

Case Report

Inferior sleeve fracture of the patella

Shu-Yuan Lin^a, Wei-Chun Lin^{b,c,*}, Jing-Wein Wang^c

^a Department of Emergency Medicine, Kaohsiung Veteran General Hospital, Kaohsiung, Taiwan, ROC

^b Department of Orthopedic Surgery, Kaohsiung Municipal Min-Sheng Hospital, Kaohsiung, Taiwan, ROC

^c Graduate Institute of Photonics and Communications, National Kaohsiung University of Applied Sciences, Kaohsiung, Taiwan, ROC

Received February 9, 2010; accepted June 9, 2010

Abstract

Patella sleeve fracture is a rare fracture that only occurs in children. Diagnosis is difficult both clinically and radiologically. A high-riding patella and hemarthrosis are important signs when diagnosing this fracture. We report a case of an 11-year-old boy who suffered from patella sleeve fracture without visible bony fragments on a lateral radiograph. Open reduction with transosseous tunneling and patellobial cerclage wiring for anastomosis protection was performed. Early weight bearing was achieved together with a satisfactory range of knee motion. Premature anterior physal arrest was noted because of insertion of cerclage wire in the open physis. However, no genu recurvatum was present 2 years after the initial operation. An awareness of sleeve fracture, together with its characteristic clinical and radiological features, is important to avoid misdiagnosis and treatment delay. If the cerclage wire technique is used, care should be taken not to disturb the proximal tibial apophysis. Copyright © 2011 Elsevier Taiwan LLC and the Chinese Medical Association. All rights reserved.

Keywords: Children; Fracture; Patella

1. Introduction

Fractures of the patella are rare in children, as the patella is largely cartilaginous and has great mobility. Sleeve fracture is a particular fracture that occurs in children, where it comprises approximately half of all patellar fractures. It is caused by rapid muscle contraction and mostly affects children between 8 and 12 years of age.¹ These fractures often involve the distal pole of the patella in the form of an osteochondral avulsion. Patients acutely present with hemarthrosis and inability to straight-leg raise. Interpretation of plain films of the children's knees is a challenge when an avulsed bony fragment is not obvious. Patella alta (high-riding patella) on a plain film may be the only and most prominent sign. Emergency physicians may misdiagnose this disease as a knee contusion when a child presents with hemarthrosis without a bony fracture on the

X-ray. The treatments available for a sleeve fracture include cylindrical plaster of Paris immobilization for a minimally displaced fracture (1–2 mm) and open reduction with internal fixation using tension band wiring for severely displaced fractures. Partial patellectomy has been described, but the related indications and possible complications have not been especially addressed.¹ In this paper, we describe an inferior patellar sleeve fracture with an obscure radiological presentation. Cartilage to bone anastomosis was performed with patellobial cerclage wiring for protection. Early weight bearing was achieved, and no limited range of motion was noted at follow-up 2 years later.

2. Case report

An 11-year-old boy sustained right knee pain when he was about to jump a hurdle with his left leg leading. His right knee impacted to the ground in the kneeling position. When seen in the emergency room, there was mild knee swelling and peri-articular tenderness. On physical examination, there was an extension lag of 30°. The active range of motion of the injured

* Corresponding author. Dr. Wei-Chun Lin, Department of Orthopedic Surgery, Kaohsiung Municipal Min-Sheng Hospital, 134, Kaisiyuan 2nd Rd., Lingya District, Kaohsiung 802, Taiwan, ROC.

E-mail address: patdrwc@gmail.com (W.-C. Lin).

knee was 30°–60° of flexion, and the passive range of motion was painful but not limited. Radiographs of the injured knee showed soft tissue swelling and patella alta (Fig. 1A) as compared with the contralateral knee (Fig. 1B). The injured knee had an Insall-Salvati ratio of 1.86 compared with 1.09 for the contralateral knee. No avulsed bony fragment was visible on the radiograph. Computed tomography of the injured knee revealed hemarthrosis and a suspicious avulsed osteochondral fragment (Fig. 1C). Patella sleeve fracture was diagnosed clinically based on the signs of a high-riding patella and a palpable gap in the extensor mechanism at the distal pole of the patella. During the operation, it was found that one-quarter of the patellar articular cartilage and a large portion of the anterior periosteum were avulsed from the distal patella (Fig. 2). The articular cartilage and patellar tendon were reconstructed by attaching the body of the patella with sutures *via* transosseous tunneling. The anastomosis was protected with a patellotibial cerclage to shield it from the tension force produced by the quadriceps muscle (Fig. 3A). The immediate postoperative Insall-Salvati ratio was 0.88, reflecting the shortening of the patellar tendon because of cerclage wiring. The wound healed well and no infection occurred. The patient started weight bearing on the injured leg in straight position 1 week after surgery. Three months after injury, he had attained satisfactory right knee function, with 5° of extension lag and flexion to 90°. Five months later, callus formation over the



Fig. 2. The avulsed patellar cartilage (thin arrow), the anterior periosteum (arrow head) and the denuded patella body (thick arrow).



Fig. 1. (A) Lateral view of injured knee. (B) Lateral view of contralateral knee. (C) Avulsed osteochondral fragment (arrow) with hemarthrosis of the injured knee.

fracture site was visible, and the cerclage wire was removed (Fig. 3B). Premature anterior physeal arrest was noted because of insertion of the cerclage wire into the open physis (Fig. 3C). There was no genu recurvatum at follow-up 2 years after the initial operation. The patient had maintained full activity including running during 2 years of follow-up.

3. Discussion

Fractures of the patella are relatively rare in children and adolescents, with an estimated occurrence rate of 1% of all fractures in this age group.² Among these, sleeve fractures constitute about 57% of all patellar fractures.³ Sleeve fracture of the patella usually occurs in children who have been taking part in activities requiring forceful extension of the knee, with the quadriceps contracting against resistance.⁴ Grogan et al. described four patterns of avulsion (sleeve) fractures, namely superior, which is the least common, inferior, which usually is caused by an acute injury, medial, which accompanies an acute lateral dislocation of the patella; and lateral, which is a chronic stress lesion resulting from repetitive tensile pull from the vastus lateralis muscle.⁵

At the initial presentation, diagnosis of a patellar sleeve fracture may be difficult both clinically and radiologically because there may be no visible bony fragment.³ In this case, no bony fragment was visible on X-ray and the clue for



Fig. 3. (A) Immediate postoperative lateral film showing patella baja because of the cerclage wire. (B) The cerclage wire was removed 5 months after the initial operation. (C) An X-ray of the injured knee 2 years after operation.

diagnosis was patella alta (high-riding patella). It is helpful to have both knees X-rayed to allow comparison of their patellar heights.

Cases with subtle patella alta may benefit from an objective index. The X-ray examination rarely provides useful information regarding patellar fractures; however, the lateral view of the knee is more helpful in demonstrating any associative patellar anomaly. The most popular method for measuring the patellar height is Insall-Salvati ratio, which divides the length of the patellar tendon (LT) by the diagonal length of the patella (LP) on the lateral radiographs.⁶ According to Agliettis et al., the mean of LT/LP ratio is 1.04 in adults, with that for males being 1.01 and for females being 1.06.⁷ Previous authors have defined patella alta as a LT/LP > 1.2 and patella baja as a LT/LP < 1.0 in adults.⁷

If sleeve fracture is suspected, other imaging modalities will be helpful. Confirmation of diagnosis can be made by ultrasound or magnetic resonance imaging. Early recognition of this injury is crucial because the result of early surgical repair of patellar tendon ruptures is more favorable than late repair or reconstruction.

Conservative treatment of sleeve fractures with cylindrical plaster of Paris immobilization should be considered for minimally displaced fractures (1–2 mm).³ For displaced fractures, open reduction with tension band wiring will usually suffice. If there is not enough bone to secure the fixation device, transosseous sutures or intraosseous anchors should be considered.⁸

Complications include wound infection, limitation of knee flexion, ectopic bone formation, and ischemic necrosis of the patella.² The blood supply of the young patella comes from the anterior surface of the distal pole, with essentially no supply from the medial margins.⁹ Therefore injury to the anterior and distal pole may lead to avascular necrosis of the proximal pole.

Concerning the treatment options in this case, it was difficult to perform open reduction and internal fixation with tension band wiring because the avulsed bony fragment was too small to be securely fixed. We reconstituted the articular cartilage and patellar tendon anatomically with silk sutures, which were secured by transosseous tunnels to the body of the patella, and the anastomosis was reinforced with patellotibial cerclage wire. This cerclage wiring procedure protects the anastomosis junction from disruption and avoids the use of extra fixation devices such as a cylinder cast. Although casting provides rigid fixation, there will be associative muscle wasting and joint stiffness; this may lead to inconvenience and limited flexion of the knee.² Patellotibial cerclage wiring is able to provide an early joint range of motion with partial weight bearing, thus decreasing the chance of muscle wasting and joint stiffness. At the same time, the stress shielding provided by the wire decreases the chance of jeopardizing the blood supply to the patella, thus avoiding ischemic necrosis and nonunion.

On the other hand, the placing of the patellotibial cerclage wire raises several concerns. Immediately after the operation, the postoperative patellar tendon has patella baja status because of the cerclage wiring procedure. According to Singh et al., patellar height will generally return to normal with a good functional result after treatment with cerclage wiring.¹⁰ In this case, the immediate postoperative Insall-Salvati ratio was 0.88, reflecting the patellar tendon shortening because of the cerclage wire. The patella baja status improved after removal of the cerclage wire.

If feasible, it would be warranted to place the cerclage wire distal to the apophysis of the tibial tubercle to avoid injury to the tibial tuberosity apophysis. As shown in Fig. 3A–C, premature anterior physeal arrest of the proximal tibia could be observed in this case. Fortunately, the patient did not have discomfort or abnormality associated with the apophysis injury, such as genu recurvatum deformity, when assessed 2 years postoperatively. However, the possibility of apophysis injury still should be of concern when wiring the tibial tuberosity apophysis, and there is a need for longer follow-up to exclude possible deformity.

In conclusion, sleeve patellar fractures in children are uncommon. They predominantly involve the cartilaginous portion of the patella. The fracture is easily missed by the emergency physicians if no bony fragment avulsion is present on the X-ray film. An awareness of this type of injury together with its characteristic features, namely patella alta and hemarthrosis, are of vital importance to avoid misdiagnosis. For a severely displaced fracture, early surgical intervention is effective. Open reduction with transosseous tunneling and patellotibial cerclage wiring might be considered for inferior patella sleeve fractures in children.

References

1. Ray JM, Hendrix J. Incidence, mechanism of injury, and treatment of fractures of the patella in children. *J Trauma* 1992;**32**:464–7.
2. Dai LY, Zhang WM. Fractures of the patella in children. *Knee Surg Sports Traumatol Arthrosc* 1999;**7**:243–5.
3. Hunt DM, Somashekar N. A review of sleeve fractures of the patella in children. *Knee* 2005;**12**:3–7.
4. Al-Khateeb H, Willett K. Sleeve fracture of the patella: an unusual mechanism of injury. *J Trauma* 2008;**65**:E8–9.
5. Grogan DP, Carey TP, Leffers D, Ogden JA. Avulsion fractures of the patella. *J Pediatr Orthop* 1990;**10**:721–30.
6. Insall J, Salvati E. Patella position in the normal knee joint. *Radiology* 1971;**101**:101.
7. Aglietti P, Insall JN, Cerulli G. Patellar pain and incongruence: measurements of incongruence. *Clin Orthop Relat Res* 1983;**176**:217–24.
8. Kaar TK, Murray P, Cashman WF. Transosseous suturing for sleeve fracture of the patella: a case report. *Ir J Med Sci* 1993;**162**:149.
9. Gao GX, Mahadev A, Lee EH. Sleeve fracture of the patella in children. *J Orthop Surg* 2008;**16**:43–6.
10. Singh RP, Shah RK, Srivastava MP. Treatment of inferior pole avulsion fractures with pole resection and patellotibial cerclage wire. *Nepal Med Coll J* 2007;**9**:93–5.