The Incidence of Acute Patellar Tendon Harvest Complications for Anterior Cruciate Ligament Reconstruction

Gregory H. Lee, M.D., Patrick McCulloch, M.D., Brian J. Cole, M.D., Charles A. Bush-Joseph, M.D., and Bernard R. Bach, Jr., M.D.

Purpose: This study was performed to determine the incidence of acute bone–patellar tendon–bone autograft harvest complications after anterior cruciate ligament (ACL) reconstruction. **Methods:** Over a nearly 20-year period (September 1986 to April 2006), 1,725 consecutive patients underwent primary ACL reconstruction using bone–patellar tendon–bone autograft by 3 fellowship-trained sports medicine surgeons at our institution. Three acute complications related to patellar tendon harvest were identified from surgical databases, and the charts of these patients were reviewed. **Results:** In this series of 1,725 consecutive patients, 3 acute complications (0.2%) related to patellar tendon harvest were noted. These complications consisted of 2 patellar fractures (1 intraoperative and 1 postoperative) and 1 postoperative patellar tendon rupture. All 3 patients healed and went on to satisfactory outcomes. **Conclusions:** A 0.2% overall acute complication rate related to patellar tendon harvest for primary ACL reconstruction supported our hypothesis. Bone–patella tendon–bone autograft remains a safe and viable choice for surgeons performing ACL reconstruction. **Level of Evidence:** Level IV, therapeutic case series. **Key Words:** ACL reconstruction—Bone–patellar tendon–bone autograft—Extensor mechanism complication—Patellar fracture—Patellar tendon rupture.

Anterior cruciate ligament (ACL) reconstruction is well established as the standard of care in ACL-deficient patients with functional instability. While alternative graft choices are gaining popularity, bone–patellar tendon–bone (BPTB) autograft remains the most widely used graft source for ACL reconstruction.[1] Although advances in surgical techniques have minimized the rate of complications related to harvest of the patellar tendon, acute complications such as patellar tendon rupture, patella fracture, and dropping the harvested graft still occur. The purpose of this study was to determine the incidence of BPTB autograft harvest complications for 3 fellowship-trained sports medicine surgeons at our institution. The hypothesis of this study was that acute extensor mechanism disruptions (patellar tendon rupture or patellar fracture) are unusual.

From the Division of Sports Medicine, Department of Orthopaedic Surgery, Rush University Medical Center, Chicago, Illinois, U.S.A.

The authors report no conflicts of interest.

Address correspondence and reprint requests to Bernard R. Bach, Jr., M.D., 1725 W Harrison, Suite 1063, Chicago, IL 60612, U.S.A. E-mail: brbachmd@comcast.net

0749-8063/08/2402-7107$34.00/0
doi:10.1016/j.arthro.2007.08.020

METHODS

Over a nearly 20-year period (September 1986 to April 2006), 1,725 consecutive patients underwent primary ACL reconstruction using BPTB autograft by 3 fellowship-trained sports medicine surgeons at our institution. Data were reviewed using the computerized surgical databases maintained by 2 of the attending surgeons and the surgical logbook maintained by the other attending. Common variables between the databases included patient demographics (age, gender, and laterality), surgical demographics (procedure[s] performed and choice of graft), and outcomes (presence of acute postoperative complications). The surgical experiences of the attending surgeons were 20, 17, and 10 years, respectively (Table 1).

TABLE 1. *Demographics of Surgical Caseload for Isolated Patellar Tendon Autograft*

Surgeon	Dates	Cases	Male	Female	Left	Right	Unknown	Age (SD)
1	September 1986-April 2006	1,062	708	354	504	549	9	27.0 (9.3)
2	November 1989-April 2006	533	374	159	234	280	19	25.9 (9.2)
3	October 1997-April 2006	130	112	18	59	67	4	24.8 (9.8)
Totals		1,725	1,194	531	797	896	32	26.5 (9.4)

The method of BPTB harvest was similar for all 3 surgeons. A vertical incision was made from the distal pole of the patella to the inferior portion of the tibial tubercle with the knee flexed. Skin flaps were created and the incision was sharply carried down through the transverse fibers of the paratenon. A No. 15 blade scalpel was then used to incise the paratenon at its midpoint, and Metzenbaum scissors were then used to extend proximally and distally and expose the entire width of the patellar tendon. Next, the tendon was maintained in a stretched position by flexing the knee as a No. 10 blade scalpel was used to incise the tendon first on one side of the graft followed by the other side to yield a 10-mm wide graft. Then, a No. 238 blade oscillating saw was used to create the tibial bone plug by scoring the tibial cortex and removing an equilateral triangle of bone with the saw. The tibial bone block was temporarily left in place while we harvested the patellar bone plug. We cut the patellar plug as a trapezoidal shape, no more than 6 or 7 mm deep, to help protect the articular cartilage underneath. Then we used a curved osteotome to carefully lift the tibial bone plug from its bed onto a lap pad followed by gentile removal of the patellar bone plug. Metzenbaum scissors were then used to remove any remaining soft tissue attachments, and the graft was removed by the harvesting surgeon.

In our study, we excluded patients who underwent multiligamentous reconstructions and those individuals who had patellar tendon allografts used for ACL reconstruction; 1,194 men (69.2%) and 531 women (30.8%) comprised our series. Our study consisted of 797 left knees (46.2%), 896 right knees (51.9%), and 32 knees (1.9%) unspecified as to laterality. The mean age of our series was 26.5 years of age (standard deviation, 9.4 years). Three acute complications related to patellar tendon harvest were identified via review of the surgical databases and the charts of these patients were retrospectively reviewed.

RESULTS

Overall, the incidence of significant acute extensor mechanism complications in our study was 1 in 1,725 (0.06%) for an intraoperative patellar fracture, postoperative patellar fracture, and patellar tendon rupture, respectively. When combined, there were a total of 2 of 1,725 intra- and postoperative patellar fractures (0.12%). We did not have any incidents of graft contamination secondary to dropping the harvested graft on the floor.

Case 1

A 24-year-old woman who worked for a health-consulting firm injured her right knee while playing soccer. She was found to have an isolated ACL tear by examination, KT-1000 (MEDMetric, San Diego, CA), and magnetic resonance imaging (MRI). She elected to undergo reconstruction using a patella tendon autograft 6 weeks after the injury, following motion recovery.

After diagnostic arthroscopy confirmed an isolated ACL tear, a longitudinal incision was made to expose the patella and patella tendon. Using an oscillating saw, a 10 × 25 mm bone block was harvested from the patella and tibial tubercle. After flexing and extending the knee for visualization, a crack was heard and a displaced longitudinal fracture of the patella was noted. Immediate fixation using two 4.5-mm cortical screws using a lag by application technique was performed (Fig 1).

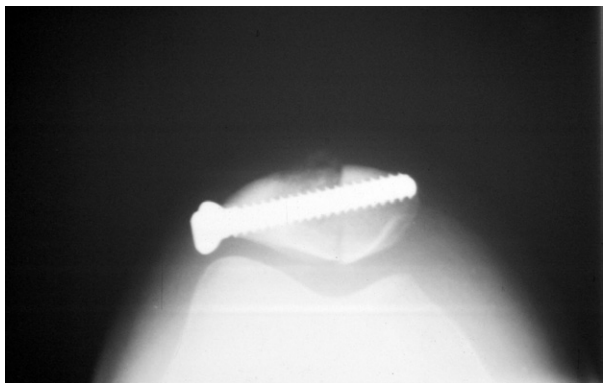

FIGURE 1. An intraoperative patellar fracture has been recognized and fixed using the standard AO technique.

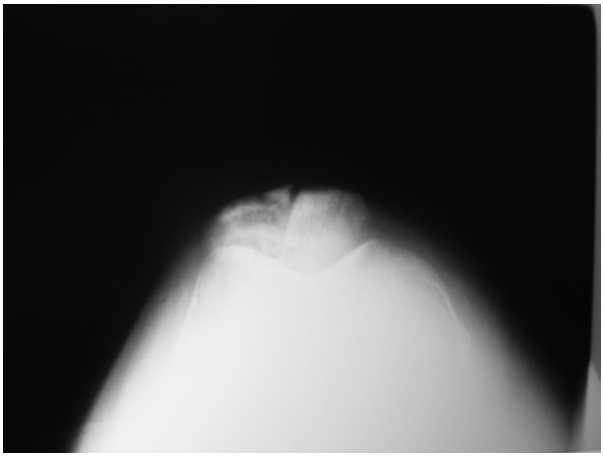

FIGURE 2. An oblique postoperative patellar fracture.

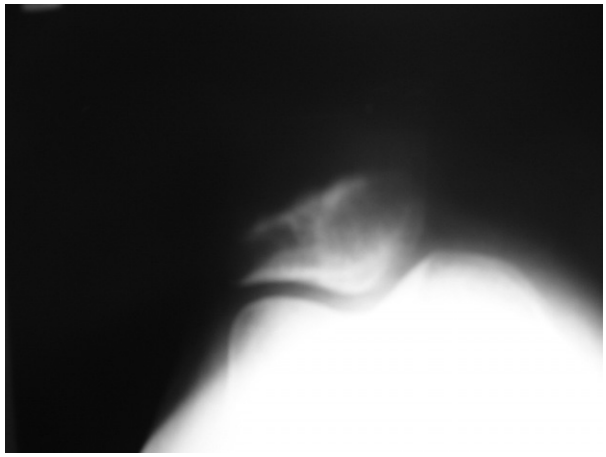

FIGURE 3. Three-week follow-up radiograph.

Postoperatively, the patient was kept on crutches with immediate motion for 6 weeks. She developed significant thigh atrophy and continued to limp 4 months postoperatively. Radiographs showed healing of the patella fracture but significant bone demineralization. Over a 12-month postoperative time frame, she improved, and by 1 year postsurgery, she was able to run, play tennis, and enjoy aerobic fitness. Her screws were removed 12 months postoperatively and thereafter she complained of patellar pain symptoms with prolonged running or impact sports. At 2 years postoperatively, she was pain-free and had no restriction to her activities.

Case 2

A 24-year-old student injured her left knee while skiing. Her physical examination, KT-1000 testing, and MRI were consistent with the diagnosis of an isolated ACL tear. She underwent an uncomplicated, endoscopically-assisted ACL reconstruction using a patella tendon autograft 6 weeks after her injury.

The patient was started on a standard accelerated rehabilitation protocol after her surgery. She was progressing appropriately in physical therapy and had normal motion until she slipped and fell directly onto the anterior aspect of her knee after tripping at work and experienced immediate pain. Radiographs demonstrated a nondisplaced oblique fracture of the patella without articular step-off (Fig 2). This was treated with weight bearing as tolerated with her brace locked in extension for 3 weeks. Radiographs obtained 3 weeks after her fall demonstrated healing of the patella fracture without displacement (Fig 3), and the patient was allowed to return to the usual ACL reconstruction rehabilitation program.

A follow-up examination at 1 year demonstrated that the patient had a 0° to 130° range of motion of her left knee with the ability of straight leg raise without extensor lag. She had a stable ligamentous exam and no complaints of knee pain. The patient had returned to her preoperative sports.

Case 3

A 42-year-old police officer with chronic ACL deficiency elected to undergo reconstruction with a patellar tendon autograft. The central one third (11 mm) of the ipsilateral patellar tendon was harvested with 2.5-cm triangular bone plugs using an oscillating saw and the tendon defect closed with interrupted No. 1 absorbable suture.

The patient was started postoperatively in a standard accelerated rehabilitation protocol and was doing well at his 2-week postoperative evaluation. He slipped on ice 4 weeks postoperatively, suffering a hyperflexion injury at the knee with associated pain and swelling. On examination, the patient was tender to palpation localized to the tibial tubercle and was unable to perform a straight leg raise or actively extend the knee. MRI confirmed the diagnosis of a distal rupture of the infrapatellar tendon with intact cruciate and collateral ligaments.

Intraoperatively, there was a 1.5-in transverse defect and 0.5-in retraction of the infrapatellar tendon at its insertion site (Fig 4). This was repaired with a double layer Bunnell suturing of the tendon ends, reinforced with double-bundle hamstring autograft, as well as figure-of-eight tension band technique using

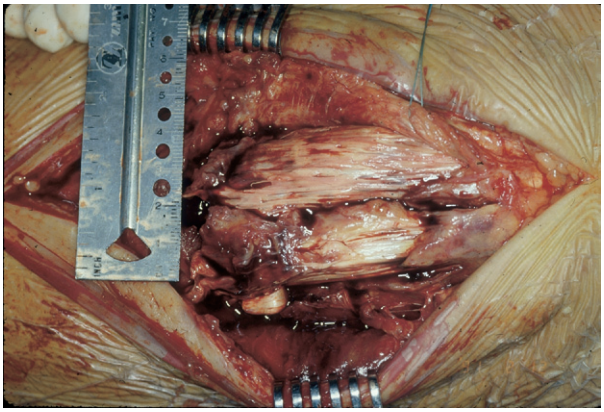

FIGURE 4. Intraoperative picture of transverse patellar tendon defect and retraction of infrapatellar tendon. Reprinted with permission from SLACK incorporated.[12]

an 18-gauge wire (Fig 5). Postoperatively, the patient was placed in a hinged knee brace allowing 0° to 30° of motion and allowed partial weightbearing in extension. Motion was incrementally increased at 30° intervals at 2 and 4 weeks postoperatively. The brace was discontinued, and the patient was allowed to bear weight as tolerated at 2 months postoperatively and active and passive extension exercises were initiated. The patient underwent hardware removal at 4 months from the date of his repair, and at his latest follow-up had a range-of-motion of his knee from 3° to 126°, ran 2.5 miles per day, and was pain-free.

DISCUSSION

Patella fracture, either intraoperatively or during the postoperative period, is a rare but reported complication of ACL reconstruction with BPTB autograft.[2,3] The incidence in the literature ranges from 0.2% to 2.3%.[1,4,5] The recommendations for minimizing the risk of patella fracture include avoiding the use of osteotomes to make the initial bone cuts and to remove no more than 25 to 30 mm of the length of the patella, and no more than 9 to 10 mm of its width. At least two thirds of the depth of the preoperatively measured patella should be preserved, and care should be taken to remove the bone plug from the center of the patella.[6] Lastly, bone grafting of the harvest site from bone plug trimming as well as bone tunnel reamings has been advocated to minimize the risk of patella fracture and postoperative donor site pain.[7]

Patellar tendon rupture after ACL reconstruction using BPTB autograft is also a rarely reported occurrence.[3,8,9] Busfield et al.[10] have described an infrapatellar tendon rupture after BPTB autograft from the contralateral knee. Also in their series of patellar tendon harvest from the contralateral knee, they report on a patient that suffered a lateral tibial tuberosity fracture. Moen et al.[11] have also described a similar case when the graft was taken from the ipsilateral knee. Recommendations to avoid patellar tendon–related complications include maintaining at least 20 mm of remaining patellar tendon width, using a double parallel blade to minimize the risk of tendon laceration, and avoiding undermining the medial and lateral edges of residual patellar tendon at its insertion on the

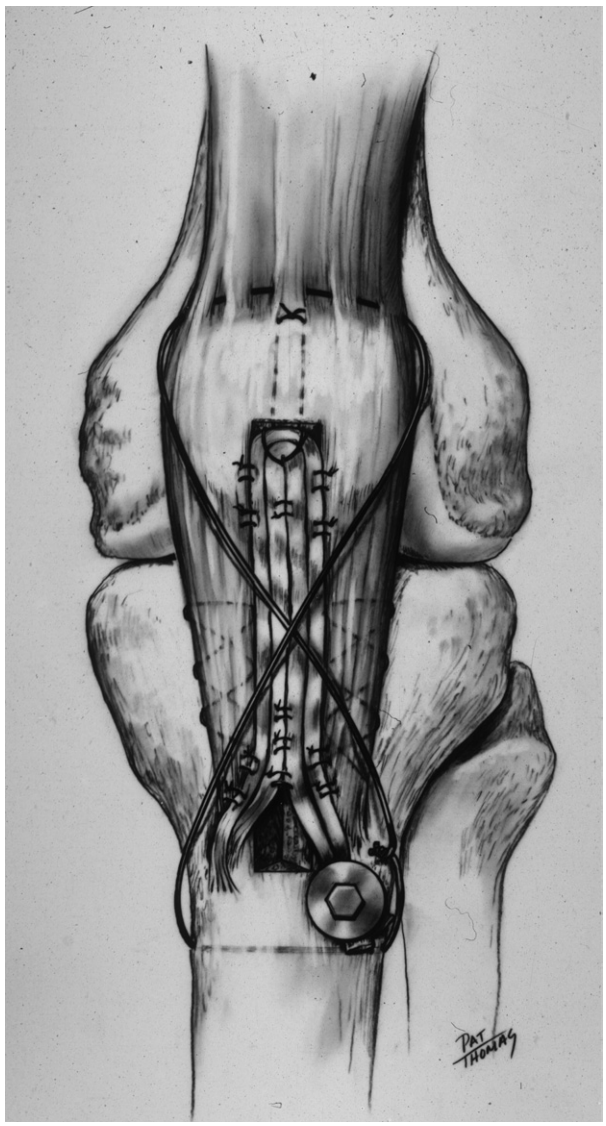

FIGURE 5. Double-layer Bunnell repair, reinforcement with double-bundle hamstring autograft, and figure-of-eight tension band technique. Reprinted with permission from SLACK incorporated.[12]

tibial tubercle both during harvest and while reaming bone tunnels.[6,12] Additionally, triangular-shaped bone plugs, rather than rectangular or trapezoidal, has been advocated to leave the greatest cross-sectional area of bone at the donor site, thereby minimizing the risk of avulsion fracture of the tibial tubercle.[12]

While we did not encounter dropping of the graft as a complication of BPTB harvest in our series, this complication has been reported. While there is no clear consensus on how to proceed after graft contamination,[13] we recommend preventive measures to avoid this complication. To minimize the risk of dropping the graft, the harvesting surgeon should walk the graft to the back table without handing it off to an assistant. Furthermore, the harvested graft should be wrapped in a saline-moistened lap sponge until it is ready to be prepared for implantation. If the graft is transported to the operative field within this sponge and should inadvertently drop on the floor, it would be less likely to be contaminated. This should minimize the degree of graft contamination if it is inadvertently knocked off of the sterile field.

Limitations of this study are its retrospective nature and duration of follow-up. We routinely follow-up all patients for a minimum of 6 months postoperatively, and patients lost to follow-up beyond that point are unlikely to sustain any complications related to their extensor mechanism. Another weakness of this study was the lack of standardization between surgeons in regards to their databases. While similar in respects to tracking patient and surgical demographics as well as the presence of acute extensor mechanism complications, other variables, such as the presence of persistent postoperative anterior knee pain or the development of late patellofemoral arthrosis, were not recorded in the surgical databases and no conclusions could be drawn on these nonacute complications of patellar tendon harvest.

Although proponents of soft tissue grafts cite extensor mechanism complications (patellar tendon rupture or patellar fracture) as potential reasons to consider avoiding the use of a patellar tendon autograft, our data suggest that the likelihood of this occurring in the hands of experienced fellowship trained sports medicine specialists is extremely low, and lower than what has been published in the literature.

CONCLUSIONS

We report a 0.2% combined overall acute complication rate for patellar tendon harvest for primary ACL reconstruction followed by a standard accelerated rehabilitation protocol. BPTB autograft remains a safe and viable choice for surgeons performing ACL reconstruction. These observations supported our initial hypothesis.

REFERENCES

1. Stein DA, Hunt SA, Rosen JE, Sherman OH. The incidence and outcome of patella fractures after anterior cruciate ligament reconstruction. *Arthroscopy* 2002;18:578-583.
2. Benson ER, Barnett PR. A delayed transverse avulsion fracture of the superior pole of the patella after anterior cruciate ligament reconstruction. *Arthroscopy* 1998;14:85-88.
3. Miller MD, Nichols T, Butler CA. Patella fracture and proximal patellar tendon rupture following arthroscopic anterior cruciate ligament reconstruction. *Arthroscopy* 1999;15:640-643.
4. Viola R, Vianello R. Three cases of patella fracture in 1,320 anterior cruciate ligament reconstructions with bone-patellar tendon-bone autograft. *Arthroscopy* 1999;15:93-97.
5. Almazan A, Miguel A, Odor A, Ibarra JC. Intraoperative incidents and complications in primary arthroscopic anterior cruciate ligament reconstruction. *Arthroscopy* 2006;22:1211-1217.
6. Malek MM, Kunkle KL, Knable KR. Intraoperative complications of arthroscopically assisted ACL reconstruction using patellar tendon autograft. *Instr Course Lect* 1996;45:297-302.
7. Ferrari JD, Bach BR. Bone graft procurement for patellar defect grafting in anterior cruciate ligament reconstruction. *Arthroscopy* 1998;14:543-545.
8. Marumoto JM, Mitsunaga MM, Richardson AB, Medoff RJ, Mayfield GW. Late patellar tendon rupture after removal of the central third for anterior cruciate ligament reconstruction. A report of two cases. *Am J Sports Med* 1996;24:698-701.
9. Mickelsen PL, Morgan SJ, Johnson WA, Ferrari JD. Patellar tendon rupture 3 years after anterior cruciate ligament reconstruction with a central one third bone-patellar tendon-bone graft. *Arthroscopy* 2001;17:648-652.
10. Busfield BT, Safran MR, Cannon WD. Extensor mechanism disruption after contralateral middle third patellar tendon harvest for anterior cruciate ligament revision reconstruction. *Arthroscopy* 2005;21:1268e1-1268e6.
11. Moen KY, Melbourne DB, Raasch WG. Fracture of the proximal tibia after anterior cruciate ligament reconstruction. *Am J Orthop* 1998;27:629-630.
12. Hardin GT, Bach BR. Distal rupture of the infrapatellar tendon after use of its central third for anterior cruciate ligament reconstruction. *Am J Knee Surg* 1992;5:140-143.
13. Izquierdo R Jr, Cadet ER, Bauer R, Stanwood W, Levine WN, Ahmad CS. A survey of sports medicine specialists investigating the preferred management of contaminated anterior cruciate ligament grafts. *Arthroscopy* 2005;21:1348-1353.