MUSCULOSKELETAL SURGERY (2019) 103:283–287
https://doi.org/10.1007/s12306-019-00587-1

ORIGINAL ARTICLE

A combined tension-band braided polyester and suture button technique is a valuable treatment alternative for transverse patellar fractures in athletes

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Received: 26 March 2018 / Accepted: 3 January 2019 / Published online: 7 January 2019

Abstract

Purpose Transverse patellar fractures (TPFs) are uncommon in athletes, and their treatment can be challenging. Stable fixation is commonly achieved by compression screw fixation and stainless steel cerclage wire, but this technique can be associated with complications like nonunion, infection and the need for early hardware removal. We used a combined tension-band (figure-of-eight) braided polyester and suture button technique to treat four athletes who presented with transverse patellar fractures. This technique has shown to be a valuable alternative to the classic technique and allows for adequate fracture compression, stability and union in TPF.

Methods Using a tension-band braided polyester and suture button technique (Arthrex FibreTape^{R}&TightRope^{R}), we treated four athletes with transverse patellar fractures from September 2015 till January 2017. The polyester was looped over the four suture button fixation points and tensioned in a figure-of-eight fashion. The average age of the athletes was 26 years (range 17–36). Follow-up ranged from 5 to 21 months. All four patients were treated using the same surgical technique (minimally invasive surgery) with the same postoperative recovery and the same physiotherapy protocol.

Results Full recovery using suture button adjustable loop fixation device was obtained in all four cases within 3 months after surgery, with fracture healing confirmed on postoperative radiographs. No patients required hardware removal. Potential problems with this technique can include bony tunnel malpositioning or soft tissue interpositioning underneath the suture buttons.

Conclusion The combination of a suture button fixation and a braided polyester tension-band technique has shown to be a valuable alternative to the fracture management of transverse patella fractures in athletes. This results in fracture healing, low risk of complications and no need for hardware removal.

Keywords Patellar fractures · Suture button · Tension-band · Athlete

Introduction

Patellar fractures make up approximately 1% of all fractures presenting to the emergency department, with about 20% involving the inferior pole of the patella [1, 2]. Transverse fractures of the patella in athletes commonly result from indirect trauma to the knee (due to quadriceps contraction), particularly in the adolescent population. Another cause can be a direct trauma/blow to the inferior part of the patella, especially in contact sports [3]. A fracture gap of more than two millimeters is considered to be an indication for surgical fixation [1]. Non-displaced transverse patellar fractures do not require surgical treatment, but their conservative treatment in athletes remains controversial [2]. Compression at the transverse patellar fracture site has to be obtained in order to achieve bony healing.

Compression also reduces the risk of malunion, delayed union and nonunion. Classic metal compression screws and stainless steel cerclage wires used in a tension-band fashion are commonly used to provide a stable fixation, but they are associated with complications like infection, nonunion,

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fracture fragmentation and the need for early hardware removal [2].

The tension-band principle (TBP) in fracture fixation was first described by Friedrich Pauwels [4]. The most widely used TBP technique is the use of two stainless steel K-wires and a figure-of-eight (FOE) stainless steel cerclage wire. This technique has been shown to be very successful for fracture fixation but is also associated with hardware-related complications such as prominence of wires, skin irritation, infection, hardware migration and hardware breakage [5–11]. Several authors have also reported TBP fixation failure due to soft tissue interposition and loss of compression [4, 6].

Principle tension-band construct can also be created by using a braided polyester non-absorbable suture instead of a stainless steel cerclage wire with reported satisfactory clinical results, fracture union and lower complication rates in cadaveric and experimental studies [5, 12–14]. Although some cases of suture failure and compression loss have been reported [5], fracture union and knot reliability are confirmed through the use of various suture techniques [14].

Our hypothesis was that a double parallel suture button technique in combination with a braided polyester tension-band (figure-of-eight) suture is a safe and valuable alternative in the treatment of transverse patellar fractures in athletes.

Materials and methods

Between September 2015 and January 2017, four athletes presented at our surgical department at Aspetar Hospital with a transverse fracture at the inferior pole of the patella (Fig. a–c). All four were treated surgically using two suture buttons in combination with a braided polyester suture tension-band (figure-of-eight) technique. Two patients were professional football players in the Qatar Football Stars League, and two patients were active recreational athletes. Their mean age was 26 years (range 17–36 years). The mechanism of injury in two patients was a direct trauma and in the two other patients an indirect injury (quadriceps contraction) during fast changing-direction ("pivoting") running. Patients demographic data are presented in Table 1.

The patients were treated by two senior orthopedic knee surgeons using the same surgical technique (Aspetar Sports Medicine and Orthopedic Surgery Hospital in Doha, Qatar). The average follow-up time was 12 months (range 5–21 months). The study was approved by Aspetar Ethical Committee, and consent forms were signed by all participants.

Description of the surgical technique

General anesthesia (GA) was administered to all four patients who were positioned in a supine position on a well-padded operation table. All patients received antibiotic prophylaxis (first generation of cephalosporin) 1 h prior to surgery.

After clinical examination under anesthesia (EUA), diagnostic arthroscopy was performed to assess for intra-articular pathology. Next, two transverse incisions (or one longitudinal) were created proximal and distal from the patellar fracture site.

Under fluoroscopic guidance, fracture reduction was achieved using a pointed reduction clamp (Fig. 1). A 2.0-mm drill hole was made in a retrograde direction in preparation for the definitive hardware. After X-ray confirmation

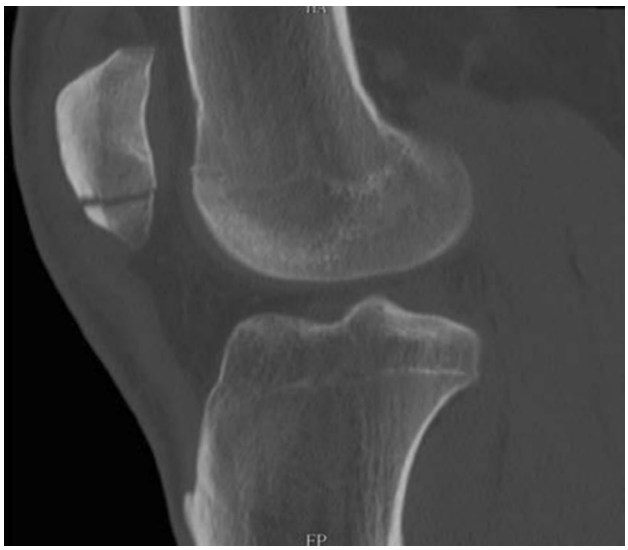

Fig. 1 Sagital CT scan image depicting a distal patellar knee fracture

Table 1 Demographic data of patella transverse fracture participants

Patient No.	Initials	Age (years)	Gender	Sports	Mechanism of injury	Follow-up (months)
1	AJZ	17	Male	Football	Direct trauma	5
2	HA	25	Male	Football	Direct trauma	10
3	MAM	27	Male	Football	Indirect (quadriceps contraction)	12
4	FH	36	Male	Football	Indirect (quadriceps contraction)	21

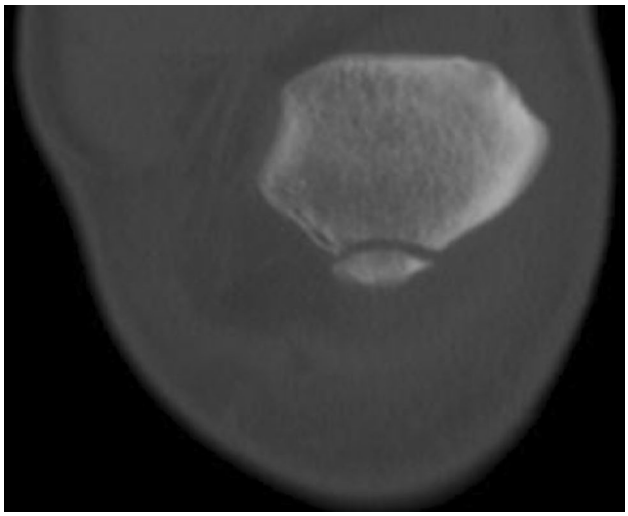

Fig. 2 Coronal CT scan image depicting a distal transverse patellar knee fracture

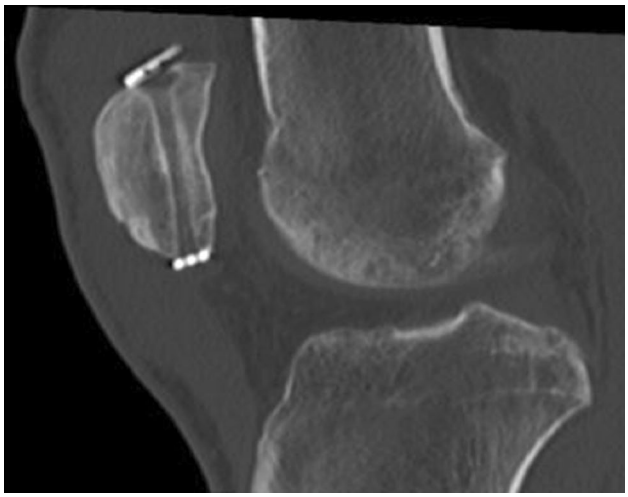

Fig. 3 Sagital CT scan image depicting a suture button fixation of a distal transverse patellar knee fracture

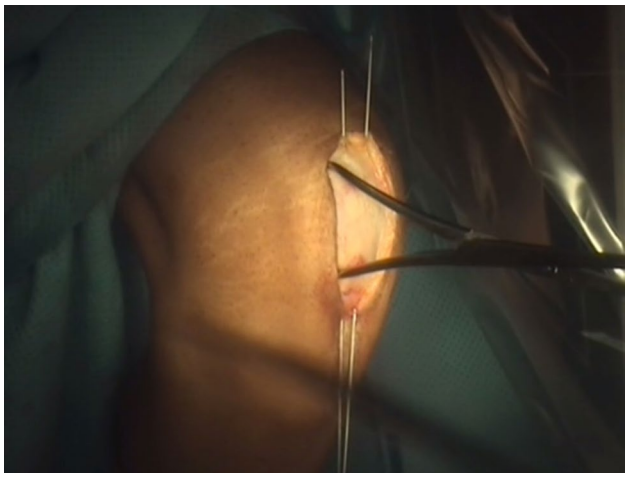

Fig. 4 Intra-operative photo image of a double K-wire preparatory fixation after fracture reduction with a surgical clamp

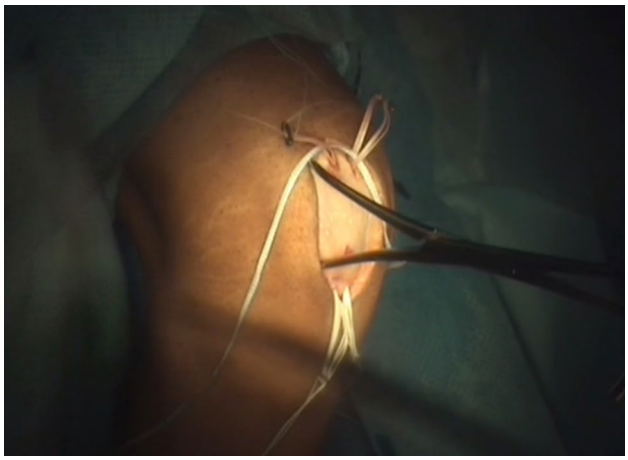

Fig. 5 Intra-operative photo image of the suture button fixation procedure

on antero-posterior (AP) and lateral view, the drill hole was enlarged to a 3.5-mm tunnel. Suture buttons (Arthrex TightRope^{R}) were passed centrally through the parallel drilled tunnels, from the patellar apex to the patellar superior cortical ridge and tightened.

A braided polyester suture (Arthrex FibreTape^{R}) was added over the suture button ends in a figure-of-eight fashion tension-band fixation principle (Fig. 2). Patellar stability was confirmed under dynamic arthroscopic view in full knee flexion and extension (Figs. 3, 4). The position of the suture buttons, fracture line compression and bony tunnels were all verified arthroscopically and radiographically through AP and lateral fluoroscopic views. After X-ray confirmation, irrigation and wound closure in three layers were performed and a knee brace was applied, locked in extension.

Postoperatively, RICE (rest, ice, compression, elevation) protocol was administered for 48 h, in addition to analgesics and anticoagulant therapy during the immobilization period. An extension brace was used for 2 weeks, and weight bearing slowly progressed. The brace was removed at the end of 2 weeks. Physiotherapy was started after brace removal with kinesiotherapy and hydrotherapy, as per our Aspetar Hospital Physiotherapy protocol. X-ray imaging in AP and lateral views was performed immediately after surgery (in the extension brace) and at 4-week intervals until complete healing had occurred

(at 3 months). All patients returned to sports 3 months after the surgery and returned to professional competition 4.5 months after the surgery (Fig. 5).

Discussion

Tension-band wire fixation of patellar fractures is commonly associated with significant hardware-related complications including infection [12]. Braided polyester suture fixation is considered an adequate alternative treatment option, but these suture fixation techniques are shown to have a higher failure rate due to problems with rigid suture knot fixation [15].

The suture button adjustable loop fixation device (Arthrex TightRope^{R}) is commonly used to treat unstable syndesmotic injuries of the ankle, but in these four athlete cases, we extrapolated this principle from the ankle to the knee (Fig. 6).

The combined use of a double suture button adjustable loop fixation device (Arthrex TightRope^{R}) and a four-point locking tension-band (figure-of-eight) braided polyester suture (Arthrex FibreTape^{R}) may not only result in a stiff rigid fixation (using a knotless system) but may also obviate the need for subsequent implant removal due to hardware-related postoperative problems (Fig. 7).

In a cadaveric study, Brink and co-workers showed that the success of the fixation was related to static compression rather than dynamic and intermittent compression via tension-band effect [16]. In another cadaveric study, Han et al. [12] found that suture button fixation using extraosseous compression produced similar results in transverse patellar fracture fixation when compared to the traditional tension-band wire technique. Their team proposed that suture button fixation, via extraosseous double-button compression, may be more reliable than cancellous screw fixation [12].

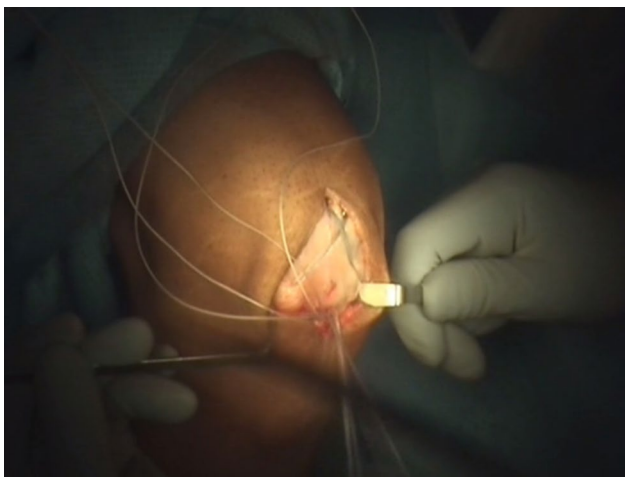

Fig. 6 Intra-operative photo image of the figure-of-eight construct with suture button fixation of the distal transverse patellar fracture

Fig. 7 Intra-operative photo image of the final fracture fixation construct with suture button in a figure-of-eight formation

Chul-Hyun and colleagues and Kraus and colleagues used suture button device to stabilize displaced lateral clavicle fractures with coracoclavicular instability [17, 18]. They reported excellent clinical and radiographic results to recreate stability of the clavicle. The major complications using these techniques are nonunion or delayed union [17, 18]. There were no complications among patients treated in our study. Postoperatively, we found no pain in our patients and during the rehabilitation process as well. After brace removal, we gradually increase the knee flexion, for 30 degrees in every 2 weeks. Respecting the "Aspetar Protocol," all patients gain the full, painless recovery. Also, using this technique, there is no need for hardware removal and full recovery (match level) was obtained in 4.5 months after injury.

Limitations to this case series are the small number of cases and the lack of any control groups. Also, all our participants were athletes, with good bone quality and without concomitant diseases.

The aim of this series is to highlight that a minimally invasive, low-demanding and low-cost surgical technique is a safe and valuable technique in the treatment of transverse patellar knee fractures in athletes and a possible alternative to the traditional fixation techniques.

We propose this technique in young patients with transverse patellar fractures, especially athletes, with good bone quality and without concomitant diseases, with transverse patellar fractures with fragment size over 1.5 cm in diameter.

Conclusion

The most important finding of the present study is that the combination of a suture button fixation and a braided polyester tension-band technique has shown to be a valuable alternative to the fracture management of transverse patella fractures in athletes. This technique allows for an adequate fracture healing and a lower risk of complications and need for early hardware removal.

Compliance with ethical standards

Conflict of interest All authors report no conflict of interest associated with the work presented in the submitted manuscript.

References

1. Lotke PA, Ecker ML (1981) Transverse fractures of the patella. Clin Orthop Relat Res 158:180–184
2. Neumann HS, Winckler S, Strobel M (1993) Long-term results of surgical management of patellar fractures. Unfallchirurg 96:305–310
3. Beamish A, Roberts G, Cnudde P (2012) A case of patellar fractures in monozygotic twin gymnasts. Sports Med Arthrosc Rehabil Ther Technol 20:1–4
4. Pauwels F (1935) Der schenkelhalsbruchemmechanisches problem: Grundlagen des Heilungsvorganges Prognose und kausale-Therapie. Ferdinand EnkeVerlag, Stuttgart
5. Hung LK, Chan KM, Chow YN, Leung PC (1985) Fractured patella: operative treatment using the tension band principle. Injury 16(5):343–347
6. Smith ST, Cramer KE, Karges DE, Watson JT, Moed BR (1997) Early complications in the operative treatment of patella fractures. J Orthop Trauma 11(3):183–187
7. Gosal HS, Singh P, Field RE (2001) Clinical experience of patellar fracture fixation using metal wire or non-absorbable polyester—a study of 37 cases. Injury 32(2):129–135
8. Kumar G, Mereddy PK, Hakkalamani S, Donnachie NJ (2010) Implant removal following surgical stabilization of patella fracture. Orthopedics 12:33
9. Choi HR, Min KD, Choi SW, Lee BI (2008) Migration to the popliteal fossa of broken wires from a fixed patellar fracture. Knee 15(6):491–493
10. Biddau F, Fioriti M, Benelli G (2006) Migration of a broken cerclage wire from the patella into the heart. A case report. J Bone Joint Surg Am 88(9):2057–2059
11. Baran O, Manisali M, Cecen B (2009) Anatomical and biomechanical evaluation of the tension band technique in patellar fractures. Int Orthop 33(4):1113–1117
12. Han F, Pearce CJ, Ng DQ, Ramruttun AK, Chong DY, Murphy D, Lim CT, Lee BC (2017) A double button adjustable loop device is biomechanically equivalent to tension band wire in the fixation of transverse patellar fractures—a cadaveric study. Injury 48(2):270–276
13. Patel CR, Parks BG, Wang Y, Ebert FR, Jinnah RH (2000) Fixation of patella fractures with braided polyester suture: a biomechanical study. Injury 31(1):1–6
14. Hughes SC, Stott PM, Hearnden AJ, Ripley LG (2007) A new and effective tension-band braided polyester suture technique for transverse patellar fracture fixation. Injury 38(2):212–222
15. Hughes SC, Stott PM, Hearnden AJ, Ripley LG (2007) A new and effective tension-band braided polyester suture technique for transverse patellar fracture fixation. Injury 38(2):212–222
16. Brink PR, Windolf M, de Boer P, Brianza S, Braunstein V, Schwieger K (2013) Tension band wiring of the olecranon: Is it really a dynamic principle of osteosynthesis? Injury 44(4):518
17. Kraus N, Stein V, Gerhardt C, Scheibel M (2015) Arthroscopically assisted stabilization of displaced lateral clavicle fractures with coracoclavicular instability. Arch Orthop Trauma Surg 135:1283–1290
18. Chul-Hyun C, Jae-Hoon J, Beom-Soo K (2017) Coracoclavicular stabilization using suture button device for Neer type IIB lateral clavicle fractures. J Shoulder Elbow Surg 26:804–808