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Patellar fractures associated with medial-third bone-patellar tendon-bone autograft ACL reconstruction

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Abstract Patella fractures following anterior cruciate ligament (ACL) reconstruction are a recognized but rarely reported complication. To our knowledge, 24 reports of patella fractures after ACL reconstruction using the central-third patella-tendon autograft have been reported in the literature. Patellar fractures associated with the use of the medial-third bone-patellar tendon-bone autograft have not been reported. This article describes four cases of patellar fractures in 478 ACL reconstructions between 1992 and 1999, using the medial third of the patellar tendon graft. All of them were transverse fractures of the patella but only one was displaced. All patients suffered local injury to the donor knee between 2 and 4 months postoperatively. No significant differences in the final outcome were noticed between the cases complicated with patellar fracture and those with uncomplicated ACL reconstructions.

Keywords Anterior cruciate ligament reconstruction · Patella fracture · Bone-patellar tendon-bone · Complication

Introduction

Autogenous bone-patellar tendon-bone (BPTB) is the most frequent graft used for anterior cruciate ligament (ACL) reconstruction. The central third of the patella as well as the medial third have been used as a BPTB graft by several authors [8, 9, 10]. There are a few reports of patellar fractures associated with central-third BPTB, but this complication is either infrequent or unreported [1, 2, 3, 4, 5, 6, 7, 11, 12, 13]. Since 1983, when McCarrol reported the first case of patella fracture that occurred 6 months postoperatively during a golf swing, few other authors have reported this complication.

Patellar fractures associated with the use of the medial-third BPTB autograft have not been reported. The objective of our study is to report four cases of patellar fractures using the medial-third patellar tendon graft.

Case reports

Between 1992 and 1999, over 478 patients underwent an ACL reconstruction using an ipsilateral BPTB graft. The medial third of the patellar ligament was used as bone-tendon-bone graft, according to the press-fit technique described by Peter Hertel in Berlin in 1992 [8]. We reviewed 478 patients retrospectively.

The patellar bone block was harvested with a small saw blade in the shape of a "flag" (approximately 25×20×6 mm), and it had a triangular shape in cross section. The graft was stabilized without screws in the femur and tibia by press-fit. Postoperatively, the patient was allowed to bend the knee between 10° and 90° and to walk with two crutches.

A brace was used to protect the knee during walking as well as during the night. Full range of motion and full weight bearing were allowed after 6 weeks [8]. Only four patients were complicated with patellar fracture (Table 1).

Case 1

A 20-year-old woman sustained a rupture of the ACL in a motor vehicle accident. Five days later, the ACL was reconstructed. Two months after operation, she sustained a direct low-energy contusion

Table 1 Patellar fractures complicating ACL reconstruction

Patient	Year	Sex	Age	Etiology	Fracture configuration	Postoperative time (months)
AX	1994	W	20	Contusion	Transverse	2
KP	1993	M	22	Hyperflexion	Transverse	4
TN	1996	M	27	Kick	Transverse	3
TA	1999	M	16	Dance	Transverse	3

Fig. 1 **A** Lateral and **B** Anteroposterior views of the injured knee showing a non-displaced fracture of the superior pole of the patella (*arrows*). (Case 1)

to the operated knee. Clinical examination and radiographs of the patella showed a transverse undisplaced fracture of the patella. Clinically, the function of the extensor mechanism was not disrupted. Excellent results had been achieved by knee bracing (Fig. 1).

Case 2

A 22-year-old man sustained a twisting injury to his knee. One year later, he underwent reconstruction of the torn ACL and partial meniscectomy. Two months after surgery, hyperflexion of his operated knee caused a transverse displaced fracture of the patella. The fracture was treated using two Kirschner wires, a circumferential cerclage wire and an anterior tension band wire. Hardware was removed 6 years later (Fig. 2).

Case 3

A 27-year-old man sustained an acute tear of the ACL during a soccer game. The ACL was reconstructed and the patient returned to athletic activity. Four months later, the patient suffered a patellar fracture on the operated knee as a result of a direct force applied on the knee. He declined surgical treatment of the fracture and remained in conservative treatment using a brace. At a recent follow-up he had a stable, asymptomatic knee with normal range of motion (ROM).

Case 4

A 16-year-old skeletally mature boy sustained a right knee injury. The patient underwent knee arthroscopy. A femoral chondral lesion, a tear of the posterior horn of his medial meniscus, and ACL

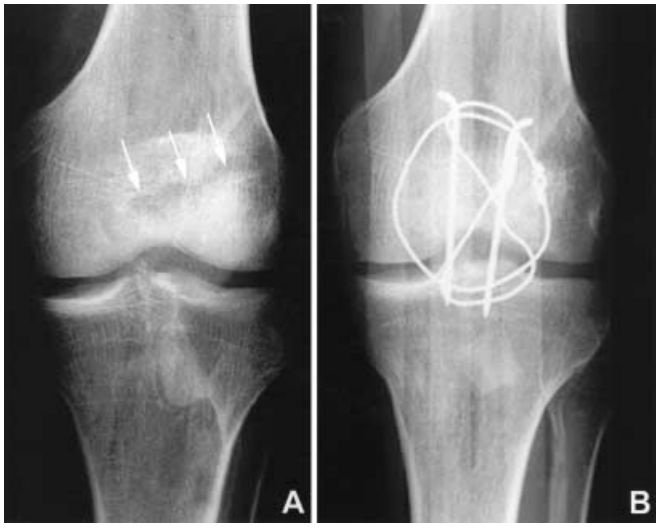

Fig. 2 **A** Anteroposterior radiographs showing patella fracture (*arrows*). **B** Postoperative radiograph showing patellar reconstruction. (Case 2)

rupture were found. Three months after ACL reconstruction, the patient sustained a new knee injury while dancing. Radiographs revealed a non-displaced transverse fracture. The fracture was subsequently treated with a knee brace.

Discussion

Incidence

Patellar fractures after ACL reconstruction, using the central-third patellar tendon graft have been reported with increasing frequency (Table 1). However, this is reported as a rare complication. The incidence ranges between 0.22% in the study by Viola and Vianello [13] and 2.3% in Berg's study [2]. In our series, the incidence rate for using the medial-third BPTB graft for ACL reconstruction is approximately 0.9%.

Postoperative time

Bonatus et al. [4] reported a case of patellar fracture after ACL reconstruction using the central third of patellar tendon on the eighth postoperative day as a result of slipping down the stairs. However, Benson et al. [1] reported a case

Table 2 Patellar fractures complicating ACL reconstruction

Year	Authors	No. of cases	Postoperative time	Etiology, fracture configuration
1983	McCarroll JR	1	6 months	Golf swing, displaced transverse
1984	Bonamo JJ	1	7.5 months	Fracture of inferior pole and patellar rupture lig.
1991	Bonatus TJ, Alexander AH	1	8 days	Fracture and patellar tendon rupture
1992	Christen B, Jakob RP	9	Intraoperative (6 cases); 3 weeks–months (3 cases)	Longitudinal fissure; vertical displaced
1995	Simonian PT, Mann FA	2	3–5 weeks	Stellate Y
1996	Berg EE	3	Intraoperative (2 cases); 4 months (1 case)	Vertical fissure; transverse displaced
1997	Brownstein B, Bronner S	2	5–7 weeks	
1998	Benson ER, Barnett PR	1	12 months	Transverse superior pole and proximal patellar
1999	Miller MD, Nichols T	1	1.5 months	Tendon rupture
1999	Viola R, Vianello R	3	2–3 months	Transverse displaced

of patellar fracture 12 months after the operation, as a result of returning to a contact sport. Most of the reported fractures occurred during the early postoperative period between the second and fourth postoperative month (Table 2). In our series, patellar fracture injury occurred between the second and fourth postoperative months.

Configuration

Christen and Jakob [7] and Berg [2] reported eight fractures of the patella intraoperatively during the harvesting of the graft. All of them occurred during levering of the graft from its patellar bed with an osteotome, and appeared as vertical fissure. Bonatus et al. [4] and Simmonian et al. [12] reported three comminuted patella fractures. Bonamo et al. [3] reported an avulsion fracture of the inferior pole of the patella. Benson et al. [1] reported one fracture of the superior pole of the patella. However, the most prevalent types are the transverse displaced or the vertical fissure fractures of the patella. Eight fractures from each type have been reported (Table 2). In our series, all of them were transverse fractures with or without displacement. None of them was patellar tendon avulsion or occurred during harvesting of the graft.

Mechanism

Simonian et al. [12] reported that these fractures were caused by direct trauma (impaction forces delivered to the patella) or due to indirect forces (isolated quadriceps contractions and tensile stresses applied across the extensor mechanism after stumbling or slipping). Direct fractures are typically stellate or comminuted, but indirect fractures are displaced transverse disruption and occur late.

In our series, only transverse fractures occurred between the second and fourth postoperative months. Two of them occurred as a result of direct forces applied to the patella (contusion), and two as a result of indirect forces (hyperflexion or twisting during dancing).

Treatment

Methods for managing this complication have been reported. Christen and Jakob [7] treated three of six fissure fractures non-operatively and all patients achieved a satisfactory result. Mild patellofemoral tenderness was found in one patient and asymptomatic patellofemoral crepitus was found in two patients at the follow-up.

Berg [2] preferred to operate on the fissure fracture cases, especially when an aggressive postoperative rehabilitation was planned.

The management in one case of our series was rigid internal fixation, while the remaining three cases were treated conservatively. In all four patellar fractures, rehabilitation was prolonged, but the final outcome was not influenced by the patella fracture. All four patients achieved full range of motion and experienced an improvement in knee function. The average Lysholm knee score was 92 out of 100 while the average Lysholm knee score of the patients without this complication was 93 out of 100 [8].

Even though the exact etiology of the patella fractures after ACL reconstruction remains unknown, disruption of the patellar blood supply or longitudinal fissures created by the osteotome during the removal of the bone-block may be implicated. Furthermore, trauma and accelerated rehabilitation can apply stress on the patella and, especially in the initial stages, may results in fracture. However, patellar fracture associated with the use of the medial third as a BPTB autograft is also a rare complication.

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