases the diagnosis was based on a posterior drawer or sag sign. In four acute cases, the sag sign was obscured by swelling around the knee and a false anterior drawer sign was present. In these, stress films were done to demonstrate posterior subluxation before the diagnosis was accepted. The technique for stress films is illustrated in Figure 1.

Eighteen cases had avulsion injuries of the posterior cruciate ligament and 30 cases had clinically

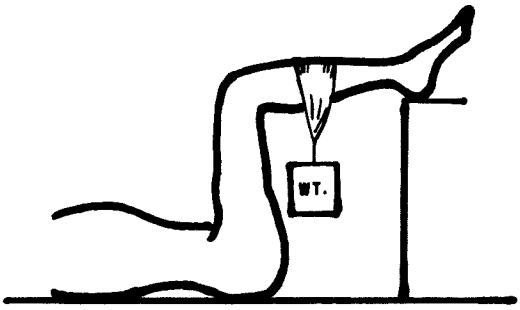

Figure 1. Stress film technique. The weight used is approximately 1/10 of the body weight. Lateral films of the knee are taken after a lapse of 1–2 min to allow for muscle relaxation. The contralateral knee is used as the control. To standardise magnification the x-ray tube to film distance was kept at 1 metre.

diagnosed attenuation or tear. The number of cases with associated ligament injuries at initial presentation could not be assessed because of lack of documentation in the earlier cases. Avulsion injuries with displaced fragments were operated unless the patient refused surgery. The posterior approach (Trickey 1968) was used. Pins and later screws were used for fixation of the fragments.

For ligament tears, surgery was undertaken less frequently.

At the final review, patients were assessed for posterior subluxation, other instabilities, functional recovery and subjective disability. Seventeen patients with ligament tears treated conservatively also had stress films done to quantitate posterior subluxation. Three patients with posterior subluxation who recovered functionally had cineradiography of the knee to demonstrate dynamic stabilisation of the knee by the quadriceps and gastrocnemius muscles.

The results were grouped into four categories. An *excellent* result had no posterior subluxation or disability and achieved pre-injury functional status. Posterior subluxation was present in all other categories. Cases with good result also achieved pre-injury functional status and had minimal, if any disability. A *fair* result meant no disability with activities of daily living but mild to moderate disability with recreational and other physical activities. Disability in performing activities of daily living was categorised as a *poor* result.

In addition to the patient study, 14 knees from fresh frozen cadavers were dissected. The morphology and orientation of fibres of the posterior cruciate ligament were studied in 11 knees. The functional instability following division of the ligament was studied in six knees. In three knees we studied the change in length of the fibres of the posterior cruciate ligament with flexion of the knee. Access to the ligament to measure its length (with a vernier caliper) was obtained by osteotomising the lateral femoral condyle (with a saw) and reflecting it. The anterior cruciate and lateral collateral ligament insertions to the lateral condyle were left intact. This enabled us to clamp the lateral condyle back to the femur and flex or extend the knee between measurements without abnormal motion occurring at the knee.

Results

In the majority of patients the status at review was excellent in avulsion injuries (Table 1) and good in ligament tears (Table 2).

Four of the 38 cases with residual posterior subluxation manifested abduction/adduction instability in extension. These were cases with multiple ligament injuries.

In 11 cadaveric knees we found the fibre orientation of the posterior cruciate ranged from anterolateral to posterior medial. These fibres were intimately fused. In three knees where the posterior menisco-femoral ligament was absent, an additional separate band of fibres was observed. The results from a sample specimen showing variation in length of the

Table 1. Avulsion injuries of the posterior cruciate ligament – results of treatment

Result/ Treatment	Excellent	Good	Fair	Poor	Total
Surgical	10	3	–	–	13
Conservative	–	4	1	–	5
Total	10	7	1	–	18

Table 2. Ligament tears of the posterior cruciate ligament – results of treatment

Result/ Treatment	Excellent	Good	Fair	Poor	Total
Surgical	–	2	1	–	3
Conservative	–	21	6	–	27
Total	–	23	7	–	30

Table 3. Distance, measured in mm, between points of attachment of the fibres of the posterior cruciate ligament in a sample specimen

Degrees of flexion/ Fibres	0°	30°	60°	90°	120°	150°
Anterolateral	39	41	42	42	42	41
Posteromedial	34	29	27	30	33	34

Table 4. Instability after division of the posterior cruciate ligament recorded as mean of six cadaver knees

Specimen no./ Anterior-posterior motion (mm)	1	2	3	4	5	6
Normal	1	3	3	2	1	2
After division of posterior cruciate	20	15	18	12	17	18

anterolateral and posterior medial fibres with flexion of the knee is shown in Table 3.

The anteroposterior motion noted in six knee specimens after division of the posterior cruciate ligament ranged from 12 to 20 mm (Table 4).

Discussion

Our study does not substantiate the claim that the posterior cruciate ligament is the prime stabiliser of the knee. Patients with isolated injury recovered significantly and their residual disability did not exceed that of other knee ligament injuries, reinforcing the report of Balkfors (1982). We now regard all knee ligaments including the posterior cruciate ligament as equally important.

Our cadaveric study revealed that the posterior cruciate ligament is a single band and not made up two separate bands as suggested by Hughston (1980). The additional band of fibres noted in 3 of the 11 cadaveric knees is probably the vestige of the menisco-femoral ligament. The variation in length of the anterolateral and posteromedial fibres of the posterior cruciate ligament with flexion of the knee indicates that not all of the ligament becomes taut in a particular position of flexion, confirming the findings of Brantigan & Voshel (1941).

Thirty-four isolated posterior cruciate ligament injuries in our clinical study establish its occurrence. We believe this entity is underdiagnosed. Patients recover significantly by adaptation and the instability becomes evident only with strenuous activities. Three of our cases were first identified months after their injury during military training.

We rely on the sag and posterior drawer signs for diagnosis of posterior cruciate injuries. Our cadaveric study confirms that once the posterior cruciate ligament is divided a posterior drawer or sag sign will be present when the knee is flexed. Butler et al. (1980) showed that the posterior cruciate ligament is the most essential restraint to posterior subluxation of the tibia. In the acute period quadriceps spasm may prevent sagging of the tibia, or swelling around the knee may obscure the sag sign.

Abduction/adduction instability in extension (Hughston 1980) was of no value in isolated posterior cruciate ligament injury.

Trickey (1968), Torisu (1977) and others have recorded excellent results following surgical treatment of avulsion injuries, as we did. We strongly advocate that avulsion injuries of the posterior cruciate ligament be treated surgically with fixation of the fragment.

Our results of cases of ligament tear, treated conservatively, compare favourably with reports presenting the results of surgical treatments (Hughston et al. 1980, Moore & Larson 1980). This we feel is because ligament repair in the intercondylar region is difficult and hence the healing is never satisfactory. Further, the loss of the posterior cruciate ligament could be compensated by dynamic stabilization of the knee. The majority of the patients surgically treated by Moore & Larson (1980) had posterior drawer or sag sign at the final review. Despite this, a majority were rated excellent or good.

The most significant determinant of the outcome in the conservatively treated cases was the presence or absence of associated ligament injuries. All six with a fair result had associated ligament injury, compared with 3 of

the 21 with a good result. Accepting a fair result as unsatisfactory, we now surgically manage cases of posterior cruciate ligament injury with other associated ligament injury. The degree of posterior subluxation noted clinically and radiologically did not correlate well with the results in the 27 conservatively treated cases with ligament tears.

To establish a basis for the good results in cases treated conservatively, we considered the existence of an alternative support in the dynamic state to prevent posterior subluxation. It is our opinion that the quadriceps femoris and gastrocnemius serve this function.

We found that whenever a patient with a positive sag sign tries to extend his knee against resistance, by contracting his quadriceps, the tibia relocates. Should he dorsiflex his foot simultaneously and contract his gastrocnemius, the relocation is more dramatic. If he then relaxes his gastrocnemius and quadriceps and contracts his hamstrings, the tibia subluxates again. This was demonstrated in three cases with cineradiography. The quadriceps femoris and gastrocnemius hence act as dynamic stabilisers of the knee in the absence of the posterior cruciate ligament. We advocate the selective strengthening of these two muscles for optimal results.

A number of our patients, who initially complained of disability on climbing stairs and inclines, became able over a period of 6 months to a year to run up and down stairs with no disability. We believe this improvement to be due largely to a subconscious adaptation of the dynamic stabilisers in maintaining the stability of the knee.

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