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Dr. Harish Babu J
M.S (Ortho), Department of Orthopaedics, Saveetha Medical College and Hospital, Thandalam, Chennai, Tamil Nadu, India

Dr. Gadhamsetty Sai Ganesh
M.S (Ortho), Department of Orthopaedics, Saveetha Medical College and Hospital, Thandalam, Chennai, Tamil Nadu, India

Dr. Shri Vishnu M
M.S (Ortho), Department of Orthopaedics, Saveetha Medical College and Hospital, Thandalam, Chennai, Tamil Nadu, India

Dr. C Nissanth
M.S (Ortho), Department of Orthopaedics, Saveetha Medical College and Hospital, Thandalam, Chennai, Tamil Nadu, India

Dr. Yeshwanth Subash
D.N.B (ORTHO), M.N.A.M.S
Professor of Orthopaedics, Saveetha Medical College and Hospital, Thandalam, Chennai, Tamil Nadu, India

Corresponding Author:
Dr. Yeshwanth Subash
D.N.B (ORTHO), M.N.A.M.S
Professor of Orthopaedics, Saveetha Medical College and Hospital, Thandalam, Chennai, Tamil Nadu, India

Factors associated with the incidence of radiocarpal stiffness following management of distal radius fractures surgically

Dr. Harish Babu J, Dr. Gadhamsetty Sai Ganesh, Dr. Shri Vishnu M, Dr. C Nissanth and Dr. Yeshwanth Subash

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Abstract
Introduction: One of the most common fractures is the distal radius fracture in all the age groups. Among Distal radius fractures, Radiocarpal stiffness is one of the worst complications encountered. This study is to record the incidence and potential risk factors of radiocarpal stiffness associated with distal radius fractures.
Method: This is a retrospective study which includes 30 patients diagnosed with distal radius fracture who underwent volar plate fixation. Patient's details such as basic data, radiological data and postoperative data were documented. The incidence of Radiocarpal joint stiffness during postoperative follow-ups were recorded and factors associated were determined.
Result: This study comprised a total of 30 individuals who had their distal radius volar plate fixation. Multiple variables such as preoperative swelling, type of fracture (Intra-articular or Extra-articular), type of fixation (with or without k-wire), post operative radiological changes pertaining to parameters such as volar tilt, Radial inclination and ulnar variance, rehabilitation was corelated with the incidence of Radiocarpal joint stiffness in distal radius fractures.
Conclusion: Factors such as intra-articular extension, preoperative severe swelling, use of additional k-wire, unsatisfied volar tilt, improper rehabilitation is associated with a higher incidence of radiocarpal joint stiffness in patients with distal radius fracture. Re-operative risk notification and postoperative precautions are necessary for relevant patients.

Keywords: Distal radius, radiocarpal joint, stiffness, volar plating

Introduction
In individual younger than 70yrs, distal radius fracture is the most common fracture and also the most common fracture in upper limb [1, 2]. As described earlier distal radius fracture accounts around one sixth of all the patients reporting to emergency department [3, 4].
It can be treated both conservatively and surgically according to the fracture type [5, 6, 7]. For unstable fracture, volar plating is the most commonly used modality as it provides improved radiological parameter and better functional outcome as compared with conservative management.
With reliable fixation, patients could return to normal functions early. The main goal of the internal fixation is to obtain pain free motion, disability and to reduce early degenerative changes. Even with surgical management complications such as tendon rupture, loss of reduction, triangular fibrocartilage complex, wrist pain or radiocarpal joint stiffness is seen out of which radiocarpal stiffness which of much significance.
Though it is important to study these complications we have only very less studies. In this study, we analyse the distal fracture cases who underwent volar plating.
The goal of this study is to track the occurrence of postoperative RJS in patients after a 6-month follow-up period, as well as the possible risk factors for stiffness.

Materials and Methods
Patient population
Thirty patients were reviewed in this study from the month of January 2021 to January 2022

who have had distal radius fracture. The inclusion criteria were radiologically confirmed closed distal radius fracture in adults treated with volar locking plate fixation. Ipsilateral upper limb injury, bilateral distal radius fracture, previous distal radius fracture, open fracture or neurovascular injury were the exclusion criteria for this study. informed and written consent were obtained in order to store the patient information in the database for study purpose. This study was research and ethical committee after which it has been registered.

Treatment and Follow-Up

The patients included in this study were performed open reduction and internal fixation for closed distal radius fracture with volar locking plating after regional or general block. All the patients included In this study were operated using standard volar approach only. After exposure of the distal radius fracture site, open reduction procedure was attempted first, and volar locking plating with or without Kirschner wire was used to fix it.

The surgeries were performed by five chief doctors only and the type of plate, screw configurations, surgical approach were decided by the operating surgeons only. Few surgeons used the help of plaster of paris after surgery, but the stability provided by the locking plate is usually sufficient to allow early controlled range of motion exercises. Elbow, shoulder and finger movements were started at post operative day zero. The follow up was at 2, 4, 6 weeks and 3, 6 months. It is only at the 6th month the range of movement at the radiocarpal joint was measured and recorded.

Data Collection

Radiographic data, basic patient data and post operative data were evaluated to recognise the associated factors. Ag, gender and pre operative swelling, habits, concomitant disease were the basic data collected.

The swelling was considered slight if the skin texture is preserved, if it is not preserved then it is considered as severe. Fracture type, volar tilt, ulnar variance, radial inclination were the parameters in radiographic data which are measured at the 6 month follow up. Intra articular and extra articular types are the fracture types included in this study. A lateral view x-ray of the involved wrist is used to measure the volar tilt whereas in the anteroposterior view the radial inclination.

Ulnar variance is also a parameter to be measured in the anteroposterior view x-ray of the wrist. Wrist mobilisation exercises were started by the surgeons in accordance with the rate of fracture healing, which is the ideal postoperative rehabilitation. Those patients who followed the advice given by the surgeon were considered to have done proper rehabilitation otherwise there were considered as improper with postoperative wrist rehabilitation.

Wrist range of motion is measured considering the flexion-extension movement of the wrist as it is the most common movement at wrist. This range is measured using goniometer and it is considered as radiocarpal joint stiffness if the ROM is less than half of that in the contralateral wrist.

Statistical Analysis

Statistical package for social sciences (SPSS) was used to perform the statistical analysis. For categorical variables frequencies and percentage and for continuous variables standard deviation were used to present the variables. The difference in frequencies of Nominal variables were identified using Fisher's exact test and independent sample t test or Mann-Whitney U test was used for numerical data. P values less than 0.05 were considered to be statistically significant whereas p value of <0.20 were considered potential variables.

Results

This study comprised a total of 30 individuals who had their distal radius volar plate fixed. Among these patients 18(60%) patients were male and the remaining 12(40%) patients were female [Fig 1], the mean age being 59.6 ranging from 49 to 79 years. Variables such as preoperative swelling (P value 0.03), type of fracture (Intra-articular or Extra-articular), type of fixation that is with or without k-wire (P value0.37), post operative radiological changes such as volar tilt (P value 0.03), Radial inclination and ulnar variance, rehabilitation(P value 0.01) were considered. Out of 30 patients in this study 20 (66%) had slight and 10(34%) had severe preoperative swelling [fig 2]. A number of 20(66%) patients had extra-articular and 10(34%) patients had intra-articular fractures respectively [fig 3]. All the patient underwent open reduction and internal fixation with plate osteosynthesis, out of which for 7(23%) patients were additionally treated with Kirschner wire [fig 4]. no patients were treated with additional casting/splinting. Only one patient had postoperative complication of incision site infection. Twelve (40%) patients had postoperative radiocarpal joint stiffness and the rest 18 patients did not have [Table 1].

In the analysis of relation between patient basic data, radiological data and postoperative data with RJS, it is found that age, preoperative swelling, type of internal fixation, volar tilt, postoperative rehabilitation exercises potential risk factors which has a higher p value of <0.05 which is considered significant while gender, Comorbid, radial inclination, ulnar variance, postoperative infection were not. In further multi-logistic studies severe preoperative swelling, intra articular fracture, postoperative unsatisfied volar tilt and rehabilitation exercise were demonstrated to be strongly associated with Radiocarpal joint stiffness during serial follow-ups.

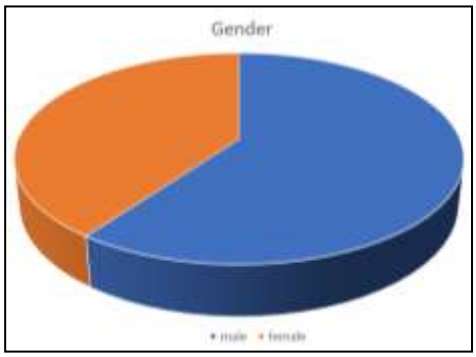

Fig 1: Gender distribution

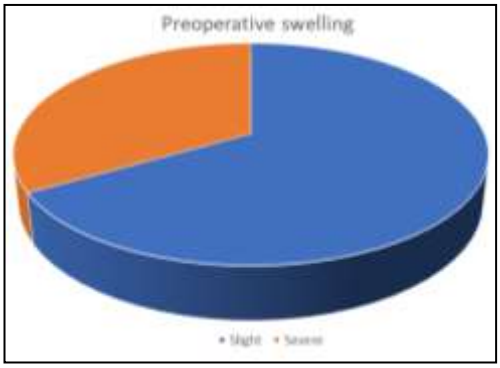

Fig 2: Severity of pre-operative swelling.

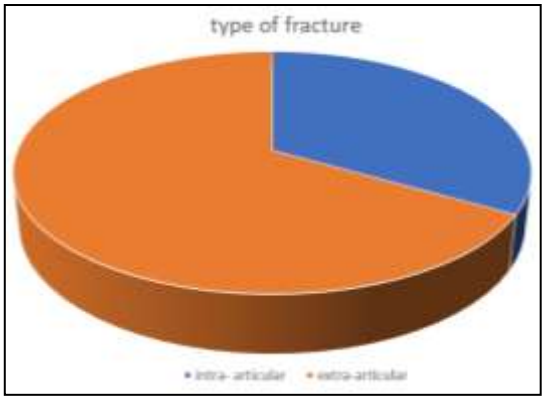

Fig 3: Type of fracture – intra or extra articular.

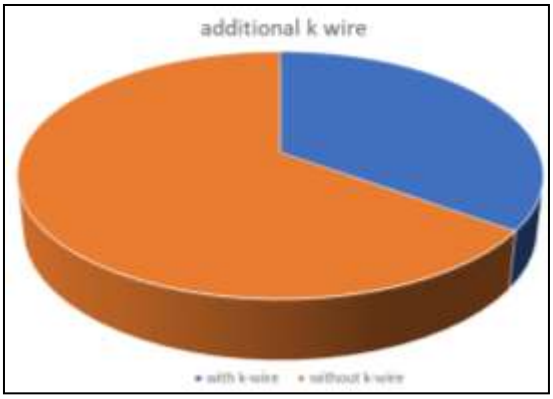

Fig 4: Additional k-wire

Table 1: Patients Demographics and data

S.no	Age/sex	Side	Type of fixation	Fracture type	Pre-op swelling	Postop Radial Inclination	Postop Ulnar Variance	Postop volar tilt (in degree)	Rehabilitation	ROM	ROM DF	ROM PF
1	55/M	L	PO	Extra articular	Slight	20	0.3	6.5	Yes	FREE	75	80
2	60/M	R	PO With K-W	Intra articular	Severe	17	0.4	7	NO	RES	30	25
3	70/F	L	PO	Intra articular	Severe	16	0.6	6	Yes	RES	25	40
4	54/M	R	PO	Extra articular	Slight	21	0.3	7.2	Yes	FREE	80	85
5	57/M	L	PO	Extra articular	Slight	22	0.3	8	Yes	FREE	85	80
6	68/F	L	PO With K-W	Intra articular	Severe	18	0.4	5.8	Yes	RES	25	20
7	63/F	L	PO	Extra articular	Slight	19	0.5	8	Yes	FREE	90	85
8	62/M	R	PO With K-W	Intra articular	Severe	17	0.5	6.2	NO	RES	25	30
9	59/M	R	PO	Extra articular	Severe	15	0.5	6.9	Yes	RES	28	35
10	56/F	L	PO	Extra articular	Slight	21	0.3	6.8	Yes	FREE	80	75
11	51/M	L	PO	Extra articular	Slight	22	0.4	7.2	Yes	FREE	85	82
12	67/F	L	PO With K-W	Extra articular	Severe	18	0.6	7.5	NO	RES	30	45
13	49/F	R	PO	Extra articular	Slight	21	0.3	6.8	NO	FREE	80	80
14	63/M	R	PO	Extra articular	Slight	22	0.3	7.5	Yes	FREE	85	82
15	58/M	R	PO	Extra articular	Slight	21	0.2	7.1	Yes	FREE	85	80
16	52/F	L	PO	Extra articular	Slight	22	0.3	7.4	Yes	FREE	82	80
17	60/M	L	PO	Extra articular	Slight	22	0.4	7.6	Yes	FREE	80	75
18	67/M	L	PO With K-W	Intra articular	Severe	19	0.4	7	NO	RES	40	35
19	60/F	R	PO	Extra articular	Slight	20	0.4	7	Yes	FREE	85	75
20	55/M	L	PO	Extra articular	Slight	22	0.3	6.9	Yes	FREE	80	70
21	79/M	L	PO With K-W	Intra articular	Slight	20	0.4	5.5	Yes	RES	40	35
22	59/M	R	PO	Extra articular	Slight	20	0.3	6.8	Yes	FREE	87	70
23	49/F	R	PO	Intra articular	Slight	22	0.3	7	Yes	FREE	80	75
24	60/M	R	PO	Intra articular	Severe	18	0.4	7.2	Yes	RES	30	35
25	54/M	L	PO	Extra articular	Slight	20	0.2	7.8	Yes	FREE	80	75
26	51/M	R	PO	Extra articular	Slight	20	0.2	7.1	Yes	FREE	85	90
27	59/F	R	PO With K-W	Intra articular	Severe	19	0.5	7.3	NO	RES	37	40
28	60/F	R	PO	Extra articular	Slight	21	0.3	7.6	Yes	FREE	78	76
29	64/M	R	PO	Extra articular	Slight	17	0.4	7	Yes	RES	40	40
30	69/F	R	PO	Intra articular	Severe	18	0.5	7.8	NO	RES	34	30

M-male, F- female, L- left, R- right, PO- plate osteosynthesis, ROM- range of motion, DF- dorsiflexion, PF- palmarflexion, RES- restricted.

Discussion

Identification of the variables associated with RJS may help surgeons in finding patients with higher risk for it and to decide the monitoring and follow up orders. This study is done with patients undergoing volar plating and revealed that the incidence of radiocarpal joint stiffness of 40% at 6 months of follow up. Intra articular fracture, pre operative swelling(severe), unsatisfied volar tilt and most importantly improper rehabilitation post operatively were the variables associated with RJS. Even after surgical intervention there is step offs and gaps associated with intra articular fracture which can result in residual articular incongruence. Karnezis *et al*. [8] concluded that post operative articular incongruity of ≥ 1mm are associated with loss of wrist joint movements that is the dorsiflexion/palmar flexion. Radiological osteoarthritis may be as high as 9 folds with persistent intra articular incongruity. For a good postoperative wrist movement, we suggest that the articular surface and maintenance of congruity should be restored.

Three parameters used to assess distal radius deformity are Volar tilt, radial inclination and radial shortening [9]. In certain cases, perfect anatomic reduction is very hard or almost impossible. If the residual dorsal angulation was ≤ 10°, radial inclination was ≥ 15°, and radial shortening with positive ulnar variance was < 3 mm was considered acceptable based on Grewal and MacDermid's [10] study. Postoperative volar tilt if unsatisfactory, is by itself an independent variable of RJS. Exaggerated dorsal angulation of more than 20 degree may worsens functional outcome [11, 12]. For every 10 degree of dorsal angulation there is loss of approximately 3 degrees of volar flexion [13], 20 degrees may cause as close to 8-degree loss in volar flexion [14].

The around ligaments are damaged extensively in high energy injury and acts as an important prognostic indicator. Limb swelling can indirectly indicate the extend of the soft tissue damage. Rehabilitation exercise is important. Home exercises are as efficient as formal physiotherapy [15]. Studies were done to compare between early wrist exercise with late wrist exercise which concluded that no significant differences in the ROM (flexion-extension) of wrist. In our study we inferred that lack of exercise is highly associated with the RJS.
Strict inclusion criteria are the strength of this study. The drawback of this study we never studied the ulnar/radial deviation, since the results were obtained from surgically managed patient, it cannot be applied to all the DRF patient.

Conclusion
Nearly half of the patients with distal radius fractures presented with post-operative radiocarpal joint stiffness following open reduction and internal fixation with a volar locking plate. An increase in age, peri-operative swelling, type of internal fixation, volar tilt, improper rehabilitation exercises were associated with the incidence of radiocarpal joint stiffness. However, volar tilt seems to be more dangerous than the restoration of radial inclination and radial shortening for wrist dorsiflexion movement. Proper precautions and necessary measures to be taken pre - operatively and post-operatively for these patients.

Conflict of Interest
Not available

Financial Support
Not available

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