

## Comminuted Fractures of The Lower Pole of The Patella - To Fix or Resect? A Case Report and Review of the Literature

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### Abstract

Comminuted lower pole patellar fractures requiring surgical intervention remains controversial in terms of the best surgical option. Current surgical options range from resection of the distal pole fragments with reattachment of the patellar tendon to the proximal fragment, to various forms of internal fixation. A case of a patient presenting with a comminuted distal patellar fracture is discussed below, followed by the pros and cons of the various surgical options. The current evidence is now in favour of fixation of the distal fragments with an implant which facilitates earlier rehabilitation.

**Keywords:** Lower pole; patella; comminuted

### Introduction

The best method of managing lower pole comminuted fractures remains controversial [1-4]. There is however general agreement that open operation is indicated when fragments are widely displaced [4]. Current surgical options include 1) internal fixation of the pole fragments and 2) resection of the distal pole fragments with repair of the patellar tendon to the patella [5]. The internal fixation options include 1) tension band wiring, 2) cerclage wiring and 3) screw fixation [6,7].

### Case Report

A 36 year old female presented to Hospital with a history of pain and swelling to her left knee. She gave a history of slipping while descending a staircase and her left knee directly hit the floor. On examination, she had minor abrasions over her left knee, a moderate effusion and markedly decreased painful range of motion. She was unable to actively extend her knee despite receiving analgesia. Radiographs of the left knee revealed a comminuted fracture of the distal third of the patella (see figure 1).



**Figure 1:** Radiographs of the left knee revealed a comminuted fracture of the distal third of the patella.

She was taken to the operating theatre two weeks post injury and via a midline longitudinal incision, the patella was exposed. The distal pole had numerous fracture lines but the articular surface was intact. This was reduced onto the major proximal fragment. The reduction was assessed by digital palpation and deemed satisfactory. The reduction was held with two Kirshner wires and reinforced with an anterior tension band in a figure of eight configuration (see figure 2).



**Figure 2:** Two Kirshner wires and reinforced with an anterior tension band in a figure of eight configuration.

She was allowed to perform active range of motion exercises and partially weight bear at six weeks post surgery. The patient was allowed to do active range of motion exercises and fully weight bear at 12 weeks post surgery. Radiographs at that time showed evidence of adequate healing.



**Figure 3:** Removal of implants.

At six months she was fully functional on the job where she was a sales representative. One year post operatively she had no pain during ambulation and her active range of motion was 0-115 degrees. She was able to perform a straight leg raise and had grade 5 power of the quadriceps. Due to minor intermittent pain while bending the knee she requested removal of implants which was done (see Figure 3). Her course three months post removal had been uneventful.

### Discussion

A patellar fracture represents approximately 1% of all fractures [8-10]. The subcutaneous location makes the patella prone to direct injuries such as in the index case [8,11]. The small amount of prepatellar soft tissue in addition to the direct contact with the distal femur posteriorly, allows the majority of the force of a direct blow to be delivered to the patella [11]. This often results in damage to the articular cartilage as well as the comminuted fracture pattern observed in the index case [5,11,12].

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The patella is the largest human sesamoid bone and lies within the knee extensor mechanism [11-13]. The patellar ligament arises from the inferior pole whereas the majority of the quadriceps aponeurosis directly inserts into the superior pole and is confluent with the patellar ligament. The proximal  $\frac{3}{4}$  of the patellar surface is covered with articular cartilage which only partially conforms to the anterior surface of the distal femur and trochlea [11,13]. The quadriceps muscle and tendon, the patella and patellar ligament all make up the extensor mechanism [13].

Brooke [14] stated that phylogeny alone is responsible for the presence and development of the patella. He felt there was no evidence supporting a functional need. The patella is known to increase the lever arm of the knee extension which increases the knee extensor moment generated by quadriceps contraction [11,12]. Brooke [14] thought that the leverage action was functionally insignificant and questioned its value in assisting in movement of the joint. The force generated by the quadriceps is transmitted to the patellar ligament via the patella, thus transmitting nearly all the force of the quadriceps contraction [11,13]. During knee flexion the posterior surface of the patella makes contact with the distal aspect of the femur and is subjected to a compressive force [7]. A three point bending configuration occurs as a result of the surface loading, resulting in a tension on the anterior surface of the patella [7].

Since patellar fractures play an important role in the knee function, effective treatment is essential. Several fractures are associated with complete disruption of the extensor mechanism. When the extensor retinaculum is torn, the quadriceps will displace the superior fragment proximally, thus necessitating operative treatment [15]. Patellar fractures were one of the first fractures to be surgically treated [4,16].

Depalma and Flynn's [17] experience with patellectomy made them conclude that the patella is an essential component of the extensor mechanism. They found that its loss reduces overall knee efficiency with associated decreased power, tone and volume of the quadriceps muscle, making the knee vulnerable to repeated stresses and strains. Levack, *et al.* [9] found that time for recovery was two years, but the patients regained full function despite an initial decrease in quadriceps power. Kaufer [18] described a mechanical study to define the function of the patella. He found that the movement arm of the knee increases during extension in order to provide a fairly constant extension torque, which contradicted Brooke's statement. He stated that if patellectomy is performed via a tendon splitting incision, the pull on the patellar ligament by the quadriceps are diverted from the central portion of the extensor mechanism, into the medial and lateral patellar retinacula which shortens the moment arm and produces decreased torque. He further stated that up to a 30% increase in the force in the quadriceps is required to achieve full extension.

Cakici, *et al.* [1] reported a case in which there was calcification in the patellar tendon post partial patellectomy and cerclage wiring. There was subsequently an unexpected rupture of the tibial tubercle. This was thought to be due to contraction of the quadriceps and the force being transmitted to the distal weaker non-ossified ligaments part of the ossified tendon.

Patellar fractures in which there is one large fragment intact, such as in the index case, is fairly common [4]. It has been felt that comminution of the inferior pole requires excision of the multiple small fragments [13]. Partial patellectomy must be considered when there is extensive comminution or intra-operative fragmentation which precludes stable fracture fixation [7,13]. The extensor mechanism is re-established via repair of the patella ligament to the remaining proximal fragment [13]. Thomson [4] introduced the surgical technique in order to maintain the stable proximal fragment while relying solely on union of the tendinous structures onto the proximal fragment. This has been said to eliminate the problem of attempting to fix multiple fragments which Thompson believed had little osteogenic activity. The possibility of refracture is decreased and allows early rehabilitation [4]. Unfortunately, patellofemoral osteoarthritis has occurred as a result of patellar tilting post partial patellectomy [19]. Marder, *et al.* [19] found that anterior attachment of the patellar ligament was associated with decreased contact area and less contact pressures than posterior reattachment with up to a 40% patellectomy. Saltzman, *et al.* [3] found that 78% of his partial patellectomy patients had a good or excellent outcome. Using concentric isokinetic testing, he demonstrated a 15% decrease in isokinetic quadriceps strength.

Fixation is an alternative for comminuted distal pole fractures. The goals of surgery in the index case were to obtain an accurate reduction of the articular surface and stable fixation and restoration of the knee extension mechanism which allows early range of motion [6,8,13,20]. Slightly worse outcome had been observed when a fracture had a greater than 2 mm gap between the major fragments [21]. Even when articular cartilage is initially damaged, injured cartilage has healing properties [21]. Potential problems with fixation include delayed rehabilitation, especially in highly comminuted injuries and the possible need for another procedure to remove implants [2,13] such as the index case. Milankov, *et al.* [10] developed a pin and wire technique for temporary protection of the patellar ligament. In contrast to delayed rehabilitation in the index case, partial patellectomy allows for good outcome utilising early rehabilitation [12]. Kastelec and Veselko [5] found no studies in the literature which compared the results of internal fixation versus patellar pole resection [5].

Displaced comminuted fractures of the inferior pole of the patella are often difficult to reduce and fix firmly enough to allow early movement of the knee [7]. Internal fixation is used to maintain reduction until full healing has occurred. It must be strong enough to resist the bending and distracting forces across the patella during the postoperative period in attempting to achieve early motion [8]. Tension band wiring resists bending loads across the fracture during knee flexion where the tension band is on the tension side that is the anterior surface [8]. It is now felt that since the patella plays such an important role in the extensor mechanism, every attempt should be made to preserve it as was done in the index case [8].

The tension band technique has been progressively modified to improve on implant strength to allow early range of motion [13]. It has been used in comminuted fractures which could not be fixed with inter-fragmentary Kirshner wires [13]. The combination of a tension band wiring and cerclage has been found to be a viable option for treating comminuted patellar fracture allowing for decreased risk of implant failure, malunion or non-union and pain free full range of motion [6,13]. Although the inferior pole was comminuted in the index case, the fragments were not significantly displaced and were solid enough for two wires to hold the inferior pole to the main proximal fragment. Mobilisation was delayed in the index case because the fixation was not deemed rigid because some of the distal pole fragments displaced when the construct was tested during the terminal portion of range of motion.

Turgut, *et al.* [22] reported the first series utilising arthroscopically assisted osteosynthesis which consisted of cross Kirshner wiring and cerclage wiring. Patients with comminuted fractures in that series all healed well and were satisfied with their results. This method minimises soft tissue damage by using four stab incisions which avoids delaying surgery in cases where the soft tissue is compromised by the initial injury [22]. The patients were then immobilised for three weeks. The disadvantage of this technique is an inability to repair a retinacular tear at that time [22].

Yang and Byun [7] noted that over-tightening of a cerclage may cause patella baja. He developed a technique for comminuted distal pole fractures using a vertical wiring technique where each wire encircled the main fragments of the inferior pole. The patients were allowed passive range of motion up to 60° in the first month and 90° in the second month. This technique allowed maintenance of patellar length and minimal injury to the tendon [7].

An alternative method of internal fixation is the basket plate which primarily was designed for surgical management of comminuted fractures of the patellar apex [5,23]. Its shape is similar to the inferior pole which allows it to hold the comminuted fragments in position [5]. Patellar ligament fibres are pushed apart by four posterior hooks and three anterior hooks. Two parallel cancellous screws are used to fix the basket plate to the main patellar fragments [5] via inter-fragmentary compression. Two lateral screws placed obliquely increases stability versus distraction forces [5,23-25]. A transverse interwoven suture through the patellar tendon just distal to the pole fragments is used to tie the fragments into a bundle [26]. Unlike other forms of osteosynthesis, this system provides stable osteosynthesis which allows loading on the affected lower limb without immobilisation in the postoperative period [23-25]. It allows for preservation of the functional length of the extensor mechanism and the normal height the patella [5]. The available information in a few hundred patients treated with the basket plate show acceptable clinical results [24]. Long term assessments of the extensor

mechanism of patients treated by the basket plate have suggested that it should be introduced as a standard method of treatment [23]. A patellar shape memory-fixator was developed with the aim of allowing earlier weight bearing and active range of motion post surgery. Its concept is not dissimilar to the basket plate. This super elastic alloy has an effective shape memory effect consisting of 2 claws at the base, a conjunctive waist and 3 claws at the apex and also demonstrated excellent fatigue behaviour and high damping capacity [26]. Hao., *et al.* [27] reported that this plate provided good osteosynthesis effect by a continuous stress recovery and is simple to use with a minimally invasive handling system. Liu., *et al.* [28] reported a healing rate of 5 to 7 weeks in 25 patients (age range 14-81) treated for comminution of the lower pole of the patella acutely using this implant. None had plate breakage, infection or restriction in range of motion. The patients were allowed to immediately perform passive range of motion exercises, commence passive exercises from the second postoperative day and active extension during the third postoperative week. This method of fixation was hence deemed to be an effective means of treatment for comminuted fractures of the lower pole of the patella [26,29].

### Conclusion

Preservation and osteosynthesis of the inferior patellar pole allows for maintenance of patellar height and the normal anatomic and biomechanical relationships of the patellofemoral joint. This provides a better clinical result compared with excision of the patellar pole fragments combined with patellar tendon repair. Newer devices allow for earlier rehabilitation and return to function while preserving high union rates.

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