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Open Reduction and Internal Fixation with a Small T-plate for Volar Barton Fracture Management

Elsayed El Etewy Soudy, Waleed Mohamed Nafea, Ahmed Hatem Farhan, Ahmed Magdy Mohamed Ibrahim*, Nagi Mohamed Fouda
Department of Orthopedic Surgery, Faculty of Medicine, Zagazig University, Egypt
***Corresponding Author:** Ahmed Magdy Mohamed Ibrahim, **E-Mail:** rotlk77@gmail.com

ABSTRACT

Background: One-sixth of all fractures in the emergency room are distal radius fractures. It is very important to recognize and adequately treat volar Barton fractures to avoid complication of malunion and its adverse effects. Although various fixation techniques have been described, with the plate, the patient can begin early active wrist workouts performing stable reduction. **Objective**: Open reduction and small T-plate internal fixation of a distal radius volar Barton fracture were used to evaluate the functional outcomes for the fracture treatment.

Patients and Methods: At Zagazig University Hospital, 30 patients with a volar Barton fracture were studied in prospective interventional research, the study was carried out through six months. Preoperative X-ray and CT were done and the patient was prepared for surgery. By adopting an FCR technique (flexor carpi radialis approach), the fracture was reduced, the plate was fixed, and the image intensification was utilized for confirming the results.

Results: Mean operative time was 54.1±8.47 and of 30 patients operated upon, 16 patients were discharged one day after operation while the mean time lapse before surgery was 1.3±0.53. The mean time of bone union was 6.5±0.89 weeks (range 5-8 weeks). There was a significant improvement in wrist range of motion in all directions postoperatively. 2 patients (6.7%) had superficial infection, 1 patient (3.3%) had tourniquet paralysis, 1 patient had stiffness (3.3%) and another had mal-united fracture (3.3%). **Conclusion**: Volar distal buttressing with the Ellis T plate is easy and inexpensive, and it delivers good functional benefits. Simplistic and low-complication procedure provides precise anatomical reduction of the fracture and restoration of the wrist's shape and function.

Keywords: Open Reduction and Internal Fixation, Small T-plate, Volar Barton Fracture.

INTRODUCTION

One-sixth of all fractures in the emergency room are distal radius fractures. It is typical among the older population to suffer from this type of injury [(1)]. As far as distal radius fractures issue, they can only occur between the radiocarpal joint and up to 3 cm away from that point. In most cases, they're closed and the skin that covers them is intact. They're called complicated since they frequently include injuries to the nearby ligaments and cartilage [(2)].

There are a variety of therapy options out there, including closed reduction and plaster application as well as external fixation and open reduction and internal fixation (ORIF) [(3)]. To prevent long-term dysfunction, the best therapy is important to give optimal anatomical reduction and repair of fracture fragments [(4)].

Operative intervention should only be considered if the fracture is unusually complex or if the surgeon has extensive experience with the various treatment options [(5,6)]. John Rhea Barton's fracture is a distal end of the radius fracture that includes the dorsal or volar rim and extends into the intraarticular region. It is named after Barton. Rare as they are, intra-articular fractures usually occur as the result of either low or high-energy trauma. Their percentage of distal radius fractures is just 1.3 percent [(7)].

In the early 1950s, James Ellis from England began employing a specifically designed T plate to support the little marginal fragment in volar Barton's fractures. The AO group developed plates for distal radius fractures in the 1970s [(8)]. Open reduction and internal fixation are preferable over conservative treatment because it allows reduction under direct vision, reliable internal fixation, a shorter period of immobility, and a faster return to normal exercise. There are several ways to treat fractures of this type, but the T-plate is a simple and successful one [(9)].

This study was designed to evaluate the functional outcomes of volar Barton distal radius fractures treated with open reduction and tiny T-plate internal fixation.

PATIENTS AND METHODS

At Zagazig University Hospital, 30 patients with volar Barton fractures were studied for six months in prospective interventional research. All cases with volar Barton fracture that fulfill the inclusion criteria were included in one study as a comprehensive sample.

Ethical considerations:

As long as all participants signed informed consent forms and submitted them to Zagazig University's Research Ethics Committee, the study was allowed (ZU-IRB#6228). We followed the World Medical Association's ethical code for human experimentation, the Helsinki Declaration.

Inclusion criteria: Adult patients from both genders with volar Barton fracture and the Fracture not more than 14 days ago.

Exclusion criteria: Patients who had associated forearm fractures, open fractures, extra-articular fractures, and patient whose follow-up was lost had been omitted from the trial.

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This is what all of the participants in this research had to go through:

1. History taking and clinical examination.
2. **Radiological evaluation:** An anterior-posterior (AP) view of the elbow, forearm, and wrist, as well as a lateral view of same segments
   Computed tomography (CT) scan: At the pre-, postoperative, and 3-month intervals, radiological measures such as radial volar tilt and radial length have been evaluated. Patients were assessed before they were allowed to participate in the trial and on a daily basis by senior members of the research team, and another pediatrician who was not aware of the patient.
3. **Laboratory Investigations:** CBC, coagulation profile, and liver and kidney function tests.
4. **Management Plan:** Provisional reduction of fractures that have been displaced: The reduction was achieved by utilizing Chinese finger traps or manual longitudinal traction. A temporary splint was used to hold the reduction in place. A temporary external fixator was useful if definitive surgery was scheduled but could not be completed within a tolerable time frame.
5. **Surgical Technique:**

Types of anesthesia used:

- General anesthesia: 20 cases.
- Regional with supraclavicular brachial plexus blockage: 7 cases.
- Local intravenous regional anesthesia: 3 cases.

Approach:

The flexor carpi radialis (FCR) tendon was followed through the skin incisions. The flexor pollicis longus muscle is located beneath the FCR sheath. To disclose the pronator quadratus muscle, the ulnar retraction was loosened and retracted. An L-shape incision was used to raise the pronator quadratus muscle. At the watershed line, a horizontal limb was positioned. The distal radius of the pronator quadratus muscle was exposed after the muscle was cut on its radial boundary. Additional K-wires were used in 6 patients with radial styloid fracture, these K-wires were removed after 3-4 weeks. We used locked plates in 6 cases and non-locked plate in 24 cases.

Reduction of the fracture by hyperextension of the wrist over a pad. Ensured that the plate was contoured so that its distal limb exerts even pressure over the fragment or fragments of the palmar rim of the radius (Figure 1). We attached the plate to the distal radial shaft, using an appropriate screw through the oblong plate hole. Then we tightened the first screw and inserted a second screw. We secured the distal fragments with at least two screws through the appropriate distal holes, as dictated by the fracture pattern.

After checking reduction, screws lengths and assuring that no screws are placed intra articular, a postoperative hematoma or swelling that could impede rehabilitation or perhaps cause postoperative median nerve damage was avoided by deflating the tourniquet and performing adequate hemostasis. After surgery, a comfortable elbow splint was applied.

Follow up: Stitches were removed after 10 days. Evaluation was performed at 4th week, 4th month, and 6th month for presence of complications. Results of clinical follow-up were assessed utilizing the Disabilities of the Arm, Shoulder and Hand (DASH) score.

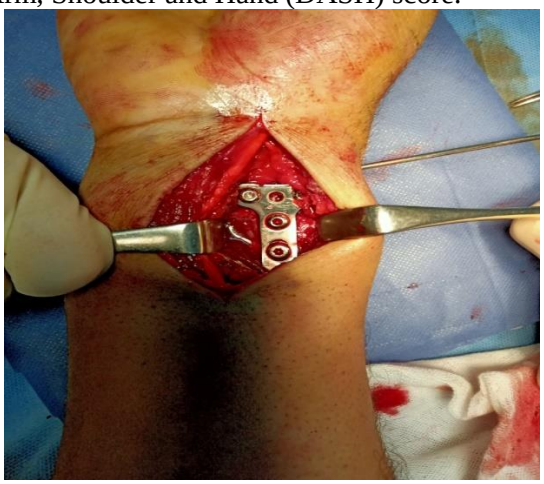

Figure (1): The plate was contoured and applied to buttress the fracture and the screws were taken.

Statistical analysis

In order to analyze the data acquired, it was loaded into a computer and run via the Statistical Package for the Social Sciences, version 25. (SPSS). Tables and graphs were used to present the findings. The Shapiro–Wilk test was used to examine the distribution properties of variables as well as the homogeneity of variance. The quantitative data were reported in the form of the mean, standard deviation, median and range. The frequency and proportions of qualitative data were used to present the information. For quantitative data, paired t test was employed to examine the data as needed. P value equals or less than 0.05 was considered significant.

RESULTS

Demographic characters and causes of trauma of studied group are shown in table 1.

Table (1): Demographic characters, causes of trauma of studied group

Variables	(n. 30)	
Age per years		
Mean ± SD	37±9.7	
(range)	19-62	
	N.	**%**
Gender		
Males	27	90.0
Females	3	10.0
Occupation		
Heavy workers	17	56.7
light workers	11	36.7
House wife	2	6.7
Causes of trauma		
Fall on outstretched hand	20	66.7
Road traffic accident	6	20.0
Fall from height	4	13.3

The mean time lapse before operation and the mean time of operation are shown in table 2.

Table (2): Perioperative, operative data of studied group (n. 30)

Variables	Mean ± SD	(range)
Time lapse before operation (day)	1.3±0.53	(1-3)
Time of operation (minute)	54.1±8.47	(40-80)

Of the thirty patients in the study there were 16 patients discharged at same operative day.
The mean time of bone union in the study was 6.5±0.89 weeks **(Table 3).**

Table (3): Hospital discharge, and time of bone union (weeks)

	N.	%
Discharge		
Same day	16	53.3
Next day	14	46.7
	Mean ± SD	**(range)**
Time of bone union (weeks)	6.5±0.89	(5-8)

Improvements were seen in the range of motion in all patients compared to the preoperative state. The difference between pre- and postoperative results was statistically highly significant as regard all the measured parameters of the range of motion **(Table 4)**.

Table (4): Comparison of range of motion in degrees pre and postoperatively for the studied patients (n. 30)

Variables in degrees	Time		P	% improvement
	Preoperative	Postoperative		
Flexion Mean ± SD (range)	29.5 ± 9.59 (10-40)	60.67±6.53 (50-75)	<0.001**	100%
Extension Mean ± SD (range)	12.47 ± 5.55 (0-20)	57.63 ± 5.28 (45-65)	<0.001**	328.57%
Supination Mean ± SD (range)	22.83 ± 6.39 (10-30)	61.67 ± 7.11 (45-75)	<0.001**	155%
Pronation Mean ± SD (range)	14.53 ± 3.56 (10-20)	63.5±8.22 (50-80)	<0.001**	333.3%
Radial deviation Mean ± SD (range)	6.57 ± 3.04 (0 -10)	10.67±2.48 (8-17)	<0.001**	33.33%
ulnar deviation Mean ± SD (range)	12.37 ± 2.95 (0 – 15)	28.7±6.3 (18-44)	<0.001**	**128.57%**

**: Highly significant

Highly significant improvements were seen in the radiological data in all patients compared to the preoperative state **(Table 5).**

Table (5): Comparison of radiological data pre and postoperative for studied patients (n. 30)

Variables	Time		p	% improvement
	Preoperative	Postoperative		
Radial length Mean ± SD (range)	9.3±1.2 (7-11)	10.2±1.2 (8-12)	<0.001**	10.56%
Radial inclination Mean ± SD (range)	18.9±1.2 (17-21)	20.9±1.49 (18-23)	<0.001**	5.88%
Volar tilt Mean ± SD (range)	8.6±1.1 (7-11)	9.9±0.99 (8-11)	<0.001**	12.5%
Articular step off: Median (range)	8 (5 – 12)	1 (0 – 2)	<0.001**	86.81%

**: Highly significant

Superficial wound infections as early complication were seen in two patients. Satisfaction level of studied patients was excellent in 16 patients **(Table 6).**

Table (6): Complications and patients' satisfaction.

Complications		N. (%)
Intraoperative complications		0
Postoperative complications		
Early	Superficial infections	2 (6.7%)
	Mal union	1 (3.3%)
	Stiffness	1 (3.3%)
	Tourniquet paralysis	1 (3.3%)
Satisfaction level	Excellent	16 (53.3)
	Good	7 (23.3)
	Fair	6 (20.0)
	Poor	1 (3.3)

(A)

(B)

(C)

(D)

Figure (2): Male aged 39 years admitted with road traffic accident in left hand (non-dominant). (A) Preoperative X-ray (AP, lateral). (B) Intraoperative photos. (C) X-ray after 1 month of follow-up (AP, lateral), (D) X-ray after 3 months of follow-up (AP, lateral).

DISCUSSION

Clinically, distal radius breaks are the most common upper-extremity fractures. However, it is not uncommon for high-energy trauma victims to fall on their outstretched hands. For more than two centuries, distal radius fractures have been the topic of intense debate [10].

A better understanding of pathological anatomy, the mechanism of injury, and the development of novel implants have all contributed to significant advancements in the treatment of distal radius fractures in recent years. The goal of distal radius fracture therapy was to restore the wrist's anatomy so that it could be used without pain as soon as possible. Distal radius fractures have been treated with closed reduction and cast immobilization, external fixation, percutaneous pin fixation, intramedullary nail fixation, and volar locking plate fixation as a single or combined treatment [11].

Analysis of our findings regarding sociodemographic characteristics of studied cases revealed that the age of patients ranged from (19-62) years with mean 37±9.7 years, there were 27 males (90%) and 3 females (10%), heavy workers as farmers and carpenter, etc., represented (56.7%) and light workers as accountants and photographers represented (36.7%), while house wives represented (6.7%). In comparison to our findings, the study of **Qayoom *et al.*** [12] was done on 35 patients, their age ranged between (20-68) years with mean of 38.83 years. There were 14 males (40%) and 21 females (60%).

In the present study, we found that the mean operative time was 54.1±8.47 (range 40-80 min) and of 30 patients operated upon, 16 patients (53.3%) were discharged at same operative day and 14 of them (46.7%) were discharged one day after operation while the mean time lapse before surgery was 1.3±0.53 (range 1-3 days). This comes in comparison with the study of **Krischak *et al.*** [13] in which timing to surgery averaged 4.77 days and the operation averaged 61.3 minutes.

Wrist flexion and extension and wrist radial and ulnar deviation, as well as forearm supination and pronation are all restricted motions because the wrist joint is essential for normal hand function. Patients often have reduced range of motion (ROM) in numerous planes of movement as a result. Inability to conduct daily tasks such as bathing, dressing, and eating can have a negative impact on one's productivity at work. Occupational therapists and their patients spend a significant amount of time treating these numerous ROM deficiencies with the goal of restoring functional ability [14].

In our study the mean time of bone union was 6.5±0.89 weeks (Range 5-8 weeks) while in **Jirangkul *et al.*** [15] 7.5 weeks was the average length of time it took for a union to be formed (Range 6-9 weeks) in contrast to **Qayoom *et al.*** study[12] in which the patients achieved full union within 3 months.

In our study, the mean ±SD of flexion improved from (29.5±9.59) range (10-40º) preoperatively to 60.6±6.5 range (50-75º) postoperatively. The mean±SD of extension improved from (12.47±5.55) range (0-20º) preoperatively to (57.6±5.27) range (45-65º) postoperatively. The mean±SD of supination increased from (22.83±6.39) range (10-30º) preoperatively to (61.6±7.11) range (45-75º) postoperatively. The mean±SD of pronation increased from (14.53±3.56) range (10-20º) preoperatively to (63.5±8.2) range (50-80º) postoperatively. The mean±SD of radial deviation improved from (6.57±3.04) range (0º -10º) preoperatively to (10.7±2.5) range (8º -17º) postoperatively. The mean±SD of ulnar deviation improved from (12.37±2.95) range (0º -15º) preoperatively to (28.7±6.3) range (18º -44º) postoperatively.

In comparison to our study, among the average final wrist ranges of motion reported by **Jirangkul *et al.*** [15], there were 55.5±10.3 degrees of extension (between 45 and 80º) and 59.3±17.9 degrees of flexion (between 50 and 90º), 86.317.2 degrees of pronation (between 30 and 100 degrees), and 90.4±5.9 degrees of supination (between 30 and 100 degrees) (range 80 -100 degrees). In **Qayoom *et al.*** [12] study, the mean of 16.4º (range 15º -20º) of radial deviation, 20º degree (range13º -30º) of ulnar deviation, 65º (range 45º -80º) of dorsiflexion, 61º (range 40º -70º) of palmar flexion, 68º (range 45º -80º) of supination and 71º (range 60º -85º) pronation. While in **Malik-Tabassum *et al.*** [16] palmar and dorsal flexion were measured at 116.7º, 39.8º, 18.3, 78.1 degrees and 81.3 degrees, respectively, while ulnar and radial deviation were measured at 18.3 and 18.8 degrees, respectively.

Complications in our study was observed in 5 patients, 2 patients (6.7%) had superficial infection, which was treated by antibiotics, 1 patient (3.3%) had tourniquet paralysis, 1 patient had stiffness (3.3%) and another had mal-united fracture (3.3%). In comparison to our study, in the study of **Qayoom *et al.*** [12], there were 5 (14%) complications, 3 of which were joint stiffness, 2 of which were superficial infections, but none of the patients had neurological complications. Only one patient had a diminished feeling across the superficial radial nerve distribution, which recovered with observation. In the study of **Malik-Tabassum *et al.*** [16], which was done on 32 patients, a painful implant site (9.4%) was reported to be the most prevalent problem; screw penetration into joint, pain over ulnar styloid infection, and injury to the sensory branch of the median nerve were all discovered.

Regarding outcome: 16 patients had excellent satisfaction level (53.3%), 23.3% of patients had good, 20% of patients had fair satisfaction level while one patient (3.3%) had poor satisfaction level by using the DASH score. In the study of **Qayoom *et al.*** [12], the DASH rating system determined that 25 patients (71%), 8 (23%), and 2 (6%) had outstanding functional outcomes, good functional outcomes, or fair functional outcomes respectively. In the study of **Jirangkul *et al.*** [15], 13 patients were rated excellent, 23 were rated good, and seven were rated fair by Gartland and Werley's criteria. In the study of **Ali *et al.*** [17], 9 of the 30 patients

(or 30 percent) had outstanding ratings. There were 15 good patients (50 percent of total) and six fair patients.

CONCLUSION

Volar plates provide a substantial advancement in the treatment of distal radius fractures through open reduction and internal fixation. Implantation of the Ellis T plate is a straightforward and inexpensive procedure that provides efficient volar distal buttressing and acceptable functional results. Simple and low-complication procedure provides precise anatomical reduction of the fracture, restoration of the wrist's shape and function.

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REFERENCES

1. **Liporace F, Adams M, Capo J *et al.* (2009):** Distal radius fractures. J Orthop Trauma, 23(10):739–748.
2. **Handoll H, Vaghela M, Madhok R (2007):** Percutaneous pinning for treating distal radial fractures in adults. https://doi.org/10. 1002/14651858.CD006080.pub2.
3. **Masood F, Sah R, Sarfaraz A (2018):** Faisal's technique to closely manage volar Barton's fracture: A pilot study. Ann King Edward Med Univ., 24: 679–683.
4. **Souer J, Lozano-Calderon S, Ring D (2008):** Predictors of wrist function and health status after operative treatment of fractures of the distal radius. J Hand Surg Am., 33: 1-8.
5. **Handoll H, Madhok R (2003):** Surgical interventions for treating distal radial fractures in adults. https://doi.org/ 10.1002/ 14651858.CD003209.
6. **Das A, Sundaram N, Prasad T *et al.* (2011):** Percutaneous pinning for non-comminuted extra-articular fractures of distal radius. Indian J Orthop., 45: 422–426.
7. **Barton D, Griffin D, Carmouche J *et al.* (2019):** Orthopedic surgeons' views on the osteoporosis care gap and potential solutions: Survey results. J Orthop Surg Res.. 14: 103-106.
8. **Gerostathopoulos N, Kalliakmanis A, Fandridis E *et al.* (2007):** Trimed fixation system for displaced fractures of the distal radius. J Trauma Inj Infect Crit Care, 62: 913–918.
9. **Aggarwal A, Nagi O (2004):** Open reduction and internal fixation of volar Barton's fractures: a prospective study. J Orthop Surg., 12: 230–234.
10. **Brogren E, Hofer M, Petranek M *et al.* (2011):** Fractures of the distal radius in women aged 50 to 75 years: natural course of patient-reported outcome, wrist motion and grip strength between 1 year and 2–4 years after fracture. Journal of Hand Surgery, 36: 568–576.
11. **Karnezis I, Panagiotopoulos E, Tyllianakis M *et al.* (2005):** Correlation between radiological parameters and patient-rated wrist dysfunction following fractures of the distal radius. Injury, 36: 1435–1439.
12. **Qayoom I, Shafi T, Rafeeq M (2020):** Evaluation of clinical and functional outcome of open reduction and internal fixation with volar plating in Volar Barton ' s fracture of distal radius. https://www.semanticscholar.org/paper/Evaluation...
13. **Krischak G, Krasteva A, Schneider F *et al.* (2009):** Physiotherapy after volar plating of wrist fractures is effective using a home exercise program. Arch Phys Med Rehabil., 90: 537–544.
14. **Kumar A, Nayak A, Dayanand B *et al.* (2020):** Study the functional outcome of Barton's fracture treated with open reduction and internal fixation by volar plating: A prospective study. Int J Orthop Sci., 6: 658–662.
15. **Jirangkul P, Jitprapaikulsarn S, Songpatanaslip T (2019):** Outcomes following temporary Kapandji pinning technique and distal radial LCP fixation for intra-articular fractures of the displaced distal radius. Tech Hand Up Extrem Surg., 23(1):38–43.
16. **Malik-Tabassum K, Pillai K, Hussain Y *et al.* (2020).** Post-operative outcomes of open reduction and internal fixation versus circular external fixation in treatment of tibial plafond fractures: A systematic review and meta-analysis. Injury, 51(7): 1448–1456.
17. **Ali M, Tahir A, Ahmed Z *et al.* (2014):** Treatment of Volar Barton's fractures of the distal radius with T-buttress plates. Pakistan J Med Heal Sci., 8: 631–634.