SLEEVE FRACTURES OF THE PATELLA IN CHILDREN

A REPORT OF THREE CASES

G. R. HOUGHTON, C. E. ACKROYD

From Nuffield Department of Orthopaedic Surgery, Radcliffe Infirmary, Oxford

The clinical characteristics of sleeve fractures of the patella are described and the methods of treatment are reviewed. Attention is drawn to the fact that the diagnosis may be missed because the distal bony fragment may be so small as not to be detectable by radiography. This is important because a large fragment of articular cartilage also separates. The best result was obtained from reconstitution of the extensor apparatus by internal fixation of the patellar fracture with repair of the quadriceps expansion.

Avulsion fractures of the lower pole of the patella with wide separation of the fragments occur uncommonly in children. An extensive sleeve of cartilage is pulled off the main body of the bony patella, together with a bony fragment from the distal pole. This injury has received little attention in the English literature.

When the patellar tendon disrupts in children it usually does so at either the upper or lower end rather than interstitially (Peterson and Stener 1976). Although avulsion of the tibial tubercle has been reported (Holstein, Lewis and Schulze 1964), avulsion of the lower pole of the patella is more usual (Blount 1954; Rockwood and Green 1975) and rarely a fracture of the body of the patella may occur (Belman and Neviaser 1973). The injury is not recorded by some authors (Tachdjian 1972; Rang 1974) and its occurrence denied by others (Pollen 1973).

CASE REPORTS

Case 1. In July 1975, an eight-year-old girl sustained an injury to the right knee while hurdling. As she was about to jump a hurdle with the left leg leading, the child collapsed with pain in the right knee. The right knee was not struck directly. When seen in the Accident Service there was a moderate effusion of the knee, the right patella was riding high and a gap was palpated at the lower end of the patella (Fig. 1). The lateral radiograph (Fig. 2) did not show any bony avulsion. At operation on the day after injury, it was noted that three-quarters of the articular cartilage of the patella and a corresponding portion of the retinacular ligament were avulsed, together with a small fragment of bone.

The articular cartilage and lower fragment were reconstituted anatomically with catgut, secured by transosseous sutures to the body of the patella. The extensor expansion was repaired. After operation the wound became infected and there was disruption of the repair. Ten days after operation the knee was re-explored and necrotic fibrous tissue excised and the extensor mechanism reconstituted with nylon. Despite rest and chemotherapy a sinus persisted, and ten weeks after injury a tomogram (Fig. 3) showed that the body of the patella was


Request for reprints should be sent to Mr C. E. Ackroyd.

Fig. 1
Case 1. Figure 1—Anteroposterior radiograph of both knees showing elevation of the right patella. Figure 2—Lateral radiograph of the right knee showing a high-riding patella with effusion in the joint. No bony fragment is visible. Figure 3—Tomogram showing avascularity of the body of the patella with avulsion of the lower pole, not visible on initial radiographs.

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avascular and the fragment had separated widely. Three months after injury the patella was excised and the extensor apparatus reconstituted with a wire suture. A discharging sinus persisted and one year later the wire was removed. When reviewed three years after injury she had satisfactory function; but there were 15 degrees of extension lag with flexion to 110 degrees.

**Case 2.** In June 1975, a nine-year-old schoolgirl was high-jumping, leading with the left leg, when she experienced pain in the right knee on take-off. She was seen in the Accident Service the same day when it was found that the right knee was swollen, with a tense haemarthrosis and pain in the region of the patella. A radiograph (Fig. 4) showed a fracture of the lower pole of the patella. Twenty-three millilitres of blood were aspirated from the knee, and the joint was immobilised in a Robert Jones bandage. She was seen one week later when the knee was immobilised in a plaster-of-Paris cylinder for two weeks. She was then allowed to mobilise the knee and taught a programme of quadriceps exercises. By the fifth week she had no pain in the knee, was back at school and walking normally. There was a small effusion in the knee, marked wasting of the quadriceps muscles and 10 degrees of quadriceps lag with free flexion to the full range.

In December 1975 her general practitioner referred her to the Fracture Clinic because of persistent deformity of the knee. She had no symptoms and was able to carry out normal sporting activities. A radiograph showed that the fragments had remained separated and that bone had filled the defect (Fig. 5).

When reviewed two years after the injury, she had no symptoms and was fully active and able to carry out all sporting activities, although conscious of the prominence of the patella. On examination there was no effusion, the patella was fully mobile although rather large. There was moderate wasting of the quadriceps with an extension lag of 5 degrees and free flexion to 150 degrees. The radiograph (Fig. 6) showed that the patella was enlarged with reconstitution of the lower pole and a subchondral defect in the central area of the patellar articular surface.

**Case 3.** In December 1977, a twelve-year-old schoolboy riding a skateboard developed sudden pain in the left knee while propelling the board with the left foot on the ground. He fell to the ground and was unable to walk. There was no direct blow to the knee. When seen in the Accident Service there was a tense haemarthrosis of the knee and a gap could be palpated at the lower end of the patella. He was unable to extend the knee fully. The radiograph showed an avulsion fracture of the distal pole of the patella (Fig. 7).

The findings at operation on the day of injury showed that the avulsed fragment consisted of a large sleeve of articular cartilage and fragment of bone (Fig. 8). The fracture was reduced and held with two Kirschner wires and a tension band wire (Fig. 9). The quadriceps expansion was repaired with polyglycolic acid (Dexon) sutures. After operation, the knee was immobilised in a plaster-of-Paris cylinder for two weeks. At four months there was a full range of pain-free movements of the knee and the metal was removed. When reviewed six months after injury he was fully active with no clinical abnormality of the knee. A radiograph showed that the fracture had united in an excellent position with good reconstitution of the subchondral bone (Fig. 10).

**CLINICAL CHARACTERISTICS**

All our cases occurred in children participating in sporting activities requiring vigorous extension of the knee. The diagnosis was suggested by the absence of a direct blow to the knee with sudden giving way, severe pain in the knee and an inability to bear weight. On examination there was a tense effusion and no active extension at the knee was possible. The patella was high-riding on the affected side and a palpable gap could be felt in the extensor mechanism at the distal pole of the patella. This was a valuable clinical sign as the fragment of bone avulsed could be so small as not to be detectable by radiography (Case 1).

**RADIOLOGICAL APPEARANCES**

An effusion and a high-riding patella was confirmed radiologically and a small fragment avulsed from the lower pole of the patella was usually seen. In Case 2, where the girl was treated without an operation, a defect of the body of the patella developed at the site of avulsion of the cartilaginous sleeve (Fig. 6).

**DISCUSSION**

The sleeve fracture of the patella occurred in children who were taking part in activities requiring forceful extension of the knee, with the quadriceps contracting against resistance. The association between avulsion injuries of the patella and high-jumping has been noted.
by previous authors (Beddow, Corkery and Shatwell 1963; Weigert 1968; Sugiuira and Kaneko 1972). The mechanism of the injury in each of our patients was witnessed by a parent or teacher and in each case the injury occurred in the "take-off" leg. In no instance was there direct trauma to the knee.

Although diagnosis may be difficult in the presence of pain and a tense haemarthrosis, an awareness of the injury together with the characteristic radiological features should lead to the diagnosis.

The avulsed patellar fragment always includes an important "sleeve" of cartilage and this must be accurately reduced in order to re-establish the articular surface of the patella. Reconstruction of the extensor apparatus with absorbable sutures (Beddow et al. 1963; Wilson 1976) did not give a satisfactory result in Case 1. The reconstruction of the extensor apparatus was not rigid, and infection with damage to the nutrient vessels of the patella (Scapinelli 1967) led to disruption of the wound and avascular necrosis of the patella.
Although splinting the limb in extension leads to reconstitution of the extensor apparatus, there is likely to be marked deformity of the patella with restriction of movement (Bensahel and Sprung 1970; Wilson 1976). This was our experience in Case 2.

Rigid internal fixation of the fracture maintains an anatomical reduction with re-alignment of the articular cartilage. If the avulsed fragment is small, it may be secured by a tension band wire (Case 3). With rigid fixation, active flexion of the knee is commenced as soon as the wound is healed and a normal range of movement of the knee is to be expected within several weeks.

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