

Original Research Article

Prospective study of cast immobilization of extra-articular distal radius colles type fractures in 10*-15° degree of wrist dorsiflexion and assessment of functional outcome**Kumar Rohit^{1*}, Abhishekh Thakur², V.B. Singh Patel³, P.K. Lakhtakia⁴**¹Senior Resident, Department of Orthopaedics, S.S. Medical College, Rewa, Madhya Pradesh, India²PGT, Department of Orthopaedics, S.S. Medical College, Rewa, Madhya Pradesh, India³Associate Professor, Department of Orthopaedics, S.S. Medical College, Rewa, Madhya Pradesh, India⁴Professor & Head, Department of Orthopaedics, S.S. Medical College, Rewa, Madhya Pradesh, India

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Abstract

Introduction: Cast immobilization of colles type fractures is very common practice worldwide. However the position of wrist during immobilisation remains controversial. It has been noted that wrist immobilisation in dorsiflexion often results in low rate of re-displacement after closed reduction and decreased incidence of stiffness of wrist and fingers. **Aims and Objective:** To evaluate the anatomical and functional outcome of cast immobilization in extra-articular colles type distal radius fracture with wrist in dorsiflexion. **Material and Methods:** This prospective study comprised of 81 patients with a mean follow-up of 3 month. Patients were evaluated for radial height, radial inclination and volar tilt according to Lindstrom criteria. Functional outcome were assessed with PRWE score. **Study design:** Prospective cohort study. **Results:** The loss of radial height of distal radius varied from 4mm to 12 mm. Average loss of radial height varied from 6.65 mm pre-reduction to 2.92 mm post-reduction to 4.11 mm at the time of final follow-up. Forty eight patients (80%) loss less than 6 mm. **Conclusion:** The study shows satisfactory functional and anatomical results when cast immobilization is done in wrist dorsiflexion.

Keywords: Colles fracture, dorsiflexion, cast immobilization.

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Introduction

Close reduction and cast immobilisation remains the mainstay of treatment of colles fracture of distal radius in majority of the cases, however the position of wrist during immobilization i.e. Palmar flexion, neutral position or dorsiflexion remains controversial. The present study was carried out to determine the effectiveness of immobilization of wrist in 10-15 degree dorsiflexion and to assess the functional outcome associated with it.[1]

Material and Methods

After getting approval from Institutional Ethics Committee (IEC), this prospective study was carried out in the Department of Orthopaedics, Shyam Shah Medical College & associated Sanjay Gandhi Memorial Hospital, Rewa between 1st August 2017 and 31st August 2018. It included 120 adult patients (above 18 years age) with closed metaphyseal fractures of radius. Patients with fracture extending into joint, gross comminution pathological fractures, underlying neuromuscular disorders and congenital bone disorders e.g. osteogenesis imperfect were excluded from the study.

As soon as the patient presented in the department a primary survey was carried out with AP and lateral radiograph of both

injured as well as uninjured limb recording of the vitals and limb assessment for neurovascular compromise. The fractured part was appropriately splinted with dorsal pop slab. Analgesics were given to relieve the pain. A detailed history was taken, noting down the mode and severity of trauma including any associated head injury, chest or abdominal injury completing the secondary survey. The patients who completed the aforementioned inclusion criteria were registered and their clinical details were recorded in the history sheet.

Temporary stabilisation

The injured limb was temporarily put in dorsal pop slab for 5-7 days to reduce the swelling and active finger movements by the patient was encouraged to reduce the swelling.

Operative technique

Closed reduction was done under general anaesthesia and C-arm. After satisfactory reduction was achieved a below elbow cast was applied. As soon the plaster was hardening the wrist was brought in 15° degree of wrist dorsiflexion and mild ulnar deviation with a caution that dorsiflexion occurs at wrist joint and not at fracture site. To ensure wrist dorsiflexion occurs at joint and not at fracture site palmar directed force was applied over distal fragment of the fracture. The end result of this procedure was a well moulded plaster cast (Figure 1).

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Fig. 1: Stabilization of fracture while simultaneously producing dorsiflexion and ulnar deviation at wrist joint

Post cast immobilization Treatment

Once the fracture was reduced a below elbow POP cast was applied for 4 weeks. Check X-rays were taken in both antero-posterior and lateral views immediately after plaster application. The reduction of fracture was confirmed. Active exercises of fingers and thumb were started from day of 1of plaster application and as patient came out of anaesthesia. Supervised physical therapy was initiated for elbow and shoulder range of motion exercises and later on patient was taught exercises for active movements of elbow and shoulder. Their data was collected with the help of proforma. Patients were followed up at intervals of 1 week, 4 weeks and finally at 3 months and repeat X-ray was taken and radiological parameter noted. PRWE score were noted at the time of injury and at final follow-up.

Radiologic assessment

The Radiographic variables (dorsal tilt, radial shortening and loss of radial inclination), were measured pre- reduction, immediately post-reduction, one week, four weeks and finally at three month follow up. The radial tilt was measured as the angle between distal radial articular surface on AP view to a line perpendicular the long axis of the radius (normal 22-23*). On lateral view the angle created between the articular surface of distal radius and a line perpendicular to the long axis of the radius denoted the palmar tilt normal is 11-12*. Radial length was represented by the distance between two perpendiculars to the long axis of the radius, one at the tip of the radial styloid and other at the distal articular surface of ulnar head. The radiological results were calculated using the Lindstrom[1] classification while functional score was evaluated using PRWE score.[2]

Statistical analysis

All data was compiled and checked for discrepancies. Statistical analysis was done using Wilcoxon statistical method. The paired t-test was used for matched pairs. The differences in values between the 2 groups were analysed using the unpaired t-test. Multivariate analysis was done by a χ^2 test. A value of $p < 0.05$ was considered significant. The anatomical outcome was assessed according to Lindstrom scoring system while functional outcome was assessed using PRWE SCORE.

Complications

Complications like median nerve compression, complex regional pain syndrome, shoulder hand syndrome etc were not seen in any of the patients.

Results

A total 120 patients were included in the study, however 39 patients were excluded due to incomplete data or being drop out patients. So a total of 81 patients were there for final evaluation The mean age of the patients taken up for the study was 42.6 years with the youngest patient being 20 years and the oldest being 88 years. There were 52 female patients (64%) and 29 male patients (36%). About 76 (93.33%) patients sustained trauma due to fall on outstretched hand while rest were due to other mode of injury.

The loss of radial height of distal radius varied from 4mm to 12 mm. Average loss of radial height varied from 6.65 mm pre-reduction to 2.92 mm post-reduction to 4.11 mm at the time of final follow-up. Forty eight patients (80%) loss less than 6 mm.

Table 1: Loss of radial length at three months follow-up

Serial number	Radial height in mm	Number of cases	Percentage
1	<3mm	27	33
2	3-6mm	39	48
3	7-11	15	18
4	Total	81	100

The loss of radial inclination varied from 7 degrees to 22degrees. It ranged from an average of 11.8 degree pre reduction to an average of 5.2 degrees post reduction to an average of 6.85 final follow-up. Forty eight patients (80%) loss less than 9 degree.

Table 2: Loss of radius angle at three months

Serial number	Radial inclination	Number of cases	%
1	0-4	36	44
2	5-9	32	39
3	10-14	08	10
4	>15	05	7

The average loss of volar tilt varied from 0 degrees to 24degrees. The loss of volar tilt varied from an average loss of 12.3 degree pre-reduction to 3.9degree post reduction to 7.06 degree at final follow-up. Forty patients (66%) have volar tilt in normal limit. Radiological assessment was done in terms of residual dorsal angulation, radial shortening and loss of radial inclination and results were analyzed according to Lindstrom criteria. Radiological outcome by Lindstrom criteria, 43.33% showed excellent, 36.6% showed good result, 05% patients showed fair result and 07% showed poor result.

Radiological assessment was done in terms of residual dorsal angulation, radial shortening and loss of radial inclination and results were analyzed according to Lindstrom criteria. Radiological outcome by Lindstrom criteria, 43.33% showed excellent, 36.6% showed good result, 05% patient showed fair result and 07% showed poor result.

Table 3: Radiological assessment of volar tilt after 3month

Serial number	Palmar tilt	Number of cases	%
1	0 to 8+	43	53
2	0 to -5	10	12
3	-06 to -10	12	14
4	-11 to -18	16	21

Functional assessment by PRWE score showed excellent(40%) to good result (36.6%) and fair (05%) to poor (7%) result respectively.

Table 4: Distribution of patients on basis on Lindstrom criteria

Serial number	Grades	Number of cases	Percentage
1	Excellent	37	45
2	Good	27	33
3	Fair	09	11
4	Poor	08	10

Table 5: Showing patients distribution on basis on PRWE score

Serial number	PRWE score	Grading	Number of cases
1	<20	Excellent	24
2	21-40	Good	22
3	41-60	Fair	08
4	61-80	Poor	06
5	81-100	Worst	00

Discussion

The main weight bearing column of wrist comprise of the distal radial articular surface, lunate and proximal two thirds of scaphoid, capitate, trapezoid and the joints of second and third metacarpals. The displacement in colles fracture are attributed to wrist flexors and extensors as they are inserted at base of second and a third metacarpal hence acts on this weight bearing column of the wrist. It was Charnley who described the principle of three point fixation when applying a moulded plaster cast[3]. Sarmiento described fractures of the distal epiphyseal radius fractures in details[4] and recommended that the arm should be immobilized in a above elbow cast, with forearm in pronation and the wrist in palmar flexion and ulnar deviation. Sermiento identified that brachioradialis muscle was the main deforming force, for loss of reduction of the fracture post immobilisation in cast.

Gupta et al explained that after a Colles' fracture, the extensors of the carpus tend to increase the posterior displacement of the fracture

while the wrist flexors act in the direction of over reduction[5,6]. The radial extensors of the wrist are more powerful than the radial flexors (VonLanz and Wachsmuth). This means that the best position for immobilization with balanced forces is dorsiflexion, where the wrist extensors are placed at a relative mechanical disadvantage. The periosteal hinge on the concave, dorsal side of a Colles' fracture is an important stabilizing factor. When it is intact, it prevents over reduction; it could be exploited by being kept undertension by slight volar angulation at the fracture. Tension can be maintained in the periosteal hinge by moulding the plaster in the direction of over correction. Flexion at the fracture site is important since it makes the best possible use of the dorsal periosteal hinge, but the flexed position should not be maintained at the wrist joint. When the wrist is palmar flexed the dorsal carpal ligament, attached mainly to the dorsal aspect of the triquetrum, limits flexion of the proximal carpal row, so that most palmar flexion takes place at the mid-carpal articulation, where there is no dorsal ligament (Figure 2a). This lack of control at mid-carpal level allows the strong radial extensors of the wrist to rotate the proximal row of the carpus, together with the distal radial fragment, into extension, with consequent loss of reduction. By contrast, when

the wrist is dorsiflexed the volar radiotriquetral and radiocapitate ligaments become taut: these stabilize both rows of the carpus with respect to radius, and resist any deforming forces by providing a volar pull on the distal fracture fragment (Figure 2b). Moreover, forces applied in the line of the dorsiflexed carpus act at an angle which

tends to reduce the fracture. In palmar flexion these forces act in a direction tending to increase displacement (Figure 2a and 2b). In a grossly comminuted fracture some collapse probably cannot be completely prevented, but this can be minimized when the wrist is immobilized in dorsiflexion.

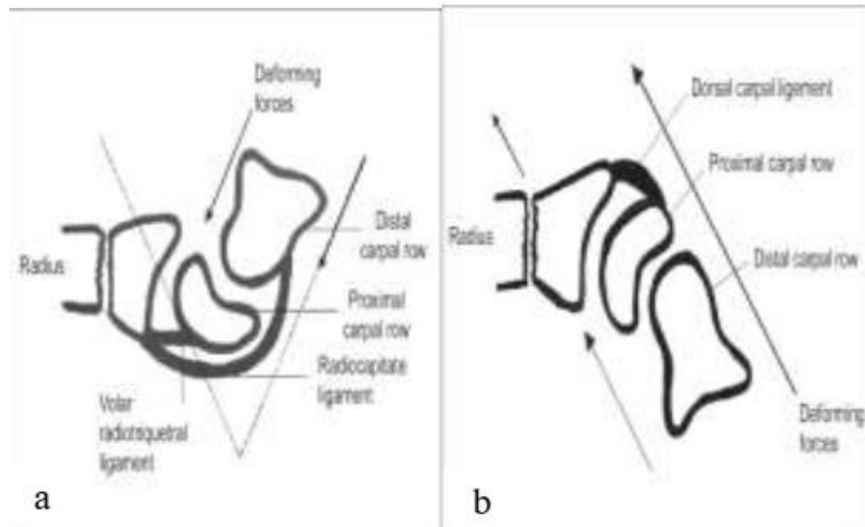


Figure 2: (a) Forces at wrist in position of dorsiflexion; (b) forces at wrist in position of palmar flexion

The fracture will collapse most easily inside a straight tube. When the wrist is dorsiflexed the plaster forms a tube with a double curve in 'S' shape. Most important radiological parameter for determination of fracture instability is loss of radial height. Other includes whether or not volar cortex is reduced[3]. Increasing age, presence of osteoporosis and dorsal comminution[6,7]. After plaster cast application the anatomical parameter most difficult to maintain is Loss of radial height followed by radial tilt and volar tilt is retained better than other two[8,9].

In our study average loss of radial height is 4.11 mm at the time of final follow-up. According to Gupta et al loss of radial length was greatest after immobilization in the neutral position and least in those immobilized in dorsiflexion[5]. According to Baruah et al functional outcome was found to be adverse in 9 out of the 11(81.82%) patients having loss of radial length more than 7 mm[10].

In our study average loss of radial inclination is of 6.85 degree at final follow-up. According to Gupta et al loss of radial inclination was same for wrist in all three position[5]. According to Baruah et al 40 out of 49 (81.62%) patients having loss of radial angulation less than 9 degree and showed excellent to good functional outcome[10]. In our study the average loss of volar tilt is 7.06 mm at final follow-up. According to Gupta et al loss of volar tilt was least with wrist in dorsiflexion compared to plantar flexion. According to Baruah et al out of 42 patients that had residual dorsal angulation of less than 10 degree, 37 (88.10%) had excellent or good functional outcome.[10] In our study 93% of patients had excellent to fair result according to Lindstrom criteria which is in accordance of Rajan et al in which 91% patients achieved good result[11], 76% in Baruah et al[10] and 99% in Gupta et al[5].

Conclusion

It is concluded that wrist immobilized in dorsiflexion have better results than immobilization in plantar flexion. Also patients with dorsiflexion have better functional outcome for the hand and less residual deformity.

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