

## Original Research Article

# Open reduction and internal fixation of volar Barton's fractures by polyaxial locking plates: a retrospective study

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## ABSTRACT

**Background:** A Barton's fracture is a compression injury with a marginal shearing fracture of the distal radius. Conservative management of these fractures are highly unsuccessful with multiple complications. Locked plate and screw systems acts as single unit for fracture fixation, allows early mobilisation with good functional recovery. The objective of the study is to evaluate the functional and radiological outcome of volar Barton's fractures treated with polyaxial locking plates.

**Methods:** Thirty six patients with volar Barton's fractures, who underwent surgical treatment with polyaxial locking plate between June 2014 to June 2018, with a minimum one year of follow up. The fractures were classified according to Mehara's classification and the outcome was evaluated using Pattee and Thompson criteria for outcome of wrist.

**Results:** We achieved 100 % union in all patients. Our results were excellent (61%), good (28%) and fair (11%). Our complications include superficial infection, finger stiffness, radiocarpal arthritis, extensor tendon rupture and Sudeck's osteodystrophy.

**Conclusions:** Polyaxial locking plates restore articular congruity of the volar Barton's fractures and give best possible results with least complication rates, provided the technique is carefully performed.

**Keywords:** Volar Barton's fracture, Fracture fixation, Open reduction, Internal fixation

## INTRODUCTION

The fractures of distal radius are the most frequent fractures encountered by orthopedicians accounting for 17.5% of all adult fractures.<sup>1</sup> Philadelphia orthopaedic surgeon John Rhea Barton first described the Barton's fracture, as a fracture of distal end of radius that involves dorsal rim and extends into the intra-articular region.<sup>2</sup> They constitute only 1.3% of distal radius fracture.<sup>3</sup>

In Barton's fracture there is no disruption of radiocarpal ligaments and the articular surface of fractured distal radius remains in contact with the proximal carpal row

which distinguishes the Barton's fracture from other types of distal radius fractures or dislocations.<sup>4,5</sup> These intra articular fractures are uncommon usually associated with low or high velocity trauma and are classified into volar and dorsal on the basis of the site and shifting direction of the fragments.

In literature various treatment modalities have been described ranging from cast immobilization, percutaneous fixation, external fixation, Faisal's technique, arthroscopic assisted internal fixation, etc.<sup>6</sup> Stable internal fixation has advantages of early mobilisation of wrist and fingers and reduces the

stiffness.<sup>7</sup> The internal fixation devices include conventional Elli's plates and locking compression plates. The conventional Elli's plate results in axial shortening of the radius which results in functional disability after fracture union.<sup>8</sup>

The locking plate osteosynthesis is considered as the 'gold standard' in treatment of volar Barton's fractures.<sup>9</sup> The polyaxial locking plates enable deeper insertion of distal screws into the subchondral bone and provides better buttress of the fracture fragments and confer greater rigidity to the construct providing superior outcome in osteoporotic distal radius fractures.<sup>10</sup>

The purpose of our study is to evaluate the functional and radiological outcome of volar Barton fractures treated with polyaxial locking plates.

**METHODS**

A retrospective study was done from June 2014 to June 2018 of patients operated for volar Barton's fractures with polyaxial plate at the Nagai hospital, Nagapattinam and Government Medical College, Thiruvapur. Data collected include name, age, sex and mode of injury. Type of volar Barton fracture was classified according to Mehara's classification.<sup>11</sup> All patients were evaluated with x-ray wrist with forearm PA and lateral view. CT and MRI were done in few selected cases.

**Table 1: Mehara's classification.<sup>11</sup>**

Types	Classification
<b>Type 1</b>	A large single displaced fragment.
<b>Type 2</b>	A comminuted and displaced fracture with large and small fragment.
<b>Type 3</b>	Large displaced fragment with an additional small cortical fragment lying beneath the displaced fragment.

Pre-operative routine blood investigations, ECG and chest x-ray were taken for cardiorespiratory fitness for surgery. We had inclusion and exclusion criteria.

**Inclusion criteria**

- Age above 16 years.
- Closed fracture.
- Fracture less than 5 days.

**Exclusion criteria**

- Head injury or major vascular injury.
- Ipsilateral upper limb trauma.
- Patient noncompliant for postoperative physiotherapy and follow up.
- Elderly with severe osteoporosis with reduced functional requirement of wrist.

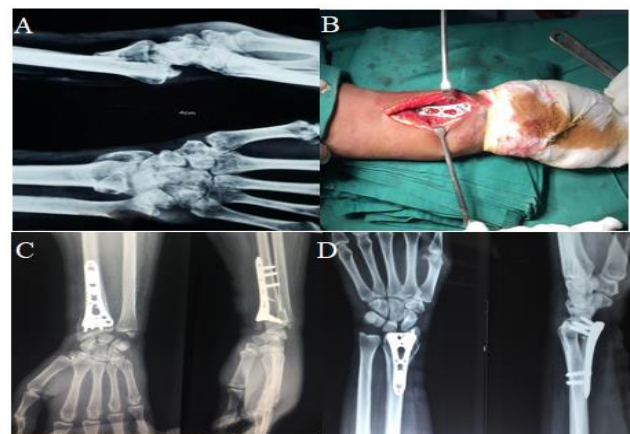
- Any other form of distal radius fracture other than volar Barton.

The patients were operated within 5 days of the occurrence of the fracture after complete pre anaesthetic evaluation under regional blocks. Injection cefuroxime 1.5 gram was administered half an hour before surgery.

**Operative technique**

Patients were operated on standard radiolucent operation table under supra-clavicular block or general anaesthesia with pneumatic tourniquet applied in order to provide bloodless field during surgery. Modified Henry approach was used, using the plane between flexor carpi radialis tendon and radial artery. After release of pronator quadratus muscle the fracture site was exposed. The volar fragment was reduced by indirect method of reduction by placing a towel beneath the wrist as it acts as self-provided traction to reduce the fracture under direct vision. Fracture reduction was achieved and was temporarily stabilized using K wires.

The plate was placed on the anterior aspect of the radius and then fixed with variable angle locking screw under image intensifier guidance. Pronator quadratus muscle was re-sutured to protect flexor tendons. Routine decompression of median nerve was not done in any patient. The wound was closed in a routine manner with drain. The wrist was immobilized with plaster for two weeks and active finger movements were advised. All patients were given enzymatic preparation for one week to reduce swelling and to encourage finger mobilization. The intravenous antibiotics were continued for next 72 hours followed by oral antibiotics for 5 days.



**Figure 1: (A) Case 1 volar Barton's fracture (Mehara type 2), (B) intra operative image of case 1, (C) immediate postoperative image of case 1 and (D) 1 year follow up of Mehara's type 2 with good result of case 1.**

All patients were reviewed after two weeks and the plaster and sutures were removed. A functional brace was applied until the fracture got united. Active wrist range of motions was started with physiotherapy. The patients were followed as out-patient at fourth week, sixth week and third month up to one year. The wrist function was evaluated using Pattee and Thompson criteria.<sup>12</sup>

**Statistical analysis**

Data were statistically evaluated with IBM SPSS statistics for windows, version 20, IBM corp, Chicago, Illinois.

**Table 2: Pattee and Thompson criteria.<sup>12</sup>**

No.	Pattee and Thompson criteria	Description
1	<b>Excellent</b>	No pain, no disability, less than 5° loss of wrist flexion or extension, no evidence of post-traumatic arthritis and very satisfied patient.
2	<b>Good</b>	Occasional mild pain, no disability, 15° or less loss of wrist flexion or extension, no evidence of post-traumatic arthritis and a satisfied patient.
3	<b>Fair</b>	Mild to moderate pain, modification of certain activities, 25° or less loss of wrist flexion or extension, some evidence of post-traumatic arthritis and patient not satisfied about his condition.
4	<b>Poor</b>	Severe pain requiring change of occupation, deformity of wrist, loss of more than 25° of wrist flexion or extension, radiological evidence of post-traumatic arthritis and an unhappy patient.

**RESULTS**

Our retrospective study included 22 (61%) males and 14 (39%) females with mean age of 32.5 (21 to 54) years. The mode of injury was road traffic accident in 29 (81%) and in 7 (19%) due to fall. The dominant wrist was involved in 20 (55%) patients. According to Mehara’s classification, there were 22 type 1 fractures, 12 in type 2 and two in type 3.

The fracture union rate was 100% with average union time of about 7.2 weeks ranging from 6 to 10 weeks depending on fracture pattern. It was longer in type 3 fractures.

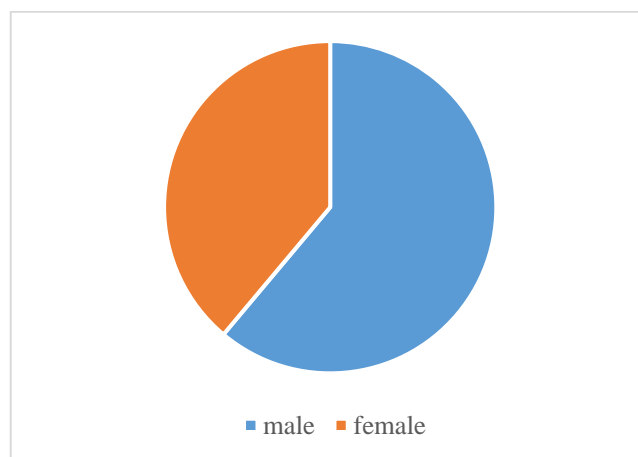
Our results were analysed using Pattee and Thompson criteria at the end of one year. We found excellent results in 22 (61%), good in ten (28%), fair in four (11%) patients.

**Table 3: Results according to Pattee and Thompson criteria.**

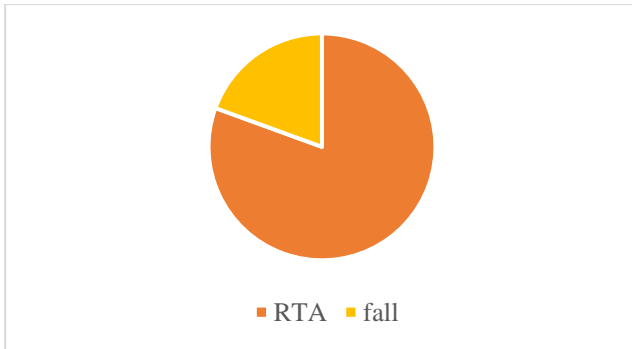
Mehara type	No. of patients (%)	Outcome according to Pattee and Thompson criteria			
		Excellent (%)	Good (%)	Fair (%)	Poor
1	22	17 ( 77)	5 (23)	0	0
2	12	5 (42)	4 (33)	3 (25)	0
3	2	0	1 (50)	1 (50)	0

The results were further evaluated according to Mehara’s classification and the outcome is illustrated in table 3. We had excellent results in most of type 1 fractures. The fractures with more comminution in type 2 and type 3 fractures had good to fair results.

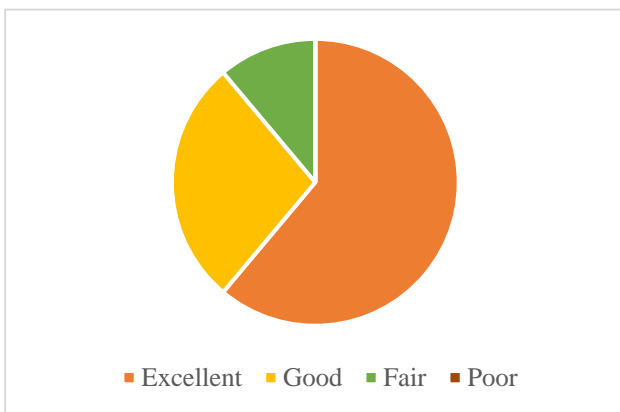
The complications encountered in our study period were superficial infection in two cases, wrist pain in two cases, finger stiffness in three cases, radiocarpal arthritis in three cases. We found one patient with extensor tendon rupture and one patient with Sudeck’s osteodystrophy at the end of six months. The tendon rupture was due to longer screw passing through the dorsal cortex with impingement of the tendons. No involvement of median nerve was seen in our study.



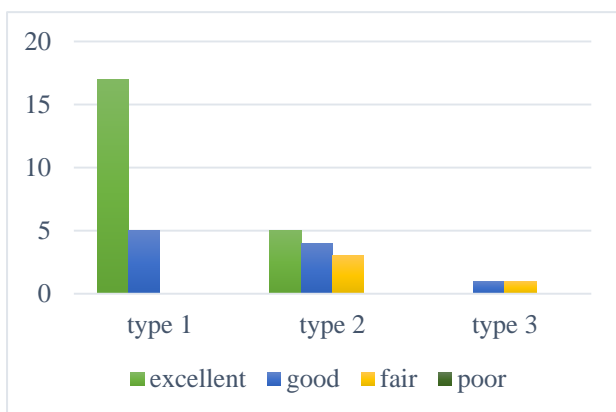
**Figure 2: Sex distribution of cases.**



**Figure 3: Mode of injury.**



**Figure 4: Results according to Pattee and Thompson criteria.**



**Figure 5: Results after 1 year of follow up.**

## DISCUSSION

Distal end radius fractures crush the mechanical foundation of man’s most dignified tool, the hand. Man is a special creation of God as he has as hand which is different from all his other creations. The primary goal in treating volar Barton fracture is to reconstruct the disrupted anatomy of distal radius and allow it to heal without complications as well as return to full function at the earliest.

Restoration of distal radius anatomy with established guidelines yields good results. Guidelines are radial shortening less than 5 mm, radial inclination more than 15°, sagittal tilt on lateral projection between 15° dorsal tilt and 20° volar tilt, intra-articular step-off less than 2 mm of the radiocarpal joint, and articular incongruity less than 2 mm of the sigmoid notch of the distal radius and these can be achieved by surgical fixation.<sup>13</sup>

In our study, volar Barton fracture was more common in male than female, and was more common in third decade which was similar to other studies.<sup>14,15</sup> Increased incidence in male population might be due to their involvement in outdoor activities, riding vehicles or heavy manual labour. The mode of injury in 29 patients was due to RTA which is more common than injury due to fall.

The volar plating for these fractures has gain popularity and plate constructs are further enhanced by polyaxial locking mechanism which enables insertion of screws at variable angles. Cadaveric studies show polyaxial locking plates are biomechanically sound for the management of distal radius articular fractures.<sup>16</sup>

In our study we had achieved 100% union which was similar to other studies and excellent results in most of type 1 fracture as the fracture fragment was a large single piece.<sup>14,15</sup> Our results in type 2 and 3 were good to fair due to fracture comminution. The fracture fixation can be improved by using polyaxial locking plates and when the uni-cortical distal locking screws are inserted at least 75% of thickness of distal radius and these construct produce stiffness similar to bi-cortical fixation.<sup>17</sup>

We had few complications in our study. The notable complication was extensor tendon rupture and this was due to long screws resulting in impingement on extensor tendons. Initial part of our study we used true lateral views to look for dorsal cortex penetration by screws. Skyline view is more sensitive than a lateral fluoroscopic view at demonstrating protrusion of the screws in the distal fragment.<sup>18</sup> To avoid this complication skyline view was taken in remaining cases. We did not have any flexor tendon complications as we have placed our volar plate just above the watershed line.<sup>19</sup>

## Limitations

- Retrospective nature.
- Inclusion of fracture pattern may have biased the implant choice.
- Sample size of the study is limited to two centre.
- We did not compare with other methods of fixation.

## CONCLUSION

Polyaxial locking plates restore articular congruity of the volar Barton fractures and give best possible results with early mobilization, least complication rates, better

stability due to its ability to vary at the angle of 15° from the centre, provided the technique is carefully performed.

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*Ethical approval: The study was approved by the Institutional Ethics Committee*

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