Double fixation of displaced patella fractures using bioabsorbable cannulated lag screws and braided polyester suture tension bands

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Introduction

Patella fractures are relatively uncommon and only account for 0.5–1.5% of all bone fractures. Due to the patella's importance as regards the extensor mechanism, efforts should be made to preserve the patella. The goal of the therapy is the anatomical reduction of both the fracture and the articular surface in addition to the stable fixation of the fracture, which allows early rehabilitation of the knee. Surgical treatment becomes necessary when the fracture displacement exceeds 3 mm or the articular incongruity exceeds 2 mm.

The tension band technique is most often used for patella fractures, and has been shown to produce satisfactory outcomes. Metal implants, such as stainless steel wires, K-wires and screws have generally been used for this method of fixation. However, numerous complications including postoperative pain, K-wire migration and other complications related to the use of metal implants are fairly common, and revision surgery to remove the implants becomes necessary. According to Hung et al., the incidence of complications related to the use of wire loops was 47%, and 15% had required wire removal. Moreover, far more serious complications, such as intra-articular migration of the broken wire, have also been reported.

In recent years, non-metallic implants have become available for use in fracture fixation. Some authors have evaluated new fixation techniques for fractures of the patella or olecranon using various materials, such as braided polyester sutures and biodegradable screws, via biomechanical studies and randomised clinical trials. Such studies have discovered that...
when compared with metal implants, bioabsorbable implants demonstrated comparable results for patella and olecranon fracture fixation and were notably characterised by less postoperative pain. However, the combined use of bioabsorbable cannulated lag screws and braided polyester suture tension bands was seldom reported.

We speculated that bioabsorbable screws and braided polyester sutures might be a useful alternative to the use of stainless steel wires, K-wires and metal screws that have been traditionally used in surgeries to repair patella fractures, due to the potential for reducing the rate of postoperative complications and avoiding additional operations to remove the implants. Thus, we developed a new double technique for patella fracture fixation using bioabsorbable cannulated lag screws and braided polyester suture tension bands. The goal of this study was to evaluate the effectiveness and safety of this new technique for the treatment of patella fractures.

Materials and methods

Patients

Nine male and six female patients with displaced transverse or comminuted patella fractures with adequate bone composition to accommodate screws were enrolled in this prospective study. Individuals with severe comminuted patella fractures were not eligible because the lag screws cannot be used without adequate bone composition (i.e., in cases involving severe comminuted patella fractures). The patients’ ages ranged from 26 to 67 years (mean 46.2 years). All of the patients were treated by the ORIF procedure using bioabsorbable cannulated lag screws and braided polyester suture tension bands between September 2008 and June 2009, after consent was obtained from all patients, and approval was obtained from the ethics committee of the authors’ institution. The patients were then followed up after the surgery to evaluate the time required for radiographic bone union, the knee joint range of motion at the time of radiographic bone union, the degree of pain assessed using the visual analogue scale (VAS), the function of knee using the Lysholm score and the presence of any additional complications from the surgery.

Materials

Two No. 5 Ethibond (Ethicon, Somerville, NJ, USA) braided polyester sutures and two bioabsorbable cannulated lag screws with a 4.5-mm diameter (Conmed Linvatec, Largo, FL, USA) were used for each procedure.

Surgical technique

Under lumbar anaesthesia, a median longitudinal or transverse skin incision approximately 7 cm in length was made above the patella. After debriding the clot, the fracture was carefully reduced to ensure that the articular surface of the patella was smooth. The anatomical reduction position of the fractured patella was maintained using bone reduction forceps prior to drilling two longitudinal parallel holes (3.5 mm in diameter) within the central portion of the patella in the sagittal plane from a distal to proximal direction (Fig. 1). The distal portions of the drill holes were overdrilled to ensure that the screws act as lag screws that could offer compression across the fracture line. The length of each screw was 1–2 mm shorter than the length of the drill hole. Two bioabsorbable cannulated lag screws were subsequently screwed into the drill holes from a distal to proximal direction, and the fracture was fixed via compression burying the heads of the screws into the distal cortical bone.

Two No. 5 Ethibond braided polyester sutures were then passed through the cannulated screws and were subsequently crossed over the front of the patella forming a horizontally oriented figure eight on the anterior surface of the patella beneath the fascia. The suture was initially tied with a sliding knot centred on the distal pole of the patella after which the suture loop was tightened with sufficient pressure to achieve a stable and firm osteosynthesis. Finally, the knot was tied a minimum of three times to secure the fractured patella (Fig. 2). For comminuted patella fractures, a circular suture surrounding the patella should be positioned using a loop of No. 5 Ethibond braided polyester suture to improve the fixation.

The knee was gently flexed, and then the position of reduced fragments and the stability of the fixation were checked. At this point, any incisions or tears observed in the retinacula were repaired. Prior to wound closure, the full range of knee motion should be assessed an additional two to three times to ensure that there is no restriction in knee motion.

Radiographs and a photograph of the operated site are shown in Fig. 3.

Postoperative management

Both active and passive knee motion exercises began 1 day after the surgery, when knee flexion was less than 90°. At this time, isometric exercises involving the quadriceps were initiated. On
postoperative day 2 or 3, partial or full weight-bearing exercises were started under the protection of a hinge brace, while walking exercises involving the use of crutches also began at this time and lasted for a period of 4 weeks. Beginning in the fourth postoperative week, normal daily activities for the participants were permitted. Approximately 3 months after the surgery, non-

Fig. 3. Radiographs and a photograph of the operated site. (a) Preoperative lateral radiograph; (b) two Kirschner wires (2 mm in diameter) drilled from a distal to proximal direction longitudinally as guide wires; (c) after the distal portions of the drill holes were overdrilled, bioabsorbable cannulated screw was screwed into the drill holes from a distal to proximal direction; (d) photograph after fixation showed that the suture was placed beneath the fascia and in intimate contact with the bone surface; (e) C-arm lateral radiograph immediately after fixation; (f) radiograph 12 months after surgery.
confrontational sports activities were permitted, provided the patient’s clinical indicators were satisfactory and that there was radiographic evidence of bone healing.

**Results**

All of the patients were followed for more than 1 year post-treatment (range, 12–19 months; mean post-treatment follow up time of 14 months), and the clinical characteristics of all patients are shown in Table 1.

**Time of radiographic bone union**

The bone fracture union occurred at approximately 3 months post-surgery in all cases not involving implants failure or redisplacement of the fractured site.

**Range of motion**

At the time of bone union, the mean knee joint range of motion was 0–134.6°. However, one obese female patient with a comminuted patella fracture had a range of knee motion of 0–120° at the time of bone union due to slow progress made during rehabilitation. However, this patient had a normal range of knee motion and satisfactory knee function at 6 months post-surgery.

**VAS score**

The mean VAS score of all patients was 0.7 at the time of bone union. The pain was most often reported to be located on the front knee and was caused by excessive activity. Notably, no patient complained of pain due to irritation from the implants.

**Function of knee (Lysholm score)**

The mean Lysholm scores at the time of bone union and 12 months after surgery were 86.7 and 95.7, respectively. All of the patients eventually returned to their preoperative activity level.

**Complications**

No postoperative complications, such as infection, dislocation or breakage of the implants were observed up through the final follow-up examination.

**Discussion**

The modified tension band wire technique suggested by the Abreitgemeinschaft für Osteosynthese (AO) appears to be the most widely accepted approach used for practically all types of patella fractures. For this technique, compression of the fracture site is obtained only by the presence of a figure-eight tension band wire located in front of the patella, especially during knee flexion. However, this tension wire system probably does not offer sufficient compression and may lead to fracture displacement during full knee extension or due to soft-tissue atrophy within a few weeks after surgery. Generally, 25–42% of the patients who underwent the modified tension band wire technique have suboptimal results due to wire migration, failure of fixation and postoperative pain because of implant irritation.

Alternatively, metal cannulated lag screws with or without a tension band wire placed through the screws have been introduced in some instances. According to previous reports, combining metal cannulated lag screws with a tension band wire could provide superior fixation strength and greater stability along with a decreased risk of fracture dislocation than each individual method. The lag screws and tension bands may offer compression of the fracture site both during knee extension and flexion, as well as during times of higher load-bearing capacity. This technique is mostly applicable to transverse and comminuted patella fractures with adequate bone composition for screws, whereas patients with severe comminuted patella fractures were not eligible, as in our study.

Previous studies have shown that postoperative symptoms related to patella fracture implants decreased in severity with the use of non-metallic implants. In recent years, a significant amount of research has been conducted on the use of braided polyester sutures with high tensile strength in patella fracture fixation procedures, suggesting their use as an alternative to metal wires. These braided polyester sutures have several advantages both in vitro and in vivo. First, in vitro studies have shown that braided polyester sutures have higher stiffness and tensile strength than other non-absorbable or absorbable sutures. Second, braided polyester sutures demonstrate minimal tissue reaction and have been shown to be safe for clinical use. Moreover, braided polyester sutures can maintain their mechanical characteristics in vivo. The examination of various suture configurations performed by Patel et al. determined that the average fracture gap size of the suture Lotke technique with two
loops of No. 5 Ethibond was comparable to the wire Lotke technique in that no failures of fixation occurred. Thus, we used two loops of No. 5 Ethibond in our study.

Metal cannulated lag screws with a tension band wire and the Lotke technique with suture were both proved to be stable fixation techniques for patella fractures.13,22 The technique reported herein originated from them and can avoid additional surgeries for implant problems. Biodegradable screws and braided polyester sutures have been widely used for fracture fixation of the olecranon and the malleoli, as evidenced by biomechanical studies and clinical trials with positive results. The tension band used in our technique is more like a horizontally oriented figure-eight tension band, which was found to be stronger than the vertically oriented bands.18 In addition, the compression provided by the lag screws could offer greater stability than the Lotke technique that only uses a suture, thus allowing for an earlier start to rehabilitation of the knee joint, as indicated in our study. For patients with comminuted patella fractures, the rehabilitation of the knee function may also be delayed, but with good results following progressed training.

Several technical points of this technique merit discussion. First, one pole of the drill holes was overdrilled to allow the screws to act as lag screws that could offer compression of the fracture site. The screws should be screwed into the drill holes gently to prevent them from being broken. Second, it is important to place the suture in close contact with the bone surface to achieve secure fixation and to avoid suture loosening after soft-tissue atrophy.6 Studies have shown that when using the tension band technique, the wire or suture tension band that is adjacent to the bone surface has to be more stable than that turned over the soft tissue.26 To ensure that the suture is in close contact with the bone, the suture should be passed under the soft tissue such that it directly contacts the bone, even when no intervening soft tissue is present at the proximal and distal poles of the patella, a manoeuvre that could not be achieved easily using metal wire. Moreover, to achieve proper suture and bone contact, the heads of the screws should be buried within the cortical bone, and the length of the screw should be 1–2 mm shorter than the length of the drill holes, which can also help avoid skin and soft tissue irritation from the screws. Third, the tension band suture loop should be gradually tightened until the fragments are in close contact. Thus, the sliding knot technique is recommended because the tightening process of the loop can be controlled.13 The knots should be buried in the soft tissue to reduce symptoms caused by them.9 Fourth, knee flexion should be repeated several times after fracture fixation is completed, but before wound closure to check the stability of the fixation and to ensure that there is no restriction in the knee’s motion. Because a gap of <2 mm may influence bone union,29 this step can help medical staff vary the rehabilitation programme for each patient.

In this study, a new double fixation technique using bioabsorbable cannulated lag screws and braided polyester suture tension bands for patella fracture fixation was devised and was shown to be safe and to produce satisfactory clinical results. The most important benefits of this technique include a reduction of complications due to the lack of metal implants and the ability to perform a single operation without the need for additional surgeries to remove the implants. On the other hand, a limitation of this technique is its relatively narrow application to patella fractures with adequate bone composition to accommodate screws.

Conclusions

This new double fixation technique using bioabsorbable cannulated lag screws and braided polyester suture tension bands was shown to be safe and resulted in satisfactory outcomes for patients with patella fractures without obvious complications. The applications include procedures involving transverse patella fractures and comminuted patella fractures with adequate bone composition to accommodate screws.

References

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