Sleeve fracture of the patella in children

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ABSTRACT
Purpose. To report the diagnosis, treatment, and outcomes of sleeve patellar fractures in children.
Methods. Records of a consecutive series of patients with sleeve patellar fractures were retrospectively reviewed.
Results. Of the 11 children (8 boys and 3 girls; mean age, 12 years), 6 had minimally displaced fractures (1–2 mm) and were managed by cylindrical plaster of Paris immobilisation, whereas the other 5 with severely displaced fractures underwent open reduction with tension band wiring. The mean follow-up period was 10 (range, 3–36) months. All patients obtained full extension of the knee except one (with an extension lag of 10 degrees). No patient complained of pain or discomfort of the involved knee.
Conclusion. Sleeve patellar fractures in children are uncommon. Diagnosis can be missed, especially in those with a very small avulsed bony fragment. For undisplaced fracture, conservative management can achieve good results. For severely displaced fractures, early surgical intervention is effective.
Key words: child; fractures, bone; patella

INTRODUCTION
The patella is a sesamoid bone and considered part of the quadriceps extensor mechanism. Ossification of the immature patella starts at 3 to 6 years of age. The incidence of patellar fracture in skeletally immature patients is low, comprising only about 6.5% of all such fractures. However, among skeletally immature children, the sleeve patellar fracture is the most common type. It can be easily missed on plain radiographs; only a small fragment of bone may be seen. This bony fragment is accompanied by a separation of a large fragment of articular cartilage, that can be detected by magnetic resonance imaging. In severely displaced sleeve fracture, open reduction and internal fixation is mandatory in order to achieve a good outcome. Conservative

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management may result in weakness of the extensor mechanism associated with patella alta and ossification of the patellar tendon.\textsuperscript{6,7} We report the diagnosis and treatment outcomes of sleeve patellar fractures in 11 children.

\section*{MATERIALS AND METHODS}

Records of 11 consecutive children (8 male and 3 female) aged 9 to 13 (mean, 12) years with sleeve patellar fractures presenting between October 1997 and June 2005 were reviewed. Each patient’s age, sex, mechanism and place of injury, time of presentation, initial diagnosis, treatment outcome, knee function, and presence of pain or discomfort were recorded (Table). The extent of fracture displacement was measured on radiographs and classified as undisplaced, minimally displaced (1–2 mm, Fig. 1), or severely displaced (with a palpable gap in the lower pole of the patella, Fig. 2). Adequacy of reduction and the status of the distal patellar pole were assessed by comparing anteroposterior and lateral radiographs of the latest follow-up with those obtained before treatment.

All injuries were secondary to a fall: at school during sports or in the playground (n=9), or slipping at home (n=1), or fall from a motorcycle (n=1). Nine patients presented on the day of injury, one a day later, and another after a week. Eight patients injured the left knee and 3 the right. The diagnosis was correct in 8 patients; 3 patients were initially misdiagnosed as having cellulitis, post-traumatic knee effusion, and a distal femoral physeal injury.

\begin{table}
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\caption{Patients’ characteristics, diagnoses, and outcomes}
\begin{tabular}{|l|l|l|l|l|}
\hline
\textbf{Patient No.} & \textbf{Sex/age (years)} & \textbf{Injury mechanism} & \textbf{Injured side} & \textbf{Diagnosis} & \textbf{Follow-up (months)} & \textbf{Outcome} \\
\hline
1 & M/13 & Fell while doing pull-ups & Left & Severely displaced patella sleeve fracture & 12 & Excellent \\
2 & F/11 & Fell off monkey bars & Left & Severely displaced patella sleeve fracture & 14 & Good \\
3 & F/12 & Fall from a height & Right & Severely displaced patella sleeve fracture & 12 & Excellent \\
4 & M/13 & Injured during long jump & Right & Severely displaced patella sleeve fracture & 9 & Good \\
5 & M/12 & Injured during high jump & Left & Severely displaced patella sleeve fracture & 36 & 10\textdegree extension lag \\
6 & M/12 & Fell at school & Left & Undisplaced inferior pole patellar fracture & 12 & Good \\
7 & M/12 & Motorcycle accident & Left & Undisplaced inferior pole patellar fracture & 3 & Excellent \\
8 & F/11 & Fell off monkey bars & Left & Undisplaced inferior pole patellar fracture & 3 & Excellent \\
9 & M/3 & Knee hit against the wall & Left & Minimally displaced inferior pole patellar fracture & 3 & Excellent \\
10 & M/12 & Fall after colliding with other & Right & Minimally displaced inferior pole patellar fracture & 3 & Excellent \\
11 & M/11 & Fell while running & Left & Undisplaced inferior pole patellar fracture & 3 & Good \\
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\end{table}

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{figure1}
\caption{Radiographs of a minimally displaced sleeve patellar fracture; the distal fragment is indicated by arrows.}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{figure2}
\caption{Radiographs of a severely displaced sleeve patellar fracture; the distal fragment is indicated by arrows.}
\end{figure}
RESULTS

The extent of displaced fracture was minimal in 6 patients (treated with cylindrical plaster of Paris immobilisation for 4 to 6 weeks) and severe in 5 patients (treated with open reduction and internal fixation with tension band wiring for 3 to 6 months, Fig. 3). Four patients underwent surgery within 24 hours; one neglected patient underwent surgery 4 weeks after injury and the diagnosis was made on follow-up radiographs (when callus was noted within the avulsed fracture site).

The mean follow-up period was 10 (range, 3–36) months. All patients achieved full extension of the knee except the neglected patient, who had an extension lag of 10º. No patient complained of pain or discomfort.

DISCUSSION

Patellar fracture in skeletally immature patients is uncommon, as secondary ossification of the patella does not start until 5 to 6 years of age, and children are less likely to expose their knees to severe forces. Moreover, the immature patella is surrounded by a thick layer of protective cartilage making it more resilient. This explains the low incidence of patellar fracture in children (accounting for <1–6.5% of all such fractures). However, in children sleeve fracture is the commonest type (accounting for 38% to 42% of patellar fractures); 11 (73%) of our 15 patients had sleeve fractures.

Avulsion fractures of the patella are classified according to their location; any segment of the patellar periphery can be involved. A sleeve fracture is defined as an avulsion of a small bony fragment from the distal pole of the patella, together with its articular cartilage, periosteum, and retinaculum, which is pulled off from the main body of the structure. The fracture is caused by an acute injury due to the powerful contraction of the quadriceps with the knee flexed during sports activity.

Avulsion fractures with a large osseous fragment are obvious on radiographs, but in some cases they are easily missed, because only a minimal portion of bone is avulsed and the fragment is largely composed of un-ossified peripheral cartilage. Two cases were reportedly undetected for 2 months. Magnetic resonance imaging is capable of identifying avulsion of the inferior pole of the patella, and is recommended when there is a high index of suspicion.

Eliciting a detailed mechanism of injury and thorough clinical and radiological examination may help in making the diagnosis. In severely displaced fractures, a palpable gap may be present at the inferior pole of the patella but could be difficult to assess in a very swollen knee. Lateral radiographs may show a high-riding patella and a small fragment of bone avulsed from the lower pole.

Surgery should aim for accurate reduction and reconstruction of the extensor mechanism with rigid fixation (such as by tension band wiring). If surgery is performed properly without delay, the results are usually good, but limitation of knee flexion is common. Other complications include: transient ischaemic changes, and the development of extensive ectopic bone within the knee. The entire blood supply of the young patella comes from the anterior surface of the distal pole, with essentially no supply from the medial, proximal, or lateral patellar margins. Therefore injury to the anterior and distal pole may lead to avascular necrosis of the proximal pole. None of our patients had such complications.

CONCLUSION

Sleeve patellar fractures in children are uncommon. The fracture is caused by an acute injury due to powerful contraction of the quadriceps with the knee flexed, usually during sports. The diagnosis can be easily missed, especially in fractures with a very small avulsed bony fragment. For undisplaced fractures, conservative management usually achieves good results. For severely displaced fractures, early surgical intervention can produce a good outcome.
REFERENCES