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Operative Treatment of Bennett's Fracture

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A B S T R A C T

We present 89 patients (average age 33 years) with Bennett's fracture (two part fracture to the first metacarpal base). All patients were treated surgically with open reduction internal fixation: 26 patients with K-wires, 19 with titanium mini T-plate, and 44 with titanium osteosynthetic screws (Herbert, AO, TwinFix). The surgical approach we used is a minimal incision of 2–3 cm modification of the radiopalmar curving incision. The Bennett fracture healed and full recovery of function was found between 4–8 weeks. There was no evidence of operative complications, instability of the trapeziometacarpal joint or degenerative changes postoperatively. K-wires were removed in 26 patients after 5–7 weeks, while all other osteosynthetic materials were not removed. We believe that it is important to choose osteosynthetic material according to the type of Bennett fracture to be treated, surgical treatment at the earliest possible time, even if the fracture dislocation is 1 mm. Physical rehabilitation is also important to start as soon as possible.

***Key words**: Bennett's fracture, first metacarpal base fracture, open reduction internal fixation*

Introduction

Intra-articular fractures involving the thumb carpometacarpal (CMC) joint are the most frequent of all thumb fractures[1–5]. Since Bennett first described the fracture in 1882[6] the continuous discussion has found that no one method of treatment is ideal for all cases[7–14]. The CMC joint of the thumb consists of two reciprocally interlocking saddles that permit flexion and extension as well as abduction and adduction[15–18]. The articular surface has been characterized by Cooney et al. as a universal joint with its longitudinal and axial rotation limited by its capsule, ligaments, and extrinsic muscle-tendon units[19,20]. The essential stabilizing unit of the metacarpal is the intracapsular volar oblique ligament as it inserts onto the ulnar articular margin of the volar beak on the ulnar aspect of the metacarpal base. Maximal tension occurs in this ligament with the metacarpal in flexion, abduction and supination. When a Bennett's fracture occurs, the medial volar beak of the first metacarpal is split off although still attached to this fracture fragment is the critical restraining ligament. The result is displacement of the metacarpal base dorsally with rotation into supination by the pull of the abductor pollicis longus. The metacarpal head is also displaced into the palm by the pull of the adductor pollicis. Bennett's fracture, along with other fractures at the base of the metacarpal, is the result of an axially directed force on the thumb metacarpal while it is partially flexed[2,17]. Males predominate in this injury with almost a 10:1 ratio males to females[17]. It has been reported by Gedda that nearly half of all Bennett's fractures occurred in patients younger than 30 years[3].

Looking historically at the management of Bennett's fractures it can be seen that there is disagreement in treatment. Originally Bennett's fractures were treated purely conservatively, though even Bennett was dissatisfied with the results of his first case[11]. In 1904, Miles and Struthers treated this fracture by manipulation and splinting the thumb in abduction for 2 weeks. However, when reduction could not be achieved the thumb was left free and active movement was encouraged. They considered the prognosis in the untreated patients was good ultimately, although the treated patients achieved »good function« earlier[11]. Gedda confirm this in 1954[3,21], and so did Charnley in 1957[1,21]. Robinson (1908) established the forerunner of modern conservative treatment. He was

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not satisfied with the results of manipulation and splinting the thumb in abduction because he had found that displacement soon reoccurred. His method consisted of plaster-of-Paris immobilization combined with continuous skin traction on the thumb achieved by adhesive strapping attached to buckles which were incorporated into the plaster splint. Later methods end with the application of a well moulded plaster after manipulative reduction and the incorporation of continuous traction[11].

The results seen after the conservative treatment of Bennett's fractures were found disappointing by many surgeons, such as Gedda (1954), Iselin, Blanquernon and Benoist (1956), Griffiths (1964) and Charnley[1,3,11,21]. Operative treatment for the management of Bennett's fractures began in 1908 when Lambotte made the first open reduction and internal fixation of the fragments with a fine nail, which was reported in 1913[11]. In the beginning there were two approaches; first by direct exposure of the fracture and fixation of the fragments with wires or a small screw, and secondly, by reducing the fracture by manipulation and stabilizing the reduction by passing one or more wires through the metacarpal bone into adjacent bones[11]. The technique of combining manipulative reduction with skeletal fixation was adopted by Johnson in 1944. He stabilised the reduction by passing one or more wires through the thumb metacarpal into the index metacarpal bone. Wagner (1950, 1951) used a similar technique but passed the wire through the base of the first metacarpal into the trapezium, transfixing the joint. Only Ellis (1946) exposed the trapeziometacarpal joint and inserted two pins into the lateral margin of the articular surface of the trapezium which formed a buttress to prevent the base of the metacarpal from re-displacing[11]. Gedda and Moberg describe a volar approach to the fracture, in which they made fixation with one or more wires passing through the small fragment into the bigger part of the bone[22]. Gedda reviewed full function after complete anatomical reduction in 1954[3,11]. In 1956: Bunnell employed a pin which transfixed the head of the metacarpal bone, Badger reported open reduction and screw fixation and Vaughan-Jackson also recommended open reduction but he fixed the fragments with a pin. Spångberg and Thorén, in 1963, used a wire passing through the metacarpal base and then bent to form a hook, with traction[13]. In 1989, Buechler identified three features that distinguished one fracture from another, they are: 1. the location and displacement of the fracture, 2. the extent of crush or impaction at the metacarpal base, 3. the presence or absence of shearing or impaction injury to the radial side of the articular surface of the trapezium. Buechler also divided the base of the metacarpal into three zones (Figure 1). The central zone, zone 2, is the largest of the zones and carries the largest surface of the joint's metacarpal thumb base. Fractures occurring in this zone most often develop posttraumatic changes. Fractures occurring in zone 1 and 3 are on the edges of first metacarpal base, and complications in these zones are much more infrequent than in zone 2[4,23]. Cullen reported there is no biomechanical basis for a predisposition to posttraumatic osteoarthrosis after a Bennett fracture[2]. Today, Bennett's fractures are treated conservatively only if there is no fragment displacement, and due to the biomechanics of this joint there is almost always displacement so that operative treatment is indicated.

Patients and Methods

We present 89 patients, with fracture of the first metacarpal base (thumb) – Bennett's fracture (two part fracture, Figure 2), who were injured over a period of 6 years (2003–2009). All patients were treated surgically with osteosynthesis of the metacarpal base. The average age of the patient group at the time of injury was 33 years with a median of 28 years. The average age of the 73 male patients was 30 years (median 28 years), and the average age of the 16 female patients was 42 years (median 37 years). Our male to female ratio was 4.6:1. Data collected included age, sex, type of fracture, type of osteosynthesis used, and the number of days after injury the patient was operated. Patient thumb range of motion was measured preoperatively as well as at postoperative follow-up. These measured movements were not forced but to the ability of the patient to move their thumb. Two measurements were recorded, radial abduction (RA) and opposition (OP). RA for normal function is from 0° to 80°. OP is the movement of the thumb maximal RA position to the head of the fifth metacarpal bone, palmar side. Our measurement is how many centimetres are missing for the thumb to achieve this position, 0 being ideal. Preoperative range of motion measurements (RA and OP) showed deficit in thumb motion. Of 89 patients a preoperative RA measurement of 30° was found in 7 patients; 35° in 1 patient; 40° in 25 patients; 45° in 47 patients; and 50° in 9 patients. The preoperative OP measurement of 1 cm was found in 37 of 89 patients; 2 cm in 50 of 89 patients; and 3 cm in 2 of 89 patients. Bennett's fractures are usually the result of either a hit or a fall. Of the 89 patients 48 fell: 12 fell from a motorcycle, 7 fell from a bicycle, 6 fell from a horse, 16 fell from a height and 7 fell from standing level. Forty-one of the 89 were injured with hits; 30 were injured in fist fighting or sport training (karate, boxing, ultimate fight) and 11 from an accident (traffic or work related).

All of the patients had preoperative radiology diagnostic: AP view of the thumb with the forearm in maximal pronation and the dorsum of the thumb resting on the cassette. If further diagnostics were needed additional X-rays were taken with the hand pronated approximately 20° with the thumb flat on the cassette, and the X-ray tube angles 10° from the vertical in a distal – to proximal direction. This view enables a more exact judgment of the metacarpal displacement, an estimate of the site and position of the volar fragment, and an estimate of the existing gap between the fragment and the metacarpal base[4]. CT was often considered if there was any suggestion of impaction of the articular surface. An impacted articular surface may be a potential cause of inadequate reduction[23]. We used CT in 31 of our 89 patients.

Surgical treatment

All patients were operated with intravenous anaesthesia (regional block on dorsum wrist). Patient preparation and positioning in all the patients was a pronate forearm on a hand table with a non-sterile pneumatic tourniquet. Prophylactic antibiotics are optional[23], however our hospital requires in its intrahospital infection protocol that prophylactive antibiotics to be administered. We used cefazolinum 1g. with the patients involved with this study. Indication for the surgical operation and choice of osteosynthetic device depended upon the type of fracture to the metacarpal base described as zones of articular involvement as proposed by Buechler[4,23] (Figure 1). All patients were operated with open reduction and internal fixation (ORIF), percutaneous Kirschner wires (K-wires) were not used.

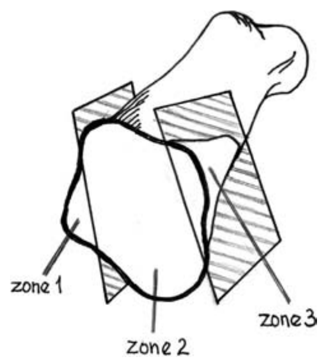

Fig. 1. Three zones of Bennett's fracture as defined by Buechler.

The surgical approach we used is a modification of the radiopalmar curving incision[23], but our approach differs in the length of the incision on the palmar side compared to the Gedda and Moberg classical approach[4,22]. Our operative incision was 2–3 cm long (Figure 3), 3 cm was used primarily for osteosynthesis using a mini t-plate. Following the radiopalmar curving incision the abductor pollicis, which is subsequently moved slightly toward palmar and terminal branches of the superficial radial sensory nerve are identified. Then the thenar muscles are reflected subperiosteally. The CMC joint capsule is identified and incised, and the fracture is exposed. If there is a hematoma it is evacuated. The joint is visually

Fig. 2. Bennett's fracture (two part fracture).

Fig. 3. Operative incision was 2–3 cm long.

Fig. 4. K-wires used for internal fixation.

inspected for free fragments, areas of impaction or injury to the trapezial cartilage. In cases of a very small bone fragment only K-wires (1.25–1.6 mm depending on the fragment size) are used for fixation (Figure 4). If screws are to be used, prior to reduction of the supinate metacarpal, drill gliding holes with 2.4 mm drill bit from within the fracture to direct centre. The fracture may then be reduced by pronation of the metacarpal and held with reduction forceps with points[23]. A core hole (or holes) is prepared with a 1.8 mm drill bit and one or two 2.0 mm screws are inserted. In some cases the fracture was reduced with a small hook or dental pick and stabi-

Fig. 5. Mini Herbert screws.

lized with a 1.25 mm K-wire, followed by 2.0–2.4 mm titanium AO cortex screw placement in the interfragmentary manner. Likewise, we used 1.5 mm titanium mini Herbert screws (Figure 5) and standard 2.0–4.0 mm titanium Herbert screws (Figure 6), 3.2 mm titanium TwinFix screws (Figure 7) which were applied on their guide wires, and mini 1.3 mm thick titanium T-plates with 6 holes, fixed with 2.3 mm titanium cortical screws (Figure 8). We have 26 patients treated with K-wires, 19 with mini T-plate, and 44 with screws (17 with Herbert screws, 15 with AO screws and 12 with TwinFix screws).

Postoperative treatment

X-ray control was made immediately postoperatively, after 7 days and after 1 month. All implant screws and mini t-plates were made of titanium, therefore it was not necessary to remove them. Patients treated with screws and/or plates did not have any immobilization. Rehabilitation began in these patients 2 days after surgery. K-wires which were used as osteosynthesis material were removed between 5 and 7 weeks postoperatively[1,4,21]. Patients treated with K-wires wore a volar forearm splint with thumb extension for about 7 days (and not more than 14 days) postoperatively. After the splint was removed these patients began rehabilitation. After full function was achieved all the patients regardless of treatment reported for follow-up examination every 2 weeks until 6 months, then every 2 months until 24 months post injury.

Fig. 6. Standard Herbert screws.

Fig. 7. TwinFix screws.

Fig. 8. Mini T-plates.

Results

All of our operated patients were diagnosed with first metacarpal base fracture (Bennett fracture) which healed within 4–7 weeks. Fracture healing can be seen on the control x-rays taken as described in postoperative treatment. Different techniques for osteosynthesis were chosen for the differing types of Bennett fracture. The positive results found in all patients are an indication that the type of osteosynthetic material was not the deciding factor in the healing. Full recovery of function (RA and OP) was found to be between 4–8 weeks. Within 4 weeks 21 patients of the 89 patients reached full functional recovery. Within 5 weeks 30 of 89 patients recovered; in 6 weeks 13 of 89 patients recovered; in 7 weeks 6 of 89 patients recovered; and in 8 weeks 18 of 89 patients recovered. The one exception is an elderly patient who fell from a height and was operated the same day with K-wires. This patient had degenerative changes to the first CMC joint prior to injury, with limited function of the thumb, and hence did not recover full function. This patient did not achieve better than RA 65°, OP 0.5 cm which was measure 12 weeks postoperatively. The remaining patients did not have preoperative degenerative changes, nor did they exhibit degenerative changes postoperatively.

Ten of our patients complained of pain, which persisted to 3 month postoperatively, the pain accompanied the range of motion functions which were satisfactory at 8 weeks. We did not have reported bone infection, nor of the operative incision following osteosynthesis. Damage to the superficial radial sensory nerve following the surgery was not evident. We also did not see instability of the trapeziometacarpal joint in our patients. There was no evidence, in our 89 patients, of movement of the osteosynthetic materials, therefore re-operation was not indicated. K-wires were removed in 26 patients with short-term local anaesthesia after 5–7 weeks, while all other titanium osteosynthetic material in 63 patients (AO screws, Herbert screws, TwinFix screws, mini T-plates and screws) were not removed. None of the patients presented with evidence which indicated their extraction.

Discussion

The incidence of intra-articular fractures of the thumb metacarpal base are considered to be relatively rare, estimated to be 1.4% of all fractures within the hand[24,25], though some authors place the incidence much lower, at 0.65%[24]. Proper reduction of these fractures appears necessary for the normal function and power grip of the hand[24,26,27]. Correlation between anatomic fracture reduction and good functional results is largely the result of the relatively unconstrained nature of the CMC joint of the thumb. Pellegrini and Burton recommended closed reduction and percutaneous pin fixation if there was less than 3 mm of fracture displacement and or if there was 3 mm or more fracture displacement[4,28] and show low incidence (2.8%) of patients who had a past history of fracture at the base of the thumb and required subsequent surgery for the symptomatic osteoarthritis[4,28]. Gedda reported correlation with persistent fracture displacement and radiographically evident arthritis[3,4,22]. Gedda further reported in 1954 that there were wide variations in the size of the volar ulnar metacarpal beak fragment and in the extent of the displacement of the metacarpal on the trapezium, even to the point complete dislocation[3,4]. He first described intraarticular impaction in Bennett's fractures. Buechler treated fractures of all three zones, except when impaction was present, with closed reduction and percutaneous pin fixation: A K-wire was placed through the base of the metacarpal into the trapezium and a second wire is passed into the proximal portion of the index metacarpal. The second wire helps to control rotation and abduction of the thumb[4]. We used this method with K-wires; however they were not percutaneous (Figure 4). We did not prefer percutaneous pinning for several reasons. As compared with direct osteosynthesis with closed pinning for Bennett fractures Brazier et al. have found that postoperative function was better after osteosynthesis than after closed pinning[29]. Conclusions such as this help shaped treatment of our patients. We have been able to have better compression in reduction when the K-wire was use internally than percutaneously. Also the possibility of secondary infection due to the external k-wires is avoided, and physical rehabilitation may be started much earlier. K-wire extraction is performed under short-term local anaesthesia with minimal incision.

In other types of upper extremity surgery where there is a small bone fragment such as with capitellum humeri fracture we have had experience using different types of screws for osteosynthesis as we have shown here with Bennett's fracture[30].

In newer literature ORIF of displaced Bennett's fractures is indicated when there is a residual displacement of the joint surface of 2 mm or more after closed manipulative reduction or when there is radiographic evidence of fracture impaction, particularly in Buechler's zone 2 which is best identified on CT[2,4,8,24]. In our study we held to the described treatment. However, we used ORIF when there was a 1 mm or more displacement of the fragment or if there was any rotation or shortening in the fractured region. Soyer suggests that reduction should be 1 mm or less to reduce the risk of radiographic arthritis[31]. The first recommendation that a reduction with less than 1 mm displacement of the fracture be achieved in cases of Bennett fracture was made in 1993[32]. We upheld this as an indication for open reduction in our patients. Recently, Carlsen and Moran state that open surgery needs to be used for patients with Bennett fractures with an irreducible reduction of 1 mm or more[33]. This was the course of treatment in the majority of our patients because they were injured in active sports, so that the later development of arthritic changes could be avoided and that the patient could most quickly start rehabilitation, and therefore return to their sports activity. In the treatment of our patients we used screws if the fragment was in zone 2 and larger. We used K-wires with smaller fragments or fractures in zones 1 and 3. It should be remembered that screw thread diameter should be 30% or less of the width of the cortical surface of the fracture to minimize further fracture of the fragment[4,34]. Osteosynthesis was preformed with a 1.3 mm thick mini-T plate with 6 holes (Figure 8) where there were larger fracture fragments and it was questionable that the screw could hold the reduced position. The osteosynthetic materials which were used, except for k-wires, were all made of titanium therefore is not necessary to remove them, unless a patient presents with evidence for their removal. We did not have any cases in which the osteosynthetic material needed to be removed.

Active motion is necessary postoperatively as soon as possible, however in all patients opposition of the thumb is avoided for 1 month. Full function is described as RA measurement of 0–80°, and OP of 0 cm. Return to full functional use can be expected in 6–8 weeks. Of course the time difference between injury and surgical treatment is very important. Better results are found in those patients whose surgical treatment was quick after injury, within 4 days[1,4,21]. This is true even when there is conservative treatment of this injury. It has been reported in the literature that reposition and treatment with a cast is helpful in the first 4 days after injury, though treatment after this time has results which are substantially worse[1,4,21]. The criteria for delayed treatment therefore is more than 4 days after injury.

Full function was achieved in all patients. There was no evidence of the development of arthritis in the last x-ray examination (approximately two years after injury) of the patients. This treatment did not bring any specific complication of extended pain in any of the 89 operated patients. Nor were there any reported infection, redisplacement of the fracture fragment, nor any reason for reoperation. Postoperative trapeziometacarpal joint instability was not reported in our patients. We followed anatomic reduction of the joint surface and carefully checked for instability of the trapeziometacarpal joint as Nagaoka et al. suggest[35]. Most of our patients were young and active, good results are frequently seen in this type of patient when adequate reduction is combined with active rehabilitation[3]. Persistent pain was evident in 10 patients 3 months postoperatively; even though full function was achieved by 8 weeks. This may be explained by socioeconomical reasons. In these instances, individual reasons may be based on a full spectrum of economic causes, and because these reasons lack firm medical evidence in the short postoperative time, pain cannot be objectively controlled. Still, Cullen et al. and other authors remind us that »many studies have shown regardless of the method of treatment few patients have clinically important pain after the fracture has united and meaningful functional impairment is uncommon«[2,8,21]. Cannon et al. further suggests that no relationship exists between reduction of the fracture, range of motion, pain, and future osteoarthrosis[2,8].

We confirm that no one method is ideal for all cases of Bennett fracture. Nevertheless, we believe that it is important to choose osteosynthetic material according to the type of Bennett fracture to be treated, the earliest possible surgical treatment, even if the fracture dislocation is 1 mm, and the early start of physical rehabilitation.

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OPERACIJSKO LIJEČENJE BENNETTOVIH PRIJELOMA

SAŽETAK

U radu smo prikazali 89 bolesnika (u prosjeku 33 godine starosti) s Bennettovim prijelomom (dvodijelni prijelom prve metakarpalne kosti u području bazalnog dijela). Svi bolesnici su operirani otvorenom metodom repozicije prijeloma i unutarnjom fiksacijom: od toga 26 bolesnika Kirschnerovim iglama, 19 titanijskom mini T-pločicom te 44 bolesnika titanijskim vijcima (Herbert, AO, TwinFix). Kirurški pristup je učinjen minimalnom incizijom duljine 2–3 cm koji je modifikacija standardne radiopalmarne incizije. Potpuno cijeljenje prijeloma i oporavak funkcije bio je između 4–8 tjedana. Nisu zamijećene post-operacijske komplikacije, nestabilnost trapeziometakarpalnog zgloba niti degenerative promjene. Kirschnerove igle su odstranjene nakon 5–7 tjedana kod 26 bolesnika. Ostali osteosintetski materijal nije odstranjivan. Mišljenja smo da je važno izabrati odgovarajući osteosintetski materijal prilagođen vrsti Bennettovog prijeloma, također što ranije provesti operacijsko liječenje, čak i ako je pomak frakturnih ulomaka 1 mm. Također, treba što prije započeti fizikalnu rehabilitaciju.