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An improvement on the technique of transosseous tunnels for the fixation of lower pole patella fracture

Cerclage around the patella

Jialang Hu, MD, Xin Guo, MD*

Abstract

The technique of transosseous tunnels is widely used in lower pole patella fracture (LPP). Though the extensor mechanism can be restored, distal avulsion fragments are usually unstable. The subsequent fracture gap and nonunion impair the extensor mechanism in turn. Cerclage is a promising method for treating the condition. The aim of this prospective cohort study is to determine if cerclage around the patella combined with the technique of transosseous tunnels stabilizes the avulsion fragments and brings out improved outcomes on LPP.

Twenty two patients with LPP were treated with the hybrid technique. The patients were followed up and evaluated clinically and radiographically. The functional outcome was assessed by the average range of knee movement and Lysholm knee rating system at 6 months after surgery, as well as the final follow-up. Radiologically, Insall-Salvati ratio and the time from surgery to bone union were assessed.

Postoperatively, with a mean followed-up of 12 months. All of the patients regained stability of the knee with an average range of movements of 131.8 degrees at 6 months after operation and 138.2 degrees at the final follow-up. On the Lysholm knee rating system, all cases were classified as excellent. The average score was 93.2 at 6 months after operation and 95.9 at the final follow-up. In radiological assessment, no fracture gap or nonunion occurred. The average Insall-Salvati ratio (I-S ratio) was 1.03.

The hybrid technique offers further stabilization for the avulsion fragments and strengthens attachment of the patellar tendon, which brings forward time of rehabilitation and achieves good clinical outcomes.

Abbreviation: LPP = lower pole patella fracture.

Keywords: cerclage, lower pole patella fracture, nonunion, transosseous tunnels

1. Introduction

Lower pole patella fracture (LPP) refers to fractures involving the lower quarter of the patella, exactly, 34A in the AO/OTA classification. The standard method for LPP is the technique of transosseous tunnels: transosseous patellar drill tunnels with Krackow sutures in the patellar tendon.[1,2] Since the fracture not involving the patellofemoral articular surface, the primary goal of the treatment is to restore the extensor mechanism of the knee rather than anatomical reduction of the articular surface. Thus, reduction and fixation of distal fragments are usually ignored. After all, it is not easy: the distal fragments of LPP are generally too complex or tiny to fix for Kirschner wires (K-wires) and intramedullary screws. However, in theory, additional reduction of the distal avulsion fragments and bone healing make patellar tendon attachments to the lower pole of patella stronger than sutures through transosseous tunnels. Cerclage wiring is an effective way to fix irregular fragments and withstand tension. In this study, we integrated cerclage wiring around patella with a technique of transosseous tunnels to treat LPP and tried to determine if the hybrid method had satisfying outcomes in the long term for LPP.

2. Materials and methods

2.1. Patient eligibility

During the period from January 2017 to December 2020, 22 patients who agreed to participate in the prospective study were identified and managed for LPP. Ethical approval and informed consent from every single patient were obtained. The study was approved by the ethics committee of Wuhan Fourth Hospital.

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The authors have no conflicts of interest to disclose.

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Department of Orthopedics, Wuhan Fourth Hospital, Puai Hospital, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, China.

** Correspondence: Xin Guo, Department of Orthopedics, Wuhan Fourth Hospital, Puai Hospital, Tongji Medical College, Huazhong University of Science and Technology, Wuhan 430033, China (e-mail: guoxwh@gmail.com).*

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Eligible patients were included in the study when they met the following criteria:

1. diagnosed with LPP (AO/OTA 34A) and, in particular, articular surface of the patella was not involved;
2. over 18 years old and in full possession of their mental faculties; and
3. 7 days or less after injury.

Patients with the following conditions were excluded:

1. soft tissue injury: open fracture type Gustilo-Anderson Type II or higher;
2. pathological fracture or re-fracture
3. additional AO/OTA 34B or 34C fractures.

2.2. Operative technique and rehabilitation protocol

Under anesthesia, the patella and patellar tendon were exposed through a mid-axial longitudinal approach. The fracture lines were irrigated and cleared of blood clots and small debris to allow exact reconstruction. Afterwards, insert the Krackow stitch of #5 non-absorbable suture into each side of the patellar tendon bilateral symmetrically, as illustrated (Fig. 1A and B). Then 3 longitudinal drill holes in the proximal patellar fragment were made and the free ends of the sutures were pulled through the holes ready to tighten. Likewise, a horizontal drill hole at the proximal pole of the patella vertical to the former three holes was made beforehand for cerclage. Next, fragment reduction was monitored, and a cerclage wire (figure-of-zero) was passed through the horizontal hole around the patella (Fig. 2A). The wire was then twisted and tightened to maintain the reduction. The sutures were then tightened and tied deep to the quadriceps tendon, with the knee in full extension (Fig. 2B). Finally, retinacular tears were repaired and the wound was closed.

After the surgery, static isometric quadriceps exercises were started on the first day postoperatively; then the program of straight leg raise and active flexion exercises were initiated on the fifth day or earlier as long as pain Visual Analogue Scale was lower than 4. Rehabilitation program continued until full range of knee motion was restored.

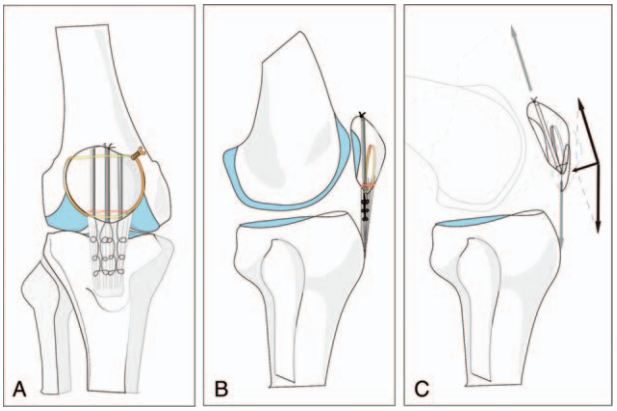

Figure 1. Schematic drawing describes the hybrid technique: cerclage wiring around patella with transosseous tunnels suture (A and B). When knee bending, the tensions exerted on the distal avulsion fragments of patella are shown as vectors in (C). The resultant force is directed vertically to the coronal plane of patella, which gives rise to the fracture gap.

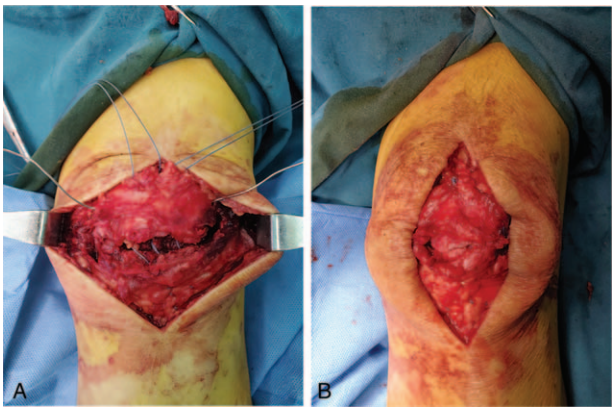

Figure 2. Intraoperative view: Krackow sutures through the transosseous patellar drill tunnels and the cerclage wire before twisting (A); The avulsion fragments was reduced after the cerclage wire and Krackow sutures were frapped (B).

2.3. Clinical and function outcome assessments

Demographic data, including the ages, gender, and mechanism of injury was reviewed. Clinical outcomes, considering complications, range of motion of the injured knee and functional outcome with Lysholm score were evaluated at the sixth month and final follow-up after operation. Radiologically, fracture was defined as healed if the fracture line was obliterated or bridged. Time to union was estimated from date of surgery to date when union was first found out at follow-up. Nonunion was defined as progressive widening of the fracture line. Furthermore, Insall-Salvati ratio and condition of the patellofemoral joint degenerative changes were assessed at the final follow-up (Fig. 3).

3. Results

Among the 22 patients, 2 sustained high-energy injuries while 20 had low-energy injuries. Other demographic data were shown in Table 1. After the operation, the patients were followed up for an average period of 12 months (range: 6–22 months). The average range of knee movement was 131.8 degrees at the sixth month after operation and 138.2 degrees at the final follow-up, compared with 142.5 degrees in the contralateral knee. As for the Lysholm knee rating system, all cases were classified as excellent. The average score was 93.2 at the sixth month after operation and 95.9 at the final follow-up. In radiological assessment, in all these patients, the avulsion fragments healed within 3 months. The average Insall-Salvati ratio (I-S ratio) was 1.03 (Table 1) at the final follow-up. There were no major perioperative or postoperative complications. And there were no incidences of advanced patellofemoral arthritis.

4. Discussion

The most common treatment for LPP and patellar tendon rupture involves the technique of transosseous tunnels. Compared to the traditional intermittent sutures between the patellar tendon and the lower part of the patella, the technique of transosseous tunnels can make the extensor apparatus stronger against tension and restore force line of the extensor. In order to get more stabilization and protect the suture, many improvements for the

Figure 3. Radiographs: Three-dimension computed tomography (CT) before operation and X-rays at 3 days, 1 months and 3 months after the operation are shown in (A, B, C, and D), respectively.

technique of transosseous tunnels have been made and advocated, including cerclage wire between patella and tibial tuberosity,[3] anchors,[4,5] allograft augmentation,[6] and so on. Almost all of the techniques involve the augmentation between patella and tibia in order to share the tension on the sutures in the transosseous tunnels. Although these improvements make early motion safe and substantially decrease the range from the operation to full range of motion of the knee, they are not perfect: on 1 hand, the strong augmentation such as metal wires or artificial ligaments may have potential risks of restriction of the knee motion range or cheese-cut phenomenon in bone.[7,8] Moreover, because connective tissue is rare between the skin and patellar tendon, thicker materials placed around the patellar tendon will cause a complaint under the skin of the anterior

Table 1

Demographic data and post operative results.

					Clinical assessment						Radiological assessment	
					Passive ROM (Month 6)		Passive ROM (Final follow-up)					
No.	Age	Gender	Side	Range of follow-up (Months)	Injured	Healthy	Injured	Healthy	Lysholm score (Month 6)	Lysholm score (Final follow-up)	I-S ratio	PF joint (comprared with preoperative)
1	72	F	R	22	0–110	0–145	0–145	0–145	94	100	1.1	Similar
2	45	M	R	15	0–130	0–140	0–135	0–140	91	98	1.0	Similar
3	56	F	L	12	0–140	0–150	0–140	0–150	96	90	1.0	Similar
4	49	M	R	14	0–140	0–145	0–145	0–145	95	99	1.1	Similar
5	37	M	L	6	0–130	0–130	0–130	0–130	98	98	1.1	Similar
6	52	F	L	20	0–130	0–140	0–140	0–140	95	100	1.1	Similar
7	25	M	L	6	0–130	0–140	0–130	0–140	96	96	1.1	Similar
8	44	M	L	16	0–140	0–150	0–140	0–150	90	96	1.2	Similar
9	33	M	L	6	0–140	0–145	0–140	0–145	85	85	0.7	Similar
10	51	F	L	12	0–140	0–140	0–140	0–140	90	96	1.1	Similar
11	50	M	L	9	0–140	0–140	0–140	0–140	97	97	1.2	Similar
12	35	M	L	12	0–135	0–135	0–135	0–135	91	96	1.0	Similar
13	52	M	L	15	0–130	0–140	0–140	0–140	97	100	1.1	Similar
14	47	M	R	14	0–135	0–140	0–135	0–140	98	95	1.0	Similar
15	44	M	L	11	0–140	0–150	0–140	0–150	100	98	0.9	Similar
16	43	F	R	12	0–130	0–150	0–140	0–150	100	100	1.1	Similar
17	47	M	R	9	0–130	0–150	0–140	0–150	90	95	1.2	Similar
18	57	F	L	12	0–140	0–140	0–140	0–140	92	95	1.0	Similar
19	61	F	R	9	5–120	5–140	5–135	5–140	90	90	1.	Similar
20	51	F	L	9	0–120	0–135	0–120	0–135	85	96	1.2	Similar
21	50	M	R	12	0–120	0–150	0–150	0–150	90	95	0.8	Similar
22	51	F	R	12	0–130	0–140	0–140	0–140	91	95	0.7	Similar

I-S ration = Insall-Salvati ration, PF = patellofemoral, ROM = range of motion.

portion of the knee.[2,9] On the other hand, almost all of the improvements pay barely attention to reduction and fixation of distal fragments of the patella. Although the articular surface is not involved, it does not mean the fragments at the lower pole of the patella should be ignored, which work as proximal attachments of the patellar tendon after all. If the fracture among the fragments and the upper part of the patella healed, the patellar tendon will have a more stable endpoint and the probability of patellar tendon rupture at the upper endpoint of the patellar tendon after operation will decrease. Furthermore, because the force line of patellar tendon deviates from the direction of the transosseous tunnel during knee bending, there comes the resultant force vertical to the coronal plane of patella (Fig. 1C), the avulsion fragments tend to distract under the resultant force even if tension from the patella tendon is shared by other artificial mechanisms.[10] If they are not reduced or fixed steadily, the distraction may give rise to fracture gap and lead to nonunion, and thus impairs the extensor mechanism in the long-term.[11] In turn, rebuilding the attachment of the patellar tendon can not only provide long term intensity of patellar tendon, but the biomechanics of the patellofemoral joint will restore at the same time profited from anatomical restoration of the proximal part of patellar tendon.[12]

There are numerous methods for patellar fracture fixation; for example, tension band wiring, lag screw, and plate fixation.[13,14] But the methods for fixation with screws are not suitable for LPP because the fragments at the lower part of the patella are too tiny or irregular to handle and have the screws inserted. As a result, we used cerclage wiring. Benefiting from the slender diameter as well as the continuity of the wire, cerclage wiring can not only act on the fragments even if they are tiny, but also can make the scattered fragments gather together all at once. It means that when tightened, the wire can exert pressures coming from multiple directions pointing to the center and draw the fragments together. Although cerclage wiring is not as stable as lag screw or plate fixation, it is still qualified because sutures of transosseous tunnels have helped to bear the tension from the patellar tendon. In our study, sutures of transosseous tunnels restored the extensor mechanism immediately after operation; cerclage wiring drew the avulsion fragments together. Both of the 2 elements provide a proper condition for early bone healing as well as early rehabilitation. When fracture healed, the bony connection between the patella and the patellar tendon is rebuilt and sutures from transosseous tunnels no longer hold the tension, which decreases the incidence of suture rupture and cheese-cut phenomenon of the bone. As shown in the results, the clinical outcomes of the 22 patients treated with this hybrid technique were excellent. There were no postoperative complications, especially, nonunion, long-term week knee extension, or pain around patella. Moreover, because the fragments were fixed firmly, a knee extension splint or hinged knee brace were not used in rehabilitation. As a result, there were no knee stiffness and muscle weakness in all of the patients.

Though the clinical outcomes of our study are satisfactory, there are still limitations in the study. First of all, this study is not a comparative study. Further studies are needed to compare our proposed technique to others to fully assess its clinical efficacy. Moreover, given the limited quantity of in-patients at our hospital, the sample size of the study is not large enough to show a more comprehensive panorama of our hybrid fixation technique, especially for efficacy as well as complications. For example, would patients with severe osteoporosis, have cheese-cut phenomenon after an operation? Would the rate of occurrence of fixation failure increase with the fixation technique compared with other techniques? All of the questions need to be answered in further studies.

5. Conclusion

This study shows that the hybrid technique for LPP, cerclage wiring around patella combined with the technique of transosseous tunnels has good clinical outcomes. Therefore, we recommend using this hybrid technique to treat LPP, especially when the avulsion fragments are dispersed and tiny.

Author contributions

Conceptualization: Jialang Hu and Xin Guo.
Data curation: Xin Guo.
Formal analysis: Xin Guo.
Investigation: Jialang Hu.
Methodology: Jialang Hu.
Project administration and investigation: Jialang Hu and Xin Guo.
Software: Jialang Hu.
Writing – original draft: Jialang Hu.
Writing – review & editing: Xin Guo.

References

[1] Marder RA, Timmerman LA. Primary repair of patellar tendon rupture without augmentation. Am J Sports Med 1999;27:304–7.
[2] Gilmore JH, Clayton-Smith ZJ, Aguilar M, Pneumaticos SG, Giannoudis PV. Reconstruction techniques and clinical results of patellar tendon ruptures: evidence today. Knee 2015;22:148–55.
[3] Ahrberg A, Josten C. Augmentation of patella fractures and patella tendon ruptures with the McLaughlin-Cerclage. Unfallchirurg 2007;110: 685–90.
[4] O'Dowd JA, Lehoang DM, Butler RR, Dewitt DO, Mirzayan R. Operative treatment of acute patellar tendon ruptures. Am J Sports Med 2020;48:2686–91.
[5] Capiola D, Re L. Repair of patellar tendon rupture with suture anchors. Arthroscopy 2007;23:906e901-904.
[6] Core M, Anract P, Raffin J, Biau DJ. Traumatic patellar tendon rupture repair using synthetic ligament augmentation. J Knee Surg 2020;33: 804–9.
[7] Greis PE, Holmstrom MC, Lahav A. Surgical treatment options for patella tendon rupture, Part I: acute. Orthopedics 2005;28:672–9. quiz 680-671.
[8] Haber DB, Ruzbarsky JJ, Arner JW, Vidal AF. Revision patellar tendon repair with anchors, allograft augmentation, and suspensory fixation. Arthrosc Tech 2020;9:e1845–9.
[9] Otsubo H, Kamiya T, Suzuki T, et al. Repair of acute patellar tendon rupture augmented with strong sutures. J Knee Surg 2017;30:336–40.
[10] Krushinski EM, Parks BG, Hinton RY. Gap formation in transpatellar patellar tendon repair: pretensioning Krackow sutures versus standard repair in a cadaver model. Am J Sports Med 2010;38:171–5.
[11] Ettinger M, Dratzidis A, Hurschler C, et al. Biomechanical properties of suture anchor repair compared with transosseous sutures in patellar tendon ruptures: a cadaveric study. Am J Sports Med 2013;41: 2540–4.
[12] Camarda L, Morello S, Balistreri F, D'Arienzo A, D'Arienzo M. Non-metallic implant for patellar fracture fixation: a systematic review. Injury 2016;47:1613–7.
[13] Jang JH, Rhee SJ, Kim JW. Hook plating in patella fractures. Injury 2019;50:2084–8.
[14] Wild M, Fischer K, Hilsenbeck F, Hakimi M, Betsch M. Treating patella fractures with a fixed-angle patella plate-A prospective observational study. Injury 2016;47:1737–43.