International Journal of Research in Orthopaedics
Verma PK et al. Int J Res Orthop. 2019 May;5(3):412-416
http://www.ijoro.org

Original Research Article

DOI: http://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20191067

Cast immobilization in fracture distal radius with wrist in dorsiflexion

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Received: 23 February 2019
Revised: 12 March 2019
Accepted: 13 March 2019

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ABSTRACT

Background: The purpose of this study was to evaluate the anatomical and functional outcome of cast immobilization in fracture distal radius with wrist in dorsiflexion. Study design selected was prospective cohort study.
Methods: The study group comprised 60 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.
Results: Mean loss of radial height was 4.11 mm. Mean loss of radial inclination was 6.85 degree and mean loss of volar tilt was 7.06 degree at the end of 3 month follow up. As per Lindstrom criteria 88% were excellent to fair and 93% were excellent to fair functional outcome as per PRWE score.
Conclusions: Cast immobilization in fracture distal radius with wrist in dorsiflexion produces better anatomical and functional outcome.

Keywords: Distal radius fracture, Cast immobilization, Dorsiflexion

INTRODUCTION

Most common occurring type of fracture occurring in humans is fracture distal radius (approximately 18%).[1] Although occur due to fall on out-stretched hand, it is often associated with osteoporosis and is therefore most common in women over 50 years of age.[1-3] Fractures of lower end radius are most common fractures of the upper extremity encountered in practice and constitutes 75% of all forearm fractures.[4] Historically, closed reduction and cast immobilization has been the mainstay of treatment in Colles' fracture and continues to do so in selected cases. Although various modalities are present to manage DRF like cast immobilization, percutaneous k wire fixation, external fixation and open reduction and internal fixation, but cast immobilization is the best modality of DRF in most of the patients.[5] The ultimate aim of any modality of treatment is to restore each patient to his or her prior level of function. Cast immobilization too involves placing the wrist in either plantar flexion, neutral or dorsiflexion. This study is conducted to evaluate the functional and anatomical outcome following closed reduction and cast immobilization of extra-articular distal radius fractures (Colles' type) in 'dorsiflexion'.

METHODS

The study was conducted in Shyam Shah Medical College, Rewa. All patients of either sex above 20 years of age with closed fracture of distal end radius, meeting the inclusion and exclusion criteria (given below) treated in during the study period from 1st March 2017 to 30th June 2017 are included of the study. All patients above 20 years (either sex), isolated metaphyseal fractures of radius and close fractures were included in the study. Pathological fractures, underlying neuromuscular

disorders, open fracture and associated other fracture in same limb were excluded from the study. Complete history including mechanism of injury and examination was carried out. AP and lateral radiograph were taken of both injured and uninjured wrists. Patients were explained about the treatment and additional radiograph of normal side for comparison was taken. The limb will be immobilized initially with a dorsal POP slab for 4–5 days to reduce swelling with elevation of the arm and active finger movements. Closed reduction was done under haematoma block and c-arm control. After satisfactory reduction, a below elbow cast was applied still maintaining the reduction. As the plaster was hardening, the assistant slowly brought the wrist to 15^0 of dorsiflexion and slight ulnar deviation while maintaining the traction. The surgeon continued the palmar flexion pressure at the distal fragment to maintain its palmar tilt all the time (Figure1). This also ensured dorsiflexion at the wrist and not at the fracture site. The plaster was well molded over the wrist. Once the fracture was reduced a below elbow POP cast was applied for 4 weeks. Check X-rays were taken in both anteroposterior and lateral views immediately after plaster application. The reduction of fracture was confirmed. Active exercises of fingers and thumb were started from day of plaster. Patient was taught exercises for active movements of elbow and shoulder. Their data was collected with the help of proforma. At one week, at four weeks and finally at three month follow–up was done and repeat X-ray was taken and radiological parameter noted. PRWE score were noted at the time of injury and at final follow- up. The 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 radiological results using the Lindstrom classification were calculated.[6] Functional score is evaluated with PRWE score.[7]

Figure 1: Wrist in dorsiflexion while surgeon keeps fracture in flexion at fracture site.

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 analyzed using the unpaired t test. Multivariate analysis was done by a χ^2 test. A value of $p<0.05$ was considered significant.

RESULTS

A total 60 patients were included in the study. 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 80 years. There were 40 female patients (67%) and 20 male patients (33%). About 56 (93.33%) patients sustained trauma due to fall on outstretched hand and 04 (6.67%) due to road traffic accident.

The loss of radial height of distal radius varied from 4 mm to 12 mm. Average loss of radial height varied from 6.65 mm pre-reduction to 2.92 mm post-reducation 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.

S. no	Radius height (mm)	No. of cases	%
1	<3	18	30.0
2	3-6	30	50.0
3	7-11	12	20.0
4	>12	00	-
5	Total	60	100.0

The loss of radial inclination varied from 7 degrees to 22 degrees. 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.

S. no	Radius inclination	No. of cases	%
1	0-4	26	43.33
2	5-9	22	36.66
3	10-4	05	8.33
4	>15	07	11.66
5	Total	60	100.0

The average loss of volar tilt varied from 0 degrees to 24 degrees. Average loss of volar tilt varied from an average loss of volar tilt from 12.3 degree pre-reduction to 3.9 degree 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% patient showed fair result and 07% showed poor result.

Table 3: Radiological assessment of volar tilt after 3 month.

S. no	Volar tilt	No. of cases	%
1	0 to +8	32	53.33
2	0 to -5	8	13.33
3	- 06 to -10	9	15.0
4	-11 to -18	11	18.34
5	Total	60	100.0

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.

S. no	Grades	No. of cases	%
1	Excellent	26	43.33
2	Good	22	36.66
3	Fair	05	8.33
4	Poor	07	11.66
5	Total	60	100.0

Table 5: Showing patients distribution on basis on PRWE score.

S. no	Grading	PRWE score	No of cases	%
1	Excellent	<20	24	40
2	Good	21-40	22	36.6
3	Fair	41-60	08	13.3
4	Poor	61-80	06	10
5	Worst	81-100	0	00
6		Total	60	100

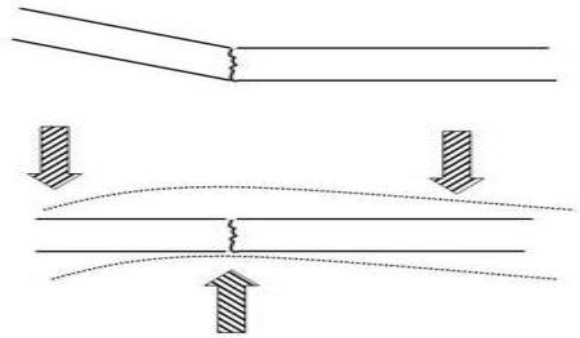

Figure 2: Showing method of three point fixation, when applying a moulded plaster.

DISCUSSION

Close reduction and cast immobilization is one of the standard method of treatment of distal radius fractures. There is general consensus that anatomical outcome of plaster cast immobilization of DRFs depends on stability of the fracture. The difficulty in management of Colles' fracture is maintenance of reduction partly due to its anatomical location near the wrist joint containing multiple carpal bones near it, and partly to poor understanding of mechanism of fracture itself. The distal radial articular surface, the lunate and proximal two thirds of scaphoid, the capitate and the trapezoid and the joints of second and third metacarpals form main force bearing column of wrist. The wrist flexors and extensors are inserted at base of second and a third metacarpal hence acts on this column and hence influence displacement.

Charnley described the method of three point fixation when applying a moulded plaster.[8] The fracture is reduced and a plaster cast is applied. The plaster is molded to apply pressure at the site of the fracture and proximal and distal to fracture.

Sarmiento classified and described fractures of the distal epiphyseal radius.[9] He recommended that the arm should be immobilized in a cast that extends from the base of the fingers to above the elbow, while holding this joint at ninety degrees of flexion the forearm in pronation and the wrist in slight flexion and ulnar deviation. Serminto identified the brachioradialis muscle as the main deforming force, for the loss of reduction of the fracture. Since the brachioradialis is attached to the distal region of the radius and functions as a flexor of the elbow when the forearm is in pronation, its stimulation easily displaces a reduced fracture, particularly if its geometry suggests axial instability and concluded that post-reduction stabilization in supination was more desirable than in pronation. They developed a forearm brace that permits flexion of the elbow, but prevented pronation of the forearm, and limited extension of the elbow in approximately the last fifteen degrees. It permits minimally limited flexion of the wrist but prevents wrist dorsiflexion. It makes impossible any radial deviation.

Gupta et al explained that after a Colles' fracture, in all the position of the wrist, 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.[10] The radial extensors of the wrist are more powerful than the radial flexors (Von Lanz 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 under tension by slight volar angulation at the fracture. Tension can be maintained in the periosteal hinge by molding 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 3a). 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 3b). 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 3a and 3b). 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 4 shows that the collapse or impaction, especially of the dorsal cortex, is more expected inside a straight or smoothly curved tube than in a tube with a double curve in an 'S' shape. Thus after manipulation of a Colles' fracture, immobilization of the wrist in dorsiflexion would provide better maintenance of reduction.

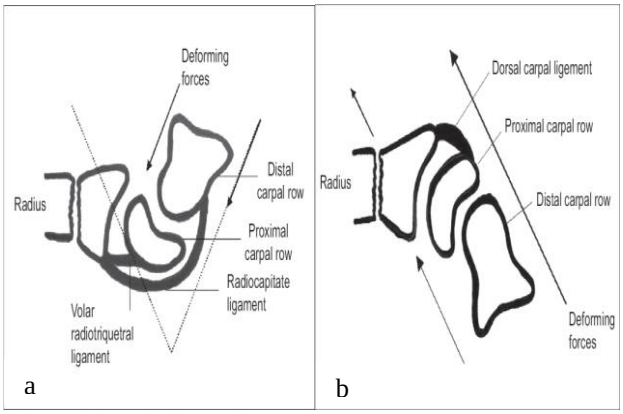

Figure 3: (a) forces at wrist in position of dorsiflexion; (b) forces at wrist in position of palmar flexion.[12]

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 to assess fracture instability is loss of radial height. Other includes whether or not volar cortex is reduced.[8] Increasing age, presence of osteoporosis and dorsal comminution leads to increased fracture instability.[11,12]

After plaster cast application not all parameters are retained equally. Loss of radial height is most difficult displacement to retain, volar tilt is retained to some extent and radial angle has intermediate position between loss of radial height and volar tilt.[13,14]

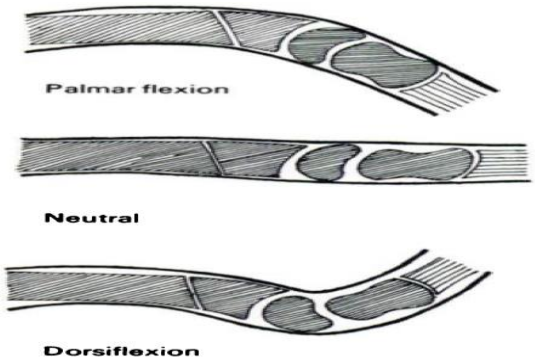

Figure 4: Fracture alignment in palmar flexion, neutral and dorsiflexion.

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.[10] 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.[15] Rajan et al found that 65% patients with DF had normal radial height compared to 40% with PF.[16]

In our study average loss of radial inclination is of 6.85 degree final follow-up. According to Gupta et al loss of radial inclination was same for wrist in all three position.[7] 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.[12] According to Rajan et al had 7 out of 34 patients with DF loss radial inclination compared to 16 out of 30 with PF.[13]

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.[10] 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.[15] According to Rajan et al had 10 patients out of 34 with DF loss palmar tilt compared to 19 out of 30 with PF.[16]

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, 76% in Baruah et al, 99% in Gupta et al.

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.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the institutional ethics committee

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Cite this article as: Verma PK, Singh R, Thakur A. Cast immobilization in fracture distal radius with wrist in dorsiflexion. Int J Res Orthop 2019;5:412-6.