ORIGINAL ARTICLE

Treatment of Volar Barton's Fractures of the Distal Radius with T-buttress Plates

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ABSTRACT

Aim To evaluate the functional and radiological results of treating unstable volar Barton's fractures of the distal radius with the T-buttress plate.

Methods: This was a retrospective study at orthopedic complex in Bahawal Victoria Hospital from January 2009 to August 2010. We used open reduction and internal fixation with a 3.5mmT-buttress plates in volarly displaced, intraarticular fractures of the distal radius which were judged irreducible or in which closed reduction failed. The volar tilt, radial length, articular step-off and intraarticular gap between fragments were improved after surgery. We included 43 patients, comprising 36 men and 7 women with a mean age of 31 years (range from 20-56 years). Preoperative, postoperative, and final follow-up radiographs were compared. The time to initiation of active range of motion was determined. Final follow-up range of motion and complications were reported. Mean follow-up time after injury was 15.5 months (range 12–24 months)

Results: At final functional assessment, the scores of 13 patients were excellent, 23 patients good, and 7 patients fair according to a criteria described by Gartland and Werley. No non-union or infection occurred. Five patients had slight finger contraction and rupture of the flexor pollicis longus tendon occurred in two patients.

Conclusion: Treatment of volar Barton's fractures of the distal radius with a 3.5mm T-buttress plates leads to satisfactory results, provided the operative technique is carefully performed to prevent complications.

Keywords: Volar Barton's fracture, open reduction, internal fixation, T-buttress plate.

INTRODUCTION

Barton's fracture, named after the American surgeon John Rhea Barton,[1] is a fracture of the distal end of the radius that involves the dorsal or volar rim and extends into the intra-articular region. Such intra-articular fractures are uncommon, and they are usually associated with either low or high-energy trauma[2]. They constitute only 1.3% of the distal radius fractures[3]. Various forms of treatment have been described in literature[4]. These include closed reduction and plaster application, percutaneous pinning, external fixation, open reduction and internal fixation (ORIF) with Kirschner wires, and ORIF with a buttress plates and screws. These options are differentiated based on their ability to reinforce and stabilize the three columns of the distal radius and ulna. Closed reduction is usually easy to achieve but difficult to maintain. Conservative treatment is usually unsuccessful, and it is also fraught with complications, such as early osteoarthrosis, deformity, subluxation, and instability. Several studies have been reported on the effectiveness of surgical treatment[5]. Plating allows direct restoration of the anatomy, stable internal fixation, a decreased period of immobilization, and early return of wrist function.[6] Buttress plates reduce and stabilize vertical shear intra-articular fractures through an antiglide effect, whereas modern locking plates address metaphyseal comminution and/or preserve articular congruity/reduction[6]. With locking plates, intra-articular fractures are directly reduced; with buttress plates, the plate itself helps reduce the intra-articular fracture. Complications associated with plating include tendon irritation or rupture and the need for plate removal[7]. Restoration of the distal radius anatomy within established guidelines yields the best short- and long-term results[8]. Guidelines for acceptable reduction are (1) radial shortening <5 mm, (2) radial inclination >15°, (3) sagittal tilt on lateral projection between 15° dorsal tilt and 20° volar tilt, (4) intra-articular step-off <2 mm of the radiocarpal joint, and (5) articular incongruity <2 mm of the sigmoid notch of the distal radius. Although different success rates have been reported for non-surgical and surgical techniques in the literature, surgical treatment is currently favored[9]. The main purpose of the study was to assess the radiological and functional results of ORIF with 3.5mm T-buttress plates in the treatment of volar Barton's fractures.

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PATIENTS AND METHODS

Forty eight patients were treated with ORIF for isolated volar Barton's fractures of the distal radial (not combined with distal ulnar fractures) between January 2009 to August 2010 at Orthopaedic complex Bahawal Victoria Hospital Bahawalpur. Five patients were lost to follow-up and were excluded from the study. The remaining 43 patients were followed up for a minimum period of 12months and formed the basis of our study. This study included 36 men and 7 women with an average age of 31 years (range from 20-56). 33 patients had fractured their dominant wrist, and 10 patients fractured their non-dominant wrist. 31 fractures were caused by road traffic accidents and 8 from a fall from a height and 4 in sports related accidents. The indication for surgery was a volary displaced intraarticular fractures with unsuccessful closed reduction or fractures judged irreducible from the primary radiographs. A persistent articular stepoff of 2 mm or more after closed reduction indicated surgery. Only less than 10 days old injuries were included in study. All fractures were closed, and there were no tendon or nerve lesions. Elderly and severely osteoporotic patients with reduced functional requirements of the wrist were not operated on. Exclusion criteria also included any distal radius fractures extending to the shaft of the radius, and concomitant fractures of the same limb. 3 patients (2 women, 1 man) were initially treated with closed reduction and cast immbolization , but were reoperated on next day with open reduction and internal fixation because of a persistent articular step-off.

The fractures were classified according to the AO classification[10] of fractures by the seniors two of us. All of the fractures were type-B3 injuries; that is, the volar aspect of the distal articular surface of the radius was involved while the dorsal aspect remained intact. The injuries were further subdivided into six B3.1 fractures (characterized by a small volar fragment, with the sigmoid notch intact), eleven B3.2 fractures (characterized by a large volar fragment that included the sigmoid notch), and twenty six B3.3 fractures (characterized by comminution of the volar fragment).

Anteriorposterior and lateral wrist X-rays were examined and compared to healthy. Preoperative, immediate postoperative, and final follow-up volar tilt, radial inclination, and ulnar variance were measured radiographically. The lack of pain in the palpated fracture area was considered as clinical union. Subjective and objective functional results were graded using the creteria of Gartland and Werley.[11] Subjective evaluation consisted of pain, disability, restricted activity, and limitation of motion. Objective evaluation consisted of range of motion of the wrist and forearm and complications such as nerve injury, finger contracture and development of osteoarthritis. The mean time interval from injury to operation was 5 (0-12) days. The patients were followed at regular intervals by the seniors two of us and the mean follow-up time after injury was 15.5 months (range 12–24 months).

Technique:

All patients were operated by the 1 most senior of 3 orthopaedic surgeons. General anesthesia was used for all patients. The upper arm tourniquet was used in all cases in order to provide bloodless field during surgery. The fracture site was exposed through the distal part of the volar approach of Henry.[10] The distal radius was exposed along the flexor carpi radialis tendon. After release of the pronator quadratus muscle from its radial insertion, the fracture site and palmar surface of the distal radius were exposed. Fracture is reduced in anatomical position. Fracture reduction was verified with the image intensifier. Provisional Kirschner wires were used occasionally. Next, the length of the radius is adjusted for proper ulnar variance by pushing the plate distally to restore the distal radio-ulnar congruity and fixation of the fracture fragments was performed by a 3.5mm T-buttress plate with small fragment screws. Iliac crest bone graft was performed for 2 patients. The pronator quadratus was repaired with 3-0 absorbable sutures.

Postoperative treatment: A above-elbow plaster splint was applied for 1-3 weeks; passive and active range-of-motion exercises started during the next 1-3 weeks, depending on the stability of the fractures. Patients were followed up initially at 3-week intervals up to 6 weeks, then every 6 weeks for 3 months and every 3 months for one year.

RESULTS

The average follow-up period was 15.5 months (range 12–24 months). All fractures were healed in a mean period of 7.5 weeks (range 6-9 weeks). Overall, seven patients exhibited complications: five patients had slight finger contraction, and two patients suffered from rupture of the flexor pollicis longus tendon, which was treated with tendon suture. There was no non-union or wound infection in this study. No breakage of plates was observed. The immediate postoperative radiographs were evaluated by the surgeon who had performed the operation. Average preoperative, postoperative, and final follow-up radiographic parameters are listed in Table I. Preoperative volar tilt was –9.3±18.8 degrees (range –40 to 28 degrees), postoperative volar tilt was noted 10.1±5.8 degrees (range 0 to 25 degrees), and final follow-up volar tilt remained at 9.7±5.0 degrees

(range 3 to 23 degrees). Preoperative radial inclination was 14.1±4.9 degrees (range 7 to 25 degrees), postoperative radial inclination was noted 19.3±4.2 degrees (range 12 to 28 degrees), and final follow up radial inclination remained at 20.0±4.2 degrees (range 12 to 28 degrees). Preoperative ulnar variance was 4.3±2.3mm (range 1 to 8.7mm), postoperative ulnar variance was noted –0.5± 1.4mm (range –2 to 2.9mm), and final follow-up ulnar variance remained at 0.2±0.9 mm (range –1.7 to 2.4 mm). Average final wrist range of motion was 55.5±10.3 degrees extension (range 45 to 80 degrees) and 59.3±17.5 degrees flexion (range 50 to 90 degrees). Average final forearm range of motion was 86.3±17.2 degrees pronation (range 30 to 100) and 90.4±5.9 degrees supination (range 80 to 100 degrees) (Table II). At final functional assessment, the scores of 13 patients were excellent, 23 patients good, and 7 patients fair according to the criteria of Gartland and Werley.

Table 1: Average (±SD) preoperative, postoperative, and final follow-up radiograph parameters

	Preop	**Postop**	**Final follow-up**
Volar tilt (degrees)	-9.3±18.8	10.1±5.8	9.7±5.0
Radial inclination (degrees)	14.1±4.9	19.3±4.2	20.0±4.2
Ulnar variance (mm)	4.3±2.3	–0.5±1.4	0.2±0.9

Table 2: Average (± SD) final wrist and forearm range of motion.

Wrist extension (degrees)	**Wrist flexion (degrees)**	**Forearm pronation (degrees)**	**Forearm supination (degrees)**
55.5±10.3	59.3±17.5	86.3±17.2	90.4±5.9

DISCUSSION

The primary goal in treatment of volar Barton's fractures of the distal radius is to achieve proper reconstruction of the disrupted anatomy and allow the quick return of hand function without complications. Volar plate fixation is effective in buttressing a volar Barton's fracture of the distal radius. In our study, results were good to excellent in 34 cases. Our results are consistent with those studies that supported the effectiveness of ORIF[13,14.15,16]. An extensive review of the literature revealed only few studies making use of ORIF with T-buttress plates in displaced volar Barton's fractures.

Most of our study patients have returned to the baseline by 1 year though some having residual symptoms during the initial period of 3 months postoperatively. Our treatment leads to good subjective end-results regardless of the initial severity of the fractures. Mild radiocarpal osteoarthritis, seen in 2 patients in our study, did not affect their functional outcome. Our results are compareable to a recent study by Stevenson et al[15] (2009). In this study volarly displaced intraarticular fractures of the distal radius were treated with volar plates and results were excellent to good in terms of anatomical restoration of the fracture segments and bone union with negligible complications.

In our study all fractures were reduced and fixed anatomically and the union rate was 100%. The fracture healing process is not hindered due to the cancellous bone character. The success rate is therefore high. In long term complications only the 5 out of 43 patients showed restriction of range of movement due to slight finger contraction that were labeled as fair result. These observations are compareable to the study of Kapoor and co-workers[16] (2000). They concluded that open reduction and internal fixation provide the best articular anatomy in highly comminuted fractures with a high union rate.

Postoperatively, median nerve function was not affected in any case in our study. This finding is consistent with that in the study of Zoubos et al.[17] in 1997. Hence, we suggest that the release of the median nerve is not necessary in ORIF of volar Barton's fractures.

Volar plate fixation of unstable distal fractures has been described recently in literature.[15,18,19.]Our results are comparable to the radiological evaluation and functional assessments presented in these recent reports.

The course of the flexor pollicis longus tendon is close to the palmar rim of the distal radius. The plate placed very close to the wrist joint can support the palmar aspect of the articular surface. However, it sometimes causes flexor tendon impairment. To avoid rupture of the flexor pollicis longus tendons, care has to be taken especially in very distal fractures, type C3 fractures. Adequate image intensifier control to verify the extra-articular and subchondral position of screws and plate is also quite important. In our study, two patients suffered from rupture of the flexor pollicis longus tendon. If fracture instability demands distal placement of hardware, close follow-up investigations and hardware removal should be considered at the first sign of flexor tendon irritation as reported by Drobetz and Kutscha-Lissberg.[19] This was also an important point for our study. T-buttresss plate is useful for achieving good anatomical reduction, but care must be taken to avoid the complication of tendon rupture.

In our study at final functional assessment, the scores of 13 patients were excellent, 23 patients good, and 7 patients fair. Agarwal[20] reported

excellent results in 9 cases, good in 5, and fair in 2 out of 16 patients with intraarticular comminuted distal radial fractures treated with the Volar Plating.

In our study, union was achieved in all cases and the resulting complications after surgery were not significant. Smith et al[21] reported 100% union rate with 71% excellent, 18% good, and 11% fair results after ORIF of intraarticular comminuted distal radius fractures.

By these considerations, volar distal radius plates will provide excellent results in treating volar Barton's fractures of distal radius.

CONCLUSION

T-buttress plate provides fracture stability and early mobilization in all displaced volar Barton's fractures. By using T-buttress plates, joint motion and daily activities is recovered in short span of time.

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