

## SURGICAL OUTCOME OF VOLAR LOCKING TPLATE OF VOLAR BARTON FRACTURE

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### Abstract

**Background:** The objectives of the study was to evaluate and correlate pain, range of motion, grip strength of the palm and limitation of functional activities in patients surgically treated with volar locking plates for volar barton fractures. **Materials and Methods:** 34 patients (23 males and 11 females) with mean age of 33.9 years that underwent Open reduction with Locking T-plate for volar barton between April 2018 to April 2019 were followed for 1 year. The functional Outcome was assessed by Green O' Brien scoring system and graded into excellent, good, fair and poor. **Result:** Majority of fractures occurred in right limb (76%). Road Traffic Accidents was the commonest cause of injury (64%). A total of 5 cases were found to develop complications including blisters joint stiffness, infection and paraesthesia. Based on Green O Brien scoring system 16 cases (64%) had an excellent outcome and 4 cases (16%) had a good result. The complication observed were in 5 cases (20%) ranged from mild (blisters) to severe such as joint infection, stiffness, and paresthesia along median nerve distribution. **Conclusion:** Open reduction and internal fixation of volar bartons fracture with volar locking T- plate is a safe and good treatment for adults. This allows early post-operative mobilisation and faster return to work due to stable fixation.

## INTRODUCTION

An orthopaedic surgeon from Philadelphia Dr. John. Rhea Barton first described about Barton fracture. Volar Barton fractures are anterior marginal intra-articular fractures of distal end radius with subluxation of radiocarpal joint with no disruption of radiocarpal ligaments and the articular surface of the fractured distal radius is in contact with the proximal carpal bones.<sup>[1-4]</sup>

Numerous types of treatment methods are described like plaster-cast immobilization, use of intrafocal, extrafocal or intramedullary percutaneous Kirschner wires, dorsal and volar plates and external fixation.<sup>[5-8]</sup>

Conservative management of these fractures are still the most popular; cast immobilization after an attempted closed reduction had been mainstay treatment of these fractures for a long time but it often results in the complications of malunion and subluxation or dislocation of distal radioulnar joint which shows poor functional outcome along with poor cosmetic result. It also results in arthrosis of the radiocarpal and distal radioulnar joints which eventually lead to pain, limitation of forearm motion, and decreased grip strength.

Now, the gold standard for the treatment of these fractures is open reduction and volar locking compression plating.<sup>[9,10]</sup> As it provides direct restoration of anatomy with a biomechanically stable fixation that allows early rehabilitation which reduces the chances of stiffness of the wrist joint.<sup>[11,12]</sup> Few complications like carpal tunnel syndrome, complex regional pain syndrome, screw penetration into radiocarpal joint, tendon irritation/tenosynovitis, tendon rupture, penetration of screw tip in dorsal cortex, and infection were reported.<sup>[13]</sup> It is heartening to note that the majority of patients will have near complete recovery of Range of Motion if all radiological measurements are restored. Through this paper we would like to share the functional outcome of surgically treated patients treated with volar locking plates for volar Barton fracture.

## MATERIALS AND METHODS

A prospective study was done at department of Orthopaedics, Government Medical College, Thrissur to evaluate and correlate the functional outcome among patients surgically treated for volar

barton fracture treated with volar locking plate. The patients underwent operation between April 2018 to April 2019. Out of 37 patients evaluated, follow up of three patients were lost due to unknown reason, rest of 34 patients underwent follow up for 1 year.

**Inclusion Criteria:** Adult Patients between 20 to 60 years presenting within 72 hours of injury were included in the study.

**Exclusion Criteria:** Adult patients with Dorsal bartons fracture, Pathological fractures, Open fractures (Gustilo Andersons Classification > 1), Osteoporotic bone, Associated injuries that increase the risk of surgery or prevent compliance with subsequent rehabilitation protocols (i.e., severe head injuries, spinal cord injury), Pregnant females, Presence of major medical comorbidities

Patients those satisfied the inclusion criteria and with radiological diagnosis of Volar Barton underwent ORIF by anterior approach to distal radius with volar locking plate under regional anaesthesia or general anaesthesia. Surgeries were performed by Orthopaedic consultants or senior registrar. The reduction assessed intraoperatively with C-ARM before fixation with implant and adequacy confirmed by post-operative x-ray. Wrist and fingers were mobilised from 3rd day, Patients were followed from 6<sup>th</sup> week, 8th week, 3 months, 6 months and 9 months with clinical and radiological evaluation. On follow up clinically patients were assessed for pain, prehension, strength and sensation and range of motion. Pain was assessed into No Pain, mild, moderate and severe, For evaluation of Prehension Opposition, lateral pinch, cylindrical grasp, Spherical grasp and Hook grasp was tested and mean loss was calculated, for strength Grip strength (using dynamometer) and pinch strength (using a pinch meter) was tested. In addition loss of sensation, deformity, complications (which included superficial and deep) and return to work were assessed. On final follow up functional outcome was evaluated with Modified Green O' Brien scoring system. Radiologically evaluated for union, malunion such as dorsal angulation, loss of radial deviation, radial shortening, prominent ulnar styloid, non-union, carpal instability, avascular necrosis and Arthritic changes.

**Data Analysis:** The descriptive data were analysed using SPSS.

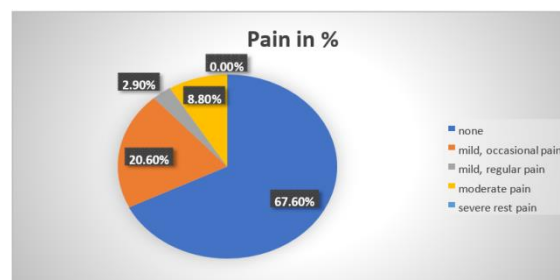
Descriptive statistics such as frequency, percentage distribution, mean, standard deviation for age, gender, mode of injury, associated injury, fracture types, wrist movements, radiological parameters and complications. Students t test were used to compare the variables measured (interval or ratio scale) in two wrist. Chi square test(p<0.05) used to investigate the association between age, sex and mode of injury with final outcome, type of volar barton and final outcome, radiological variables and outcome, complications and final outcome.

## RESULTS

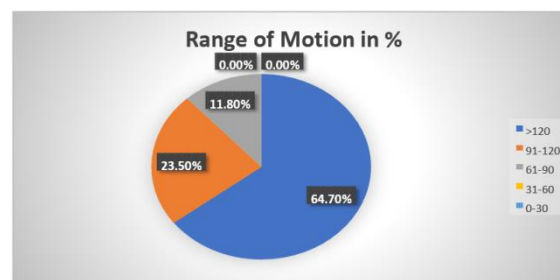
The age distribution of the 34 patients ranged from 20 to 60 years in our study and the mean age was 34.47 years. Most of the cases are in between 20 to 29 years of age, i.e. 52.9 percent. Least number of cases were seen in the range of 40 to 49 years, i.e. 11.7 percentage .73.5% of cases were under 40 years,26.5% were over the age of 40years.

Maximum number of cases happened to be males, i.e. (23 cases 67.6 % and 11 cases i.e.32.4% were females. Right side 25 cases (73.5%) was involved more than the left side 9 cases (26.4.5%). The most common mode of injury is found to be Road Traffic Accidents (RTA), (22 cases i.e. 64.7 %). Rest of the cases were due to fall on outstretched hand, (12 cases i.e. 35.3%). The mean duration between injury and surgery was 9.79 days, mean post fracture rehabilitation were 19.35 Weeks (min-4 weeks, max-39weeks) and return to normal activities were 4 months.

During final follow up, Majority of patients (30 cases 88.3%) returned to their employment, while 11.7% (4 cases) were unemployed but was able to do work. Three patients (8.8%) had moderate level of pain due to arthrosis and infection, one patient had paresthesia along median nerve distribution. 23 patients(67.6%) were pain free, while 7 patients(.20.6%)experienced mild occasional pain which did not affect in their occupation.

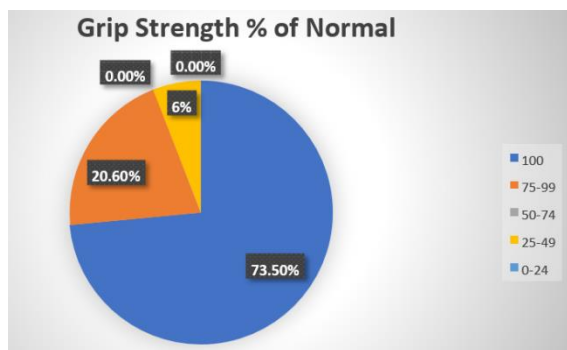
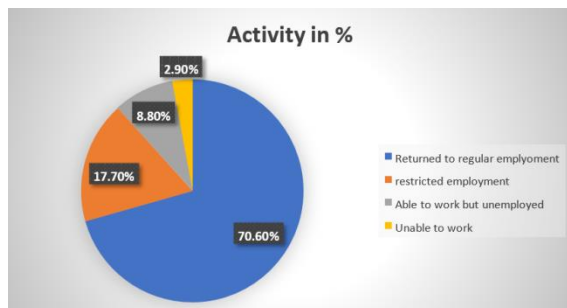


The range of motion at operated wrist were compared with the normal unaffected wrist of the patient and graded as percentage of normal. 0 at of 34 patients 30 of them ( 88.2 %) had palmarflexion -dorsiflexion arc above 90 degrees in which 22(64.7%) patients had comparable movement with the unaffected hand, where the palmarflexio. dorsiflexion arc is more than 120 degrees.



Muscle strength was evaluated by assessing the grip strength of operated limb by hand held dynamometer

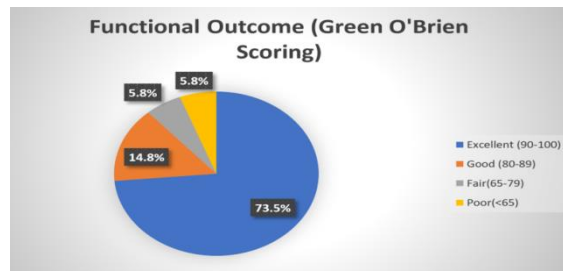
with respect to normal hand. Grip strength was evaluated with forearm in neutral position. 73.5% (25 patients) of patients had full grip strength with respect to contralateral hand. 2 patients (5.8%) were having grip strength below 49% of normal.



Functional grading is done by Green O' Brien Scoring System. It is based on pain, range of movements, Grip Strength and activities. There are four grades namely Excellent, Good, Fair, Poor. As per Functional Grading (Green O'Brien score) 88.3% (30

patients) had excellent to good outcome, 11.7% (4 patients) had fair to poor outcome.

Functional Outcome	Green score	Frequency	Percentage
Excellent		25	73.52%
Good		2	5.88%
Fair		5	14.8%
Poor		2	5.88%
Total		34	100%



Two patients have fair outcome due to arthrosis of the joint, patient sustained with joint infection and another one with median nerve paraesthesia had poor outcome. Patients with excellent to good outcome had the mean range of movements of 54.41 degree for palmar flexion, 62.67 degree for dorsiflexion, 18.23 degrees and 32.79 degrees for radial and ulnar deviation, 80.88 degree and 75.44 degree for supination and pronation respectively.

Functional grading devised by Green O' Brien Scoring System is based on four parameters such as pain, range of movements, Grip Strength and activities. There are four grades namely Excellent, Good, Fair, Poor.

**Table 1**

Parameter	Findings	Score
Pain	No pain	25
	Mild Occasional	20
	Mild, regular, no significant effect on activity	15
	Moderate, activity reduced, no rest pain	10
	Severe, rest pain	0
Range of movements ( arc)	>120 degrees	25
	91-120	20
	61-90	15
	31-60	10
	<30	0
Grip Strength	Normal	25
	75 to 99 %	20
	50-74%	15
	25-49%	10
	<25%	0
Activity	Returned to employment	25
	Restricted employment	20
	Able to work but un employed	15
	Unable to work	0
Final Results	Excellent	90-100
	Good	80-89
	Fair	65-79
	Poor	<65

**Table 2: Report**

GREEN grade	age	duration	post#rehab
EXCELLENT	Mean	32.08	9.32
			14.88

	N	25	25	25
	Std. Deviation	10.000	2.610	5.570
	Median	28.00	9.00	13.00
FAIR	Mean	43.50	8.50	39.00
	N	2	2	2
	Std. Deviation	23.335	3.536	.000
	Median	43.50	8.50	39.00
GOOD	Mean	35.80	11.80	26.00
	N	5	5	5
	Std. Deviation	11.077	3.493	.000
	Median	38.00	14.00	26.00
POOR	Mean	52.00	12.00	39.00
	N	2	2	2
	Std. Deviation	.000	2.828	.000
	Median	52.00	12.00	39.00
Total	Mean	34.47	9.79	19.35
	N	34	34	34
	Std. Deviation	11.500	2.869	9.550
	Median	29.00	10.00	13.00

**Table 3: Anova Table**

		Sum of squares	df
Age* Green Score	Between groups ( combined)	929.331	3
	Within groups	3435.140	30
	Total	4364.471	33
Duration*Green Score	Between groups ( combined)	38.819	3
	Within groups	232.740	30
	Total	271.559	33
Post #rehabilitation * Green Score	Between groups ( combined)	2265.125	3
	Within groups	744.640	30
	Total	3009.765	33

**Anova Table**

		Mean square	F	Sig
Age* Green Score	Between groups (combined)	309.777	2.705	0.063
	Within groups	114.505		
	Total			
Duration*Green Score	Between groups (combined)	12.940	1.668	0.195
	Within groups	7.758		
	Total			
Post #rehabilitation * Green Score	Between groups (combined)	755.042	30.419	0.000
	Within groups	24.821		
	Total			

**Measures of Association**

	Eta	Eta squared
Age* Green Score	0.461	0.213
Duration*Green Score	0.378	0.143
Post #rehabilitation * Green Score	0.868	0.753

Age\* Green score

**Table 6: Comparison of functional outcomes**

Study	Excellent and good outcomes
Julfiqar et al	86.9%
Osada D et al	98%
Anto jose et al	70%
Kk Wong et al	96.6%
Stefan Quadlbauer et al	93%
Hanaeminegishi et al	80%

## DISCUSSION

Volar Barton involves fracture of volar margin of distal end of radius with subluxation of radiocarpal joint. Most of the fractures are treated surgically due to strong pull of digital and wrist extrinsic flexor and extensor muscles, which makes redislocation. Various surgical methods includes Closed reduction with external fixation and K-wire fixation, Open reduction with Volar Buttress Plating. Buttress plating can be accomplished by Ellis T plate fixation Or using Volar Locking plates. Results are best when these fractures are treated surgically with volar plates as surgically treated with external fixation leads to stiffness at wrist. Volar approach is preferred technique to dorsal approach as it avoids soft tissue effects such as extensor tendon attrition. There is adequate space for implant between volar aspect of distal radius and flexor tendons, and the plate can be adequately contoured. Locking of screws to the plate provides best fixation at cancellous area of the distal radius fracture fragments preventing loosening of the screws and thus the implant. Moreover it provides early mobilisation of wrist and improves surgical outcome.

In this study, 52.9% of patients were below 30 years and the fracture is seen more common in males (67.6%) compared to females. Road traffic accidents constitute 64.7% of injuries, 73.5% of the patients have fracture of right wrist due to right dominance in the general population.

Julfiqar et al studied 23 patients for Functional Outcomes of Volar Locking

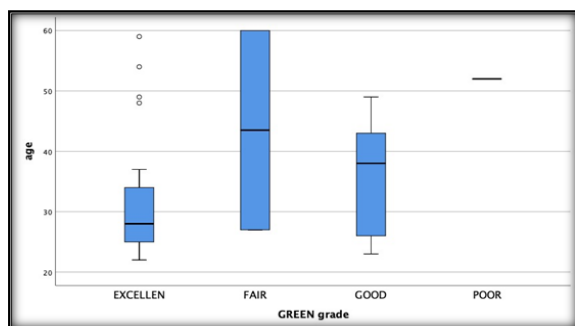
Compression Plate Fixation for Volar Barton Fractures Distal End Radius. Out of the 23 patients 11 (47.8%) had excellent results, 9 (39.1%) had good, 2 (8.7%) had fair while 1 (4.4%) had poor outcomes. Overall, satisfactory outcomes were seen in 86.9%.

Osada D et al did a prospective study of distal radius fractures treated with a volar locking plate system of 49 patients. 98% excellent results was attained by Green O' Brien score.<sup>[14]</sup>

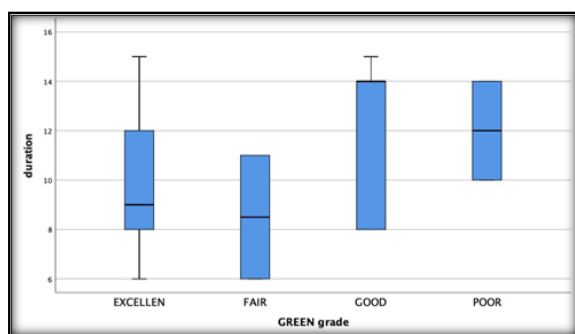
Anto jose et al studied outcome of unstable distal radius fractures treated by volar locking anatomical plates. Out of the 53 patients, 11 cases had excellent outcome (20.75%), 26 cases had good outcome (49.06%), 10 cases satisfactory outcome (18.87%) and 6 cases had poor outcome (11.32%).

Hanaeminegishi et al did a retrospective review of 15 patients (3men and 12 women) with a mean age of 64.4 years using the volar locking plate to treat intra-articular and extra-articular distal radius fractures, followed up for a period of 1year. At final functional assessment, the scores of 5 patients were excellent, 7 patients good, and 3 patients fair according to Cooney's Clinical Scoring Chart.<sup>[15]</sup>

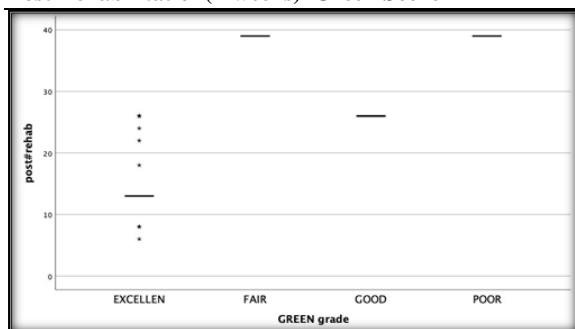
In our study of 34 patients with volar barton fracture, according to Green O'Brien scoring system 30 cases (88.3%) had an excellent to good outcome and 4 cases (11.7%) had a fair to poor result. Good reduction, stable internal fixation, and early



Duration \*Green Score



Post#rehabilitation(inweeks)\*Green Score



Pos

One-way ANOVA showed no association between demographic variables such as age, gender, mode of injury and outcome. Post-operative Radiological parameters such as radial inclination, volar tilt, radial height didn't have any association with the outcome. Complications after surgery occurred in 4 patients which had a significant association with the outcome. Infection, median nerve involvement and arthrosis had caused moderate to severe pain, and decreased the range of motion and grip strength, which hindered the activities of daily living. Infection and arthrosis had caused significant fibrosis of joint hindering the range of movements, while median nerve damage caused weakness and thus decreasing the grip strength. One-way ANOVA showed Post rehabilitation is more significant in predicting Green Score also Eta Square indicating the proportion of variance associated with each main effect and interaction effect in an ANOVA model showed strong association between post-rehabilitation and green score compared to age and duration between injury and surgery.



mobilisation are the important criteria's to achieve excellent to good result after volar barton fracture, since it is found to be unstable. Supination and pronation were first to recover after 6 weeks followed by flexion from 3 months to 6 months. All wrist movements were above 75% than normal from 6months and 44% of patients achieved 100% return of wrist movements with the contralateral side. The grip strength returned to 88% to normal within 1 year. There was tremendous improvement in pain after 6 weeks due to rehabilitation measures. Improvement were much faster in dominant hand.

All Fracture united within 12 -20weeks, as locking plates found to minimize compressive forces on the bone, thus maintain the periosteal blood supply, which promoted healing of the bone without interval bone grafting procedure. Two patients had deep postoperative infections (within 10 days) which had to manage with wound care and antibiotics which caused delay in mobilisation and had fair-poor outcome. A Few of the patients had post-operative swelling which needed elevation had severe comminution of distal radius thus prolonging the surgical time, and even one patient had evidence of carpal tunnel syndrome, which was released, but the median nerve paresthesia was persisting till 1 year. So we feel that it is advisable to release the carpal tunnel in case of comminution of distal radius. One patient who had early onset of arthrosis had comminution.

The primary limitation of the study is the small sample size, to generalise our result to draw definite conclusion, and the long term functional outcome related to implant related lysis, radial shortening, and radio carpal degeneration warrant long follow up instead of short follow up as advocated in this study.

## CONCLUSION

Volar Barton's fractures are uncommon and unstable fractures of distal end radius. Closed manipulative reduction techniques give unsatisfactory results as the fracture fragments are devoid of any capsular attachment. These fractures most commonly occurs in males who sustains high velocity injury.

The conclusion that can be drawn from the above study is that in the event of volar bartons fracture the most befitting treatment is open reduction and internal fixation with volar locking T-plate. Majority of patients demonstrated good to excellent results, with outcomes comparable to other studies in literature. Majority of the patients had no complications post-surgery. Most common

complication encountered during the follow up was joint stiffness.

Post-operative rehabilitation is pivotal for ensuring an excellent functional outcome.

This study corroborates the finding of other well-designed studies showing association between functional outcomes in the patient population with volar barton fractures as an improved functional outcome when fixed with volar locking T- plate.

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