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Prospective Study of Evaluation of Outcomes of Volar Barton Fractures of Distal Radius Treated by Volar Plating

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Abstract: ***Background: Volar Barton fracture is a shearing mechanism of injury that results in a fracture dislocation or subluxation of the distal end radius in which the volar rim of the distal end radius is displaced with the hand and carpus. As open reduction and volar plate fixation ensures more consistent correction of displacement, maintenance of reduction and early mobilization, this study evaluates the anatomical and functional outcome of open reduction and plate fixation in the management of volar Barton fractures in a series of 30 patients. Aim: To evaluate the results of volar Barton fracture treated by volar plating, on the basis of anatomical and functional outcomes. Material and Methods: Study site: J.L.N. Hospital and Research Centre, Bhilai (C.G.) Study population: All volar Barton fracture of distal radius cases satisfying the inclusion criteria and willing to take part in the study. Study design: 'A PROSPECTIVE STUDY, OBSERVATIONAL STUDY' Objective Outcome: Objective outcomes were assessed at 12 weeks after the procedures using the demerit point system of Gartland and Werley based on objective and subjective criteria, residual deformity and complications. Results: Maximum numbers of cases were recorded in the age group of 41-50 years with males being more affected than females. Right side was predominantly involved. Cause of injury was road traffic accident in 50% of the cases. Injury to ulnar styloid process was present in 26.67% of patients. Volar tilt of more than or equal to 15 degrees was present in 83% of the patients pre-operatively while it was present in 86.67% of the patients post-operatively and in follow-up period. Pre-operative radial shortening of 3-6mm was present in 50% of the patients and in 36.67% in the post-operative and follow-up period. Radial inclination of more than 14 degrees was present in 83% of the patients in pre-operative period and in 87% in post-operative and follow-up period. Maximum patients had movements in the normal functional range in the post-operative period. According to Demerit score system of Gartland and Warley, results were good in 53% of the patients in post-operative period and in 40% after 12 weeks while they were excellent in 33% in post-operative and 47% of the patients after 12 weeks. Complications occurred in 23% of the cases.***

Keywords: volar bartons, surgical fixation, volar plating, anatomical and functional outcomes

1. Introduction

Volar Barton fracture is a shearing mechanism of injury that results in a fracture dislocation or subluxation of the distal end radius in which the volar rim of the distal end radius is displaced with the hand and carpus. Because, the fragment is small and unsupported, the fracture is inherently unstable[(1)]. Earlier, close reduction and cast immobilization had been the mainstay of treatment of these fractures but malunion of fracture and subluxation/ dislocation of distal radioulnar joint resulting in poor functional and cosmetic results are the usual outcome[(2)], this malunion and residual deformity of wrist adversely affects wrist motion and hand function by interfering with the mechanical advantage of the extrinsic hand musculature[(3)]. It may cause pain, limitation of forearm motion, and decreased grip strength as a result of arthrosis of the radiocarpal and distal radioulnar joints[(4)].

The problem with the distal end radius fracture is that the available classification systems do not provide straight-forward treatment options or prognosis, and a great deal of clinical judgement and experience is necessary to define the best treatment options for wrist fractures[(5, 6)]. Fernandez classification explains better about shear type of injury and treatment option.

Recent studies have emphasized that, open reduction and stable fixation is best option for these unstable volar Barton fracture[(7)].

As open reduction and volar plate fixation ensures more consistent correction of displacement, maintenance of reduction and early mobilization, this study evaluates the anatomical and functional outcome of open reduction and plate fixation in the management of volar Barton fractures in a series of 30 patients.

Aims:

To evaluate the results of volar Barton fracture treated by volar plating, on the basis of anatomical and functional outcomes.

Objectives

- To study the effectiveness of volar buttress plate fixation in volar Barton fractures of distal radius in 30 patients.
- To study complications of volar Barton fractures fixed with volar Buttress plate.
- To study and understand contemporary literature on internal fixation of volar Barton fracture and compare our results with others. series with them. To study functional outcome using Modified Harris hip score.fracture.
- To study anatomical and functional outcome using modified Gartland and Werley score.

2. Material and Methods

Study site: J.L.N. Hospital and Research Centre, Bhilai (C.G.)

Study population: All volar Barton fracture of distal radius cases satisfying the inclusion criteria and willing to take part in the study has been included.
Study design: 'A Prospective Study, Observational Study'

Sample size
On calculation we found minimum sample size should be 18.96 patients. So 30 patients were included in our study to increase strength of the study.

Study period: 07.05.2015 to 06.05.2017

Inclusion criteria
1) Adults over 18 yrs of age with volar Barton fracture, with or without coexisting ulnar styloid fracture.
2) Patients medically fit for surgery.
3) Willing for surgical treatment and have given informed written consent.

Exclusion criteria:
1. Patients below 18 yrs of age.
2. Patients medically unfit for surgery.
3. Patients with compound fracture.
4. Patients not willing for surgery.

Methodology

Immediate Management:
The involved extremity was immobilized in below elbow POP slab and kept elevated. Pain and inflammation were managed by using analgesics and NSAIDs.

Radiographic Assessment
The radiographs were assessed in terms of loss of palmar tilt or presence of dorsal tilt, radial shortening and loss of radial inclination. Volar Barton fractures were classified according to Fernandez Classification (Shearing type of injury).

The fracture pattern with a shear component involving atricular surface was proposed for volar buttress plating.

Technique
The time interval between injury and date of operative fixation was 0-5 days. All procedures were performed under general or regional anesthesia.

Operative steps
The fracture site was exposed through the standard extended Flexor Carpi Radialis (FCR) approach in all cases, An incision was made just radial to FCR tendon. FCR retracted radial side to protect radial artery and the pronator quadratus muscle was identified. The distal and radial borders of pronator quadratus were lifted and retracted ulnarly. Open reduction of all major fragments was performed, focusing on restoring articular congruity. A Kirschner wire was used to provisionally fix the position of the fragments. Definitive fixation was done with a 3.5-mm non locking or locking volar plate. Image intensifier was used in theatre to assist the evaluation of fracture reduction and fixation.

Post- operative protocol
Post–operative pain and inflammation were managed using anti-inflammatory analgesics. All patients were given intravenous cefuroxime 750mg twice daily and intravenous amikacin 250mg twice daily for 3 days.

Immediate post operative check X–rays were taken in both PA and lateral views.

Wound was inspected on the 3rd post –operative day and patients were discharged. Sutures were removed on the 14th post–operative day.

All patients were reviewed after 3 weeks, 6 weeks and 12 weeks. Patients were assessed subjectively for pain at the fracture site, clinically for tenderness, loosening of the implant and any signs of infection. Pronation and supination of the forearm and active movement of the elbow and shoulder were advised throughout the period of healing. The ranges of wrist movements were recorded and any deformity was assessed. Final follow up was done at 12 weeks of surgery.

Rehabilitation:
Active finger movement and forearm rotation are encouraged immediate after surgery, in few cases with significant comminution, judicious splintage was advised for 2-3 weeks.

Objective Outcome:
Objective outcomes were assessed at 12 weeks after the procedures using the demerit point system of Gartland and Werley based on objective and subjective criteria, residual deformity and complications. The objective evaluation is based on the following ranges of motion as being the minimum for normal function: dorsiflexion 45; palmar flexion 30°; Radial deviation 15°; ulnar deviation 15° ; pronation 50°; supination 50°.

3. Observations & Results

The present study consists of 30 cases of volar Barton fracture of distal end radius at JLN Hospital and Research Centre, Bhilai (Chhattisgarh) from May 2015 to May2017. All cases were closed fractures. All cases were followed up periodically during the period 2015 to 2017. The following are the observations made and the available data are analyzed as follows-

Table 1: Age Incidence

Age in Years	No. of cases	Percentage
21-30	06	20
31-40	06	20
41-50	11	36.67
51-60	05	16.67
>60	02	6.67
Total	30	100

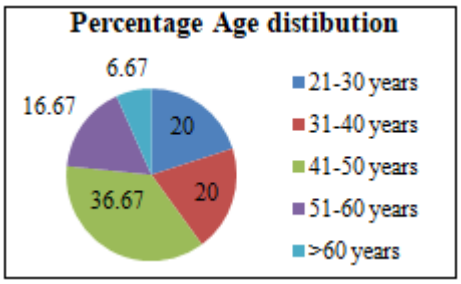


Table 2: Sex Incidence

Sex	No. of Cases	Percentage
Male	17	56.67
Female	13	43.33
Total	30	100

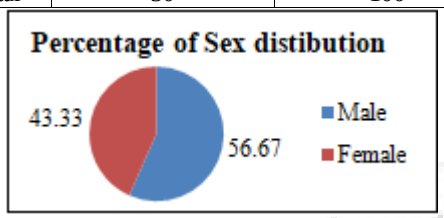


Table 3: Side of Involvement

	No. of Cases	Percentage
Right	19	63.33
Left	11	36.67
Total	30	100

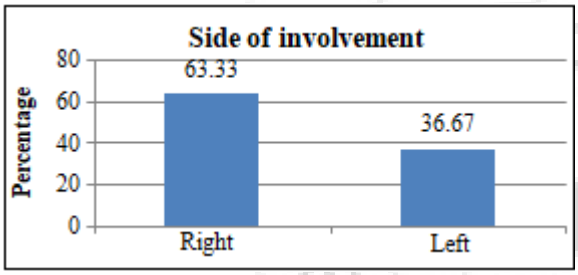


Table 4: Mode of Injury

Mechanism of Injury	No. of Cases	Percentage
Road traffic accident	18	60
Fall on outstretched hand	08	26.67
Fall from height	02	6.67
Direct injury	02	6.67
Total	30	100

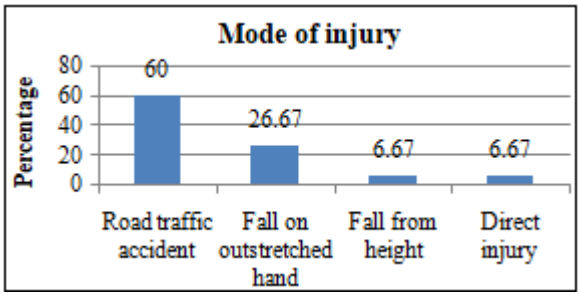


Table 5: Ulnar Styloid Injury

Associated ulnar styloid injury	No. of Cases	Percentage
Unlar Styloid + Present	08	26.67
Ulnar Styloid –Absent	22	73.33
Total	30	100

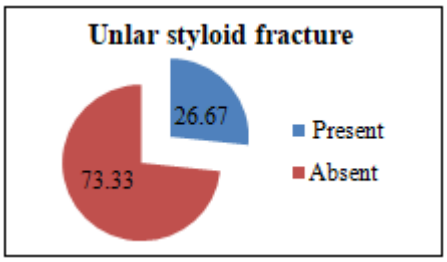


Table 6: Anatomical Evaluation

Volar Tilt	0o	1-10o	11-14o	≥15o	Total
Pre op	1(3.33%)	4(13.33%)	0(0%)	25(83.33%)	30(100%)
Post op	0(0%)	4(13.33%)	0(0%)	26(86.67%)	30(100%)
Follow up	0(0%)	4(13.33%)	0(0%)	26(86.67%)	30(100%)

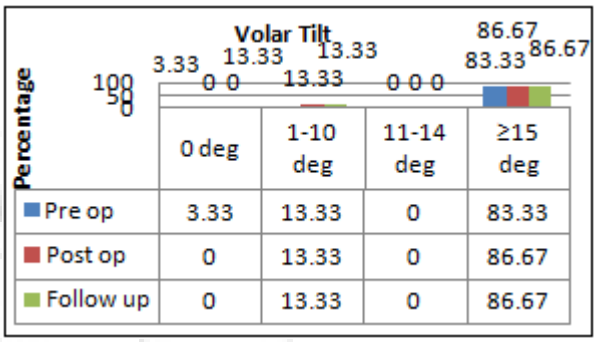


Table 7

Radial Shortening	<3mm	3-6mm	7-11mm	≥12mm	Total
Pre-op	2(6.67%)	15(50%)	12(40%)	1(3.33%)	30(100%)
Post-op	15(50%)	11(36.67%)	3(10%)	1(3.33%)	30(100%)
Follow up	15(50%)	11(36.67%)	3(10%)	1(3.33%)	30(100%)

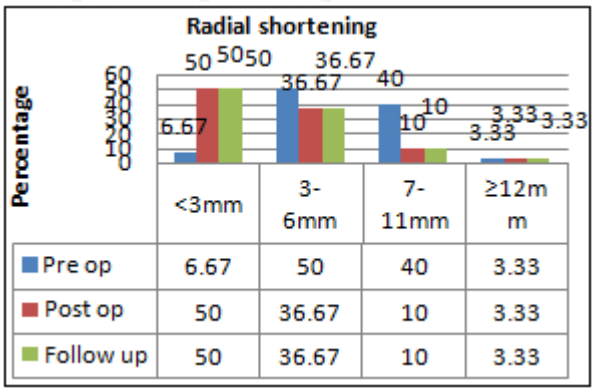


Table 8

Radial Inclination	<5 deg	5-9 deg	10-14 deg	>14 deg	Total
Pre op	2(6.67%)	8(26.67%)	17(56.67%)	25(83.33%)	30(100%)
Post op	0(0%)	0(0%)	4(13.33%)	26(86.67%)	30(100%)
Follow up	0(0%)	0(0%)	4(13.33%)	26(86.67%)	30(100%)

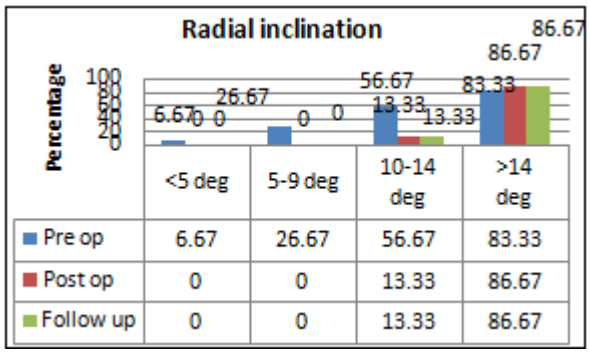


Table 9: Objective Evaluation (Range of Motion)

Movement (within normal functional range)	No. of Cases	Percentage
Dorsi flexion (min.45º)	25	83.33
Palmar flexion (min.30º)	28	93.33
Pronation (min.50º)	25	83.33
Supination (min.50º)	25	83.33
Radial deviation (min.15º)	22	73.33
Ulnar deviation (min.15º)	28	93.33
Pain in distal radioulnar joint	08	26.67
Grip strength (60% or less than on opposite side)	04	13.33

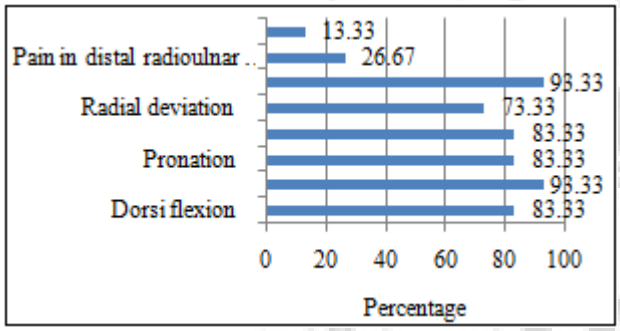


Table 10: Subjective Evaluation (Evaluation of Results)
The assessment of results were made using the demerit score system of Gartland and Werley based on objective and subjective criteria, residual deformity and complications.

Results	Immediate post-operative		After 12 weeks	
	No. of Cases	Percentage	No. of Cases	Percentage
Excellent	10	33.33	14	46.67
Good	16	53.33	12	40
Fair	03	10	03	10
Poor	01	3.33	01	3.33
Total	30	100	30	100

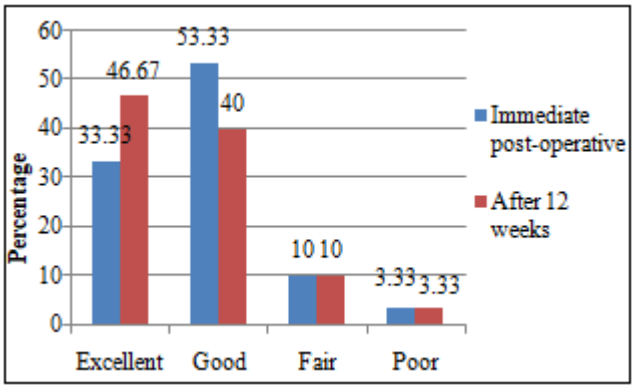


Table 11: Final Out Come

Results	No. of Cases	Percentage
Excellent	14	46.67
Good	12	40
Fair	03	10
Poor	01	3.33
Total	30	100

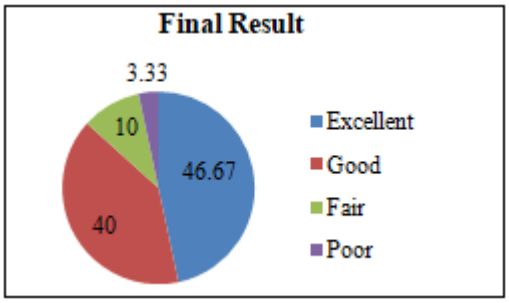
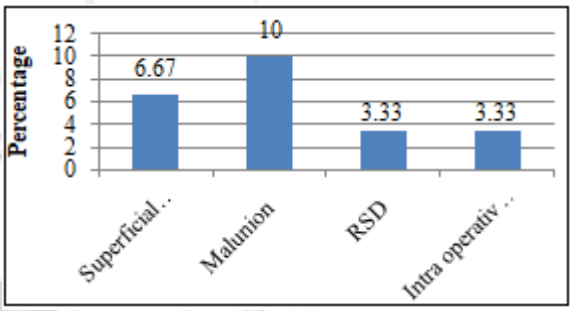


Table 12: Complications

Complications	No. of Cases	percentage
Superficial infection	02	6.67
Malunion	03	10
RSD	01	3.33
Intra operative complication	01	3.33



4. Discussion

The primary goal in treatment of volar Barton's fracture of the distal radius is to achieve proper reconstruction of the disrupted anatomy and allow the quick return of hand function without complications.

Increased awareness of the complexity of distal radius fracture has generated a growing interest and prompted new ideas regarding their optimal management. Although closed reduction with cast immobilization remains a reliable standard method of treatment for stable extra articular fractures and minimally displaced articular injuries, similar management for unstable articular disruption is likely to fail. The best method of obtaining and maintaining an accurate anatomy remains a topic of considerable controversy. However recent critical evaluation of fracture patterns and outcome highlights the need for surgical fixation in potentially unstable fracture such as volar Barton.

In our study, Fernandez Classification was used for classification purpose. Internal fixation of volar Bartons fracture by buttress plate (simple/ locking type) has been performed in all our cases. In our study the number of male patients (56.67%) was more than female patients (43.33%) because of greater outdoor activity.

It is to be understood that these fractures are not only having displacement of fragments but also have compressed and crushed juxta-articular fragments. This degree of variable comminution offers no stability or support. Many such fractures may not be appreciated on plane x ray. So a good hold till union is the only option for a good result and early mobilization.

In our study we used simple buttress plate in 16 patients and locking buttress plate in 14 patients for volar Barton fractures, followed up for a minimum 12 weeks period and were analyzed according to the criteria of demerit point system of Gartland and Werley[69]. 14 patients had excellent results (46.67%), 12 patients had good results (40%), 3 patients had fair results (10%) and 1 patients had poor result (3.33%).

A study was conducted by John K. Bradway and William P Cooney(1989) on 16 patients with comminuted intraarticular fractures of distal radius, with a mean follow up of 5.7 years. The evaluation was based on the criteria of Garland and Werley and also by Green and O'Brien scoring system. They had 56% of their patients rated excellent, 25% good and 19% fair. They had no poor results. This high percentage of excellent and good results compared to our study may be due to fact that the follow up was of longer duration and they had better patient compliance. Also bone grafting was done in more number of patients in their series. In our series the average age of the 30 patients was 42 years. The youngest was 24 years old and oldest was 63 year old. 12 patients were below the age of 40 years, 18 patients were above 40 years of age.

In the series of Bradway and Cooney (1989), the average age of the 16 patients were 40 years. The youngest being 18 years and oldest being 75 years. Thus compared to this series the average age of the patients in our study was almost similar.

In our study 19 patients (63.33%) had right side involvement as compared to 11 patients (36.67%) of left side involvement. The right sided dominancy noted in most of patients with right side involvement. This may be due to fact that dominant extremity reaches out first to respond to first impact of trauma.

Series of Bradway and Cooney (1989), showed equal involvement of both wrists in their study but the series of Jesse B. Jupiter et al. (1996) and Harish Kapoor et al. (2000) had increased involvement of the right wrist which was also the same in our series.

In our series the mode of injury was RTA in 18 patients (60%), fall on outstretched hand in 8 patients (26.67%), fall from height in 2 patients (6.67%) and 2 patients (6.67%) sustained direct blunt (industrial injury) injury to the wrist.

Bradway and Cooney (1989), found the commonest mechanism was fall on outstretched hand, seen in 11 patients (69%) and RTA in 4 patients (31%).

Jesse B. Jupiter et al. (1996) and Harish Kapoor et al. (2000) also reported similar findings in their series. Our series is comparable to that of Harish Kapoor et al. (2000) as it was also done in the Indian scenario.

Madhukar et al.(2016) also reported 75% case injured by RTA, 11% by fall on outstretched hand and 14% as a direct injury which is also quite similar to our series.

Industrial work injuries, extensive use of two wheelers, poor road conditions and lack of adherence to traffic rules seems to have contributed to high prevalence of road traffic accident as causative factors.

We found that there were 8 patients (26.67%) presenting with ulnar styloid fracture as a associated injury while 22 patients (73.33%) presented without fracture ulnar styloid. There was no any separate intervention done for ulnar styloid.

The final results in our series after an average follow up of 12weeks (12-24 weeks and longest follow up was for 2 years) showed that 14 patients (46.67%) had excellent results. Out of these 7 patients were below 40 years age group, 7 patients were above 40 years age group. Out of these 14 patients 8 were male patients and 6 were female patients. 10 patients had right sided involvement and 4 had left sided involvement.

12 patients (40%) in our series had good results. out of these 4 patients were below 40 years of age and 9 patients were above 40 year of age group.

Out of these 12 patients, 5 were male patient and 7 were female patients.

Out of these 12, 6 patients involved with right side and 6 were with left side involvement.

3 patients (10%) in our series had fair results. All these are above 40 years of age group. Out of these 3, 1 was male patient and 2 were female patients and all of these 3 were right side wrist involvement. Only 1 male patient (3.33%) in our series had poor result with left sided involvement.

Series	G & W scoring system			
	Excellent	Good	Fair	Poor
John K. Bradway et al[8]	44	12	44	00
Bhattacharya et al[9]	40	50	05	05
Madhukar et al[10]	57	33	07	03
Present study	47	40	10	03

Our series is comparable in term of outcomes to John K. Bradway et al. (1989), Jesse B. Jupiter et al. (1996), Harish Kapoor et al. (2000), Bhattacharya et al. (2015) and Madhukar et al.(2016).

At 12 weeks the anatomical and functional outcome showed non-significant variation. Anatomical result was good to excellent in 26/30 patients while functional result was also good to excellent in 26/30 patients. It suggests that anatomical reduction has direct correlation with favourable functional out come. Hence, nothing short of a near anatomical reduction should be accepted for satisfying functional out come in such fracture.

5. Complications

The complications seen in our study were as follows:-

3 patients had mild deformity due to malunion, which put them into poor and fair category due to restriction of wrist movement and reduced grip strength but all could carry activity of daily living without gross discomfort. 2 patients had superficial infection which was healed in due course of time with appropriate antibiotic coverage and wound dressing.

1 patient had reflex sympathetic dystrophy and recovered fully with physiotherapy. 1 patient had intra-operative bleeding as a complication probably a small tear of radial artery which was managed with manual compression. Persisting complication in form of malunion was 10%. Rest all regressed with the time.

John K. Bradway et al. (1989) and Jesse B. Jupiter et al. (1996) reported a complication rate of 30% and 36% respectively which is higher than our series. While other Indian studies like Harish Kapoor et al. (2000) reported a complication rate of just 4% and Bhattacharya et al. (2016) had only 5% complication rate in their series.

6. Conclusion

The present study was undertaken to assess the anatomical and functional outcome of management of volar Barton fractures by open reduction and internal fixation with volar plating. Following conclusions were drawn:

- Incidence of volar Barton fracture is on rise, due to mainly road traffic injuries involving two-wheelers.
- Being shearing type of injuries they are unstable fracture and liable to get displaced after an attempt of close reduction. So operative fixation becomes the treatment of choice.
- Main cause of volar barton fracture in younger population is road traffic accident involving two wheelers. They show high velocities injuries. Low velocity trauma is more in higher age groups.
- Varying degree of associated comminution is present in high velocity injuries hence pre-operative CT scan can be a useful tool.
- Good local skin condition and control of blood sugar level in diabetic patient can avoid infections.
- Extended FCR approach appears to be the safest and easily performable and gives good exposure too.
- Following exposure anatomical or near anatomical reduction is a must. Apart from plate, K-wire may be used for optimal reduction in comminuted scenario.
- Osteoporotic fractures are best treated with locking plates and no implant pull-out/ loosening was seen in our series.
- Pre-contoured and variable designed plates are available to fix comminuted fragments and they can be judiciously used for fixation.
- Following surgery, early mobilization and ROM exercises improve the result. Patient compliance is also important.

7. Recommendation

- As a preventive measure the younger population should be counselled about careful and reasonable driving so as to avoid such injuries at the first instance.
- Shear type injuries like volar Barton fracture must be fixed operatively.
- Pre-operative planning and evaluation is must.
- Anatomical reduction and sound fixation with Non-locking/Locking plates gives good to excellent outcome, thereby avoiding fracture disease.
- Locking plate is suitable for volar Barton fracture in osteoporotic patient for stable fixation.
- Further studies with larger number of patients and multicentric in nature can give more insight in these type of unstable fracture management.

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