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RESEARCH ARTICLE
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EVALUATION OF RESULTS OF VOLAR LOCKING PLATE OSTEOSYNTHESIS FOR DISTAL RADIUS FRACTURES

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INTRODUCTION

Distal radius fractures accounts for around 15% of all fractures diagnosed and treated in the emergency rooms. These fractures usually common in elderly patients due to trivial fall as a result of osteoporosis and due to high velocity injury such as a motor vehicle accident or fall on an out stretched hand in the young. Volar Locking Compression Plates (LCP) is effective devices for fixation of the distal radius fractures[1].

The goal of the treatment of any distal radius fractures is to restore the patient to preoperative status safely and efficiently, while minimizing the risk of medical/ surgical complications and technical failures[2]. To achieve this, we need a good implant which can be applied easily, holds the reduced fracture until union and helps in early mobilization until consolidation and union.

Advantages of a locking compression plate are as follows:

1.The basic principle of LCP is its angular stability whereas stability of convectional plate osteosynthesis relies on friction between the plate and bone.
2. There is no disruption of underlying cortical bone perfusion but conventional plate compresses the plate to the cortical bone and may disrupt cortical bone perfusion.
3. It is a stable fixation than the conventional plate[3].

Numerous techniques have been described for the treatment of patients with distal radius fractures; However assessment of each technique has been inconclusive as to which is better. Hence the need for this study.

MATERIALS AND METHODS

Patients with distal radius fractures who satisfy the inclusion criteria, presenting to MVJ Medical college and Research Hospital will be included in this study. This study is done from October 2017 to May 2019.

Inclusion criteria:

a) Patients with distal radius fractures.
b) Patients above 20 years of age.
c) Patients who are willing to participate in this study.

Exclusion criteria:

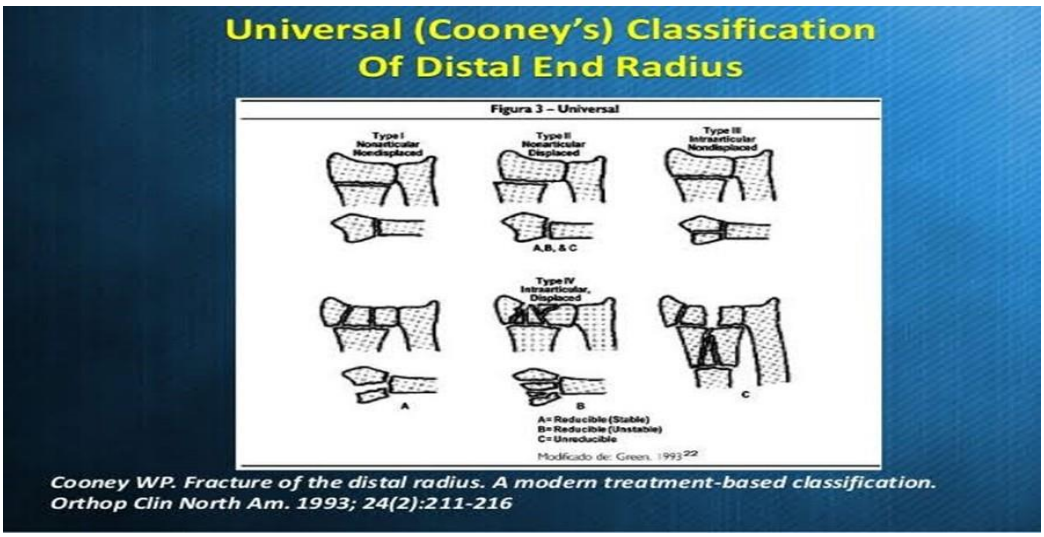
a) Patients with polytrauma.
b) Open fractures.
c) Neurovascular injuries.
d) Patients with pathological fractures.
e) Intra- articular communited distal radius fractures.
f) Isolated distal styloid process fractures.

Radiographic examination:

Standard radiographs in PA and lateral views were taken for confirmation of the diagnosis and also to know the type of fracture. Oblique views were also taken in a few patients who had complex comminuted fractures. The fracture fragments were analysed and involvement of radiocarpal and distal radioulnar joints were as-sessed and classified according to the universal classification.

2 - *Universal classification for radius distal end fractures*

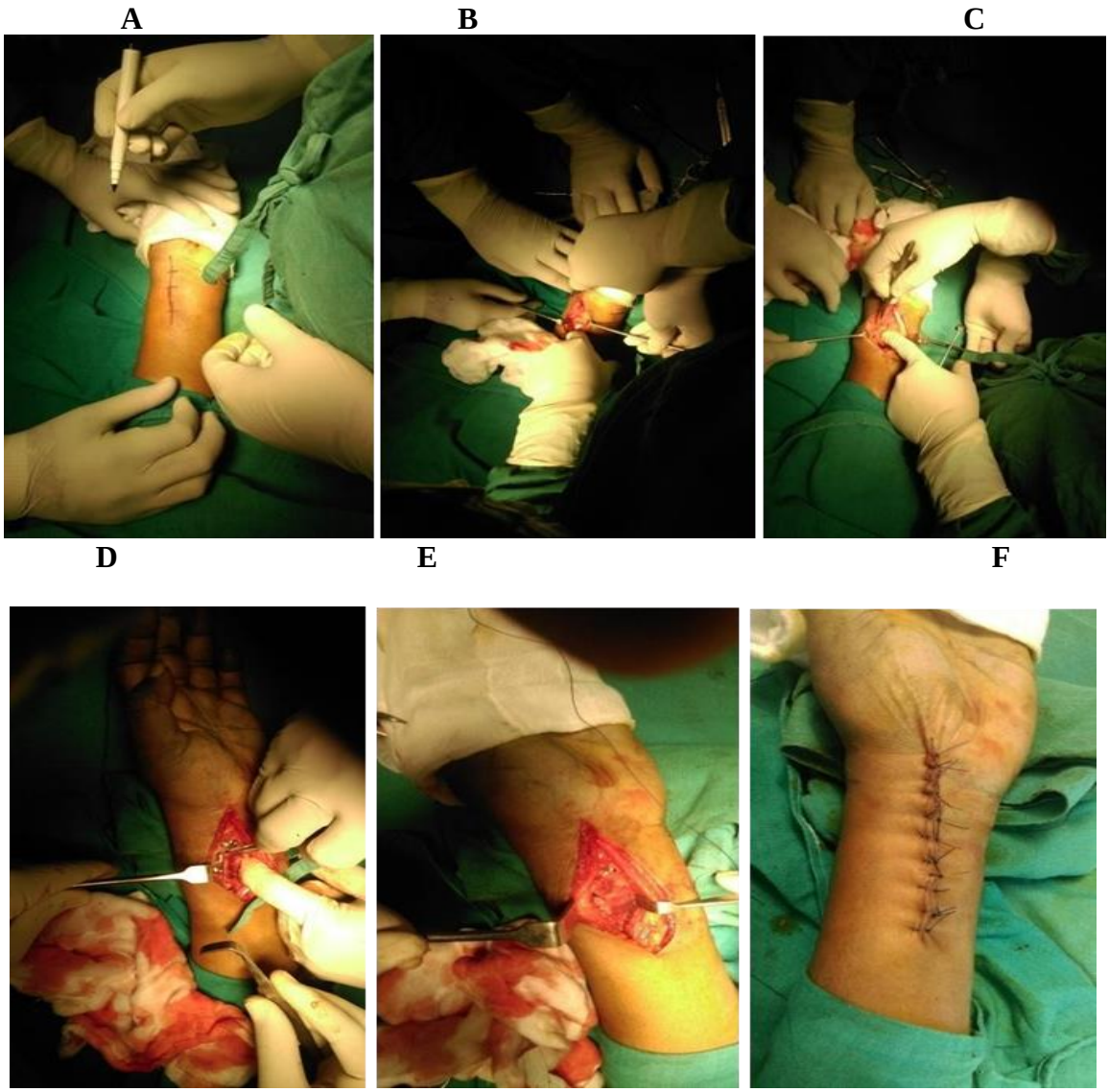
Type 1 – Extra-joint fracture, without deviation
Type 2 – Extra-joint fracture, with deviation
2A Reducible and stable
2B Reducible and unstable
2C Irreducible
Type 3 – Intra-joint fracture, without deviation
Type 4 – Intra-joint fracture, with deviation
4A Reducible and stable
4B Reducible and unstable
4C Irreducible



SURGICAL TECHNIQUE:

The incision for volar fixation of the distal radius is typically performed through the distal extent of

the modified Henry's approach. An incision is made be-tween the flexor carpi radialis (FCR) tendon and the radial artery[2]. This interval is de-veloped, exposing the flexor pollicis longus (FPL) muscle at the proximal extent of the wound and the pronator quadratus muscle more distally. The radial artery is carefully retracted radially, while the tendons of the flexor carpi radialis (FCR) radially and flexor pollicis longus (FPL) ulnar side**.**

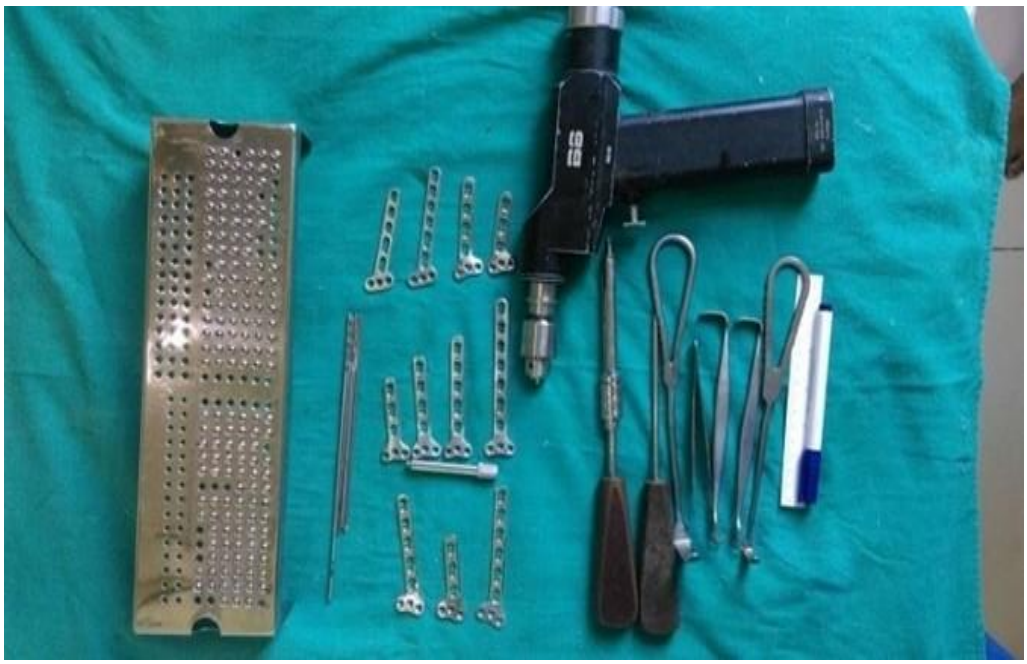


A) Skin incision site , B) plain between FCR and radial artery, C)fracture reduction , D)post reduction plate fixation , E) pronator quadratus re sutured F) skin closure

The pronator quadratus is divided at its most radial aspect. Any elevation of the muscle of the FPL should be performed at its most radial aspect, as it receives its innervation from the anterior interosseous nerve on its ulnar side. After the pro-nator quadratus has been divided and elevated, the fracture is readily visualized, and reduction maneuvers can be accomplished under direct vision. After exposure and freshening of the fracture site, the fracture is reduced and provisionally fixed under fluoroscopy with temporary K-wires, reduction forceps . Reduction aids should be placed so as not to interfere with placement of the plate. The appropriate plate is selected following fracture reduction. First a standard corti-cal screw was applied to the most distal oval hole of the vertical limb of the plate in order to temporarily secure the plate to the proximal fragment. This allowed concomitant proximal and distal plate adjustment. After fixing the distal fragment with sub-chondral locking screws, radial length was gained, when necessary, by pushing the plate distally[4]. The first, standard screw can be either left in situ or exchanged with another locking screw. The oval hole is a combination hole designed for locking head screw placement at the distal end and standard screw

placement at the proxi-mal end of the same hole.
The optimal placement of the distal screws is important. They must be insert-ed at the radial styloid, beneath the lunate facet, and near the sigmoid notch. More volar tilt can be achieved during distal screw placement when the wrist is volarly flexed as much as possible by an assistant[2]. Moreover, radial length can be further improved by pushing the whole plating system distally while using the oval plate hole and screw as a glide. The final position of the plate was confirmed using fluoroscopy. Pronator quadratus muscle was used at the time of closure, to cover, in part, the implants that were applied to the anterior surface of the radius.
Once stable fixation was achieved and hemostasis secured, the wound was closed in layers and sterile compression dressing was applied. The tourniquet was removed and capillary refilling was checked in the fingers. The operated limb was supported with an anterior below elbow POP slab with the wrist in neutral position.

INSTRUMENTS AND IMPLANT USED:
•Locking compression plates
•3.5mm LCP drill bit and sleeve system
•Power drill
•Tap for 3.5mm cortical screws and 3.5mm depth gauge
•Hexagonal screw driver for 3.5mm cortical screws and locking screw driv-er
•General instruments like retractors, periosteal elevators, reduction clamps, bone levers etc.
•Esmarch bandage.



Post-operative care, Follow up:
Follow-up of patients was done at six weeks, three months and six months fol-lowing the surgery.

Assessment:
For all subjects, radiographs were performed at the end of six weeks, three months and six months follow-up. Patients were evaluated based on the following parameters at the time of discharge and all the four follow ups;

Range of motion
•Wrist - Flexion, extension, supination, pronation, ulnar deviation and radial deviation
•Elbow - Flexion, extension, supination and pronation.
Final outcome was evaluated by MODIFIED MAYO WRIST SCORE evaluation questionnaire.

The MODIFIED MAYO[5] consists of 4 items to measure physical function and symptoms in Upper limb musculoskeletal disorders.

SL	CATEGORY	SCORE	FINDINGS
1		25	NO PAIN
		20	MILD PAIN WITH VIGOROUS ACTIVITIES
		20	PAIN ONLY WITH WEATHER CHANGES
	PAIN(25 POINTS)	15	MODERATE PAIN WITH VIGOROUS ACTIVITIES
		10	MILD PAIN WITH ACTIVITIES OF DAILY LIVING
		5	MODERATE PAIN WITH ACTIVITIES OF DAILY LIVING
		0	PAIN AT REST
2		25	FULLY SATISFIED
		20	VERY SATISFIED
	SATISFACTION (25 POINTS)	15	POOR SATISFIED
		10	FAIRLY SATISFIED
		5	NO SATISFIED,BUT WORKING
		0	NO SATISFIED,UNABLE TO WORK
3		25	100% PERCENTAGE OF NORMAL
		20	80-99% PERCENTAGE OF NORMAL
	RANGE OF MOTION (25 POINTS)	15	60-79% PERCENTAGE OF NORMAL
		10	40-59% PERCENTAGE OF NORMAL
		5	20-39% PERCENTAGE OF NORMAL
		0	0-19% PERCENTAGE OF NORMAL
4		25	100% PERCENTAGE OF NORMAL
		20	80-99% PERCENTAGE OF NORMAL
	GRIP POWER (25 POINTS)	15	60-79% PERCENTAGE OF NORMAL
		10	40-59% PERCENTAGE OF NORMAL
		5	20-39% PERCENTAGE OF NORMAL
		0	0-19% PERCENTAGE OF NORMAL

From the item scores, a summative score is calculated. The final score ranges between 0 (no disability) and 100 (the greatest possible disability). Only one missing item can be tolerated and if two or more items are missing, the score cannot be calculated. Based on the MODIFIED MAYO[5] score the functional outcome among patients was graded as below.

- Excellent outcome Score between 90 - 100
- Good outcome Score between 80 - 89
- Fair outcome Score between 65 - 79
- Poor outcome Score between >65

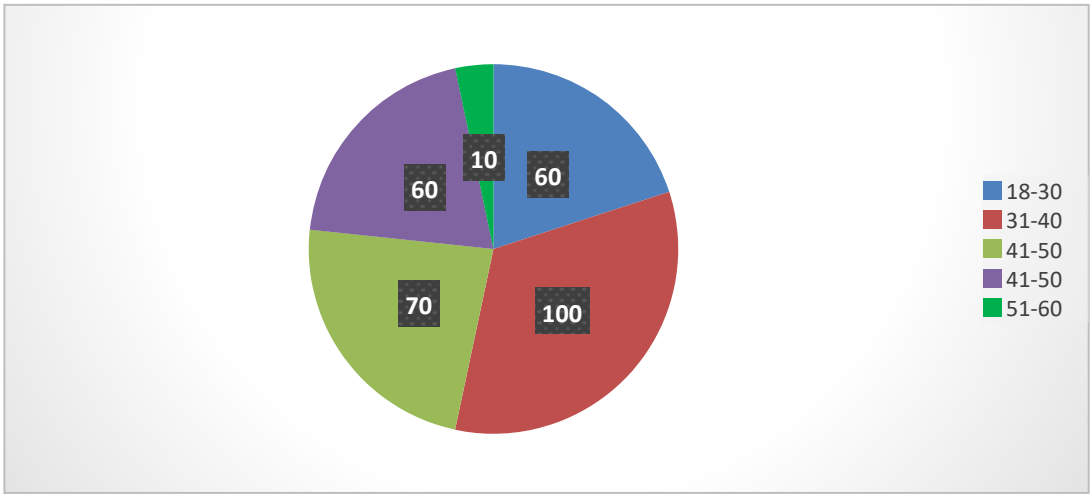
OBSERVATIONS AND RESULTS:

INCIDENCE OF DRFS IN DIFFERENT AGE GROUPS

Age in Years	No. of cases	Percentage
18-30	**60**	**20**
31-40	**100**	**33.3**
41-50	**70**	**23.3**
51-60	**60**	**20**
61-70	**10**	**3.3**

The age of the patients ranged from 18-70 years with an average of 41.2 years

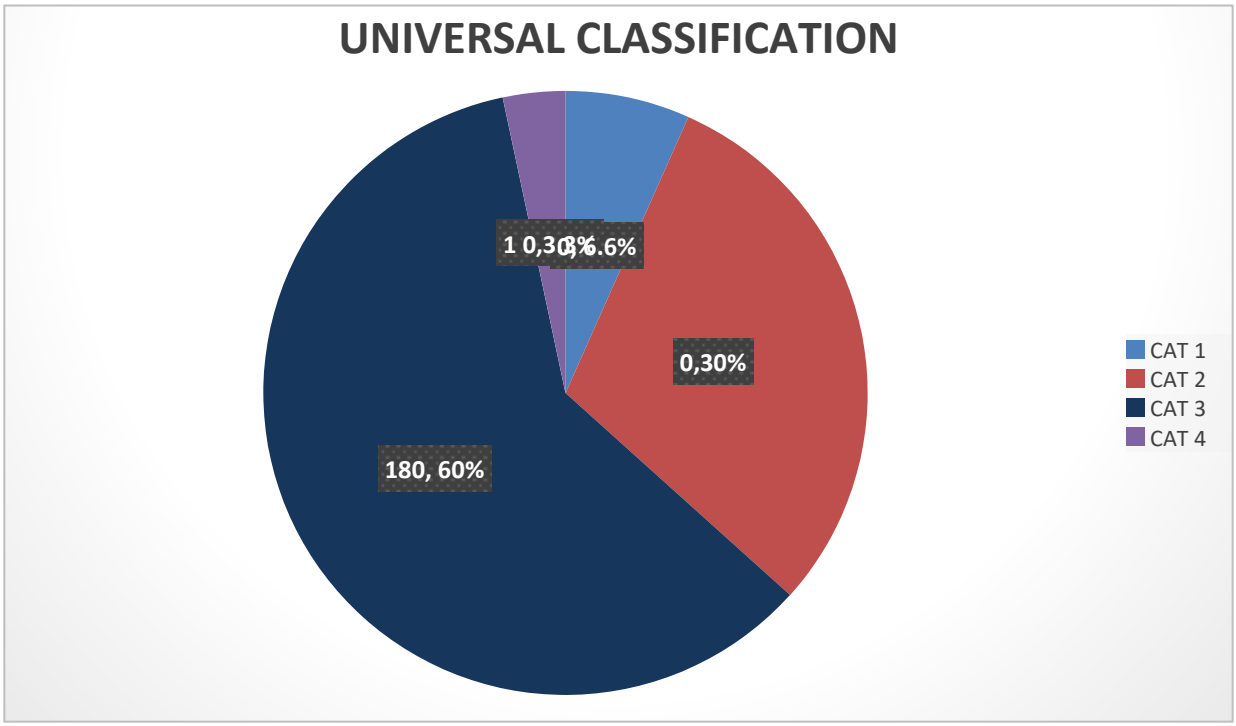
INCIDENCE OF FRACTURES IN DIFFERENT AGE GROUPS



TYPE OF FRACTURE ACCORDING TO UNIVERSAL CLASSIFICATION

Type	No. of Cases	Percentage
I	20	6.6%
II	90	30%
III	180	60%
IV	10	3.33%

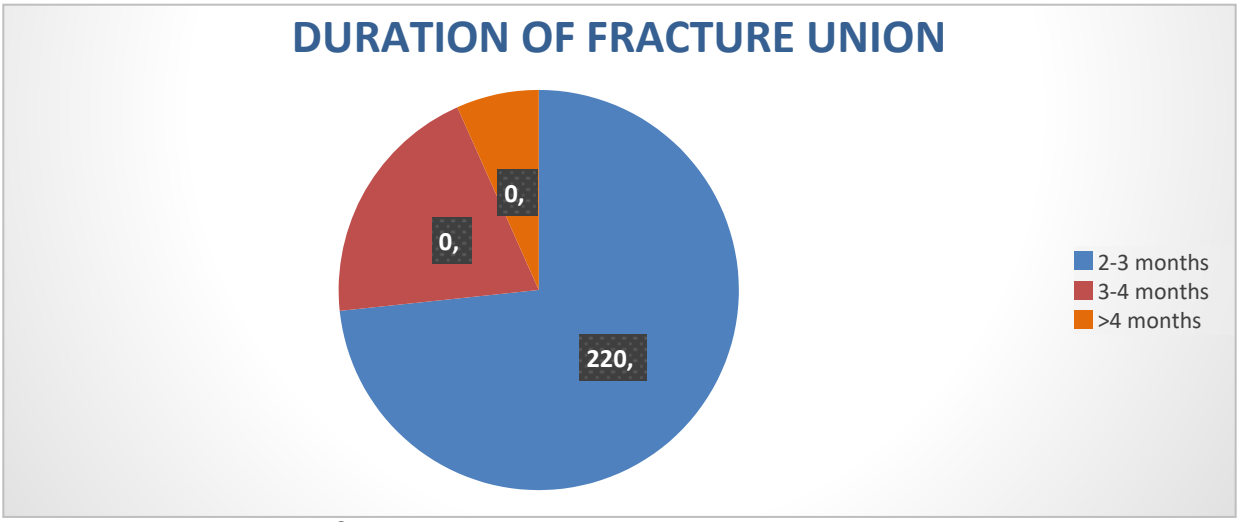
Out of 300 cases, 20(6.6%%) of the fractures were of Type I UNIVERSAL Classification, 90 (30%) of Type II, 180 (60%) of Type III, 10(3.33%) of Type IV, fractures**.**



DURATION OF FRACTURE UNION

Time of Union	No. of cases	Percentage
2-3 months	220	73
3-4 months	60	20
4-6 months	20	07

In the present study 220 (73%) patients had union within 2-3 months and 60 (20%) patients had union in 3-4 months and 20 (07%) had union in 4-6 months.

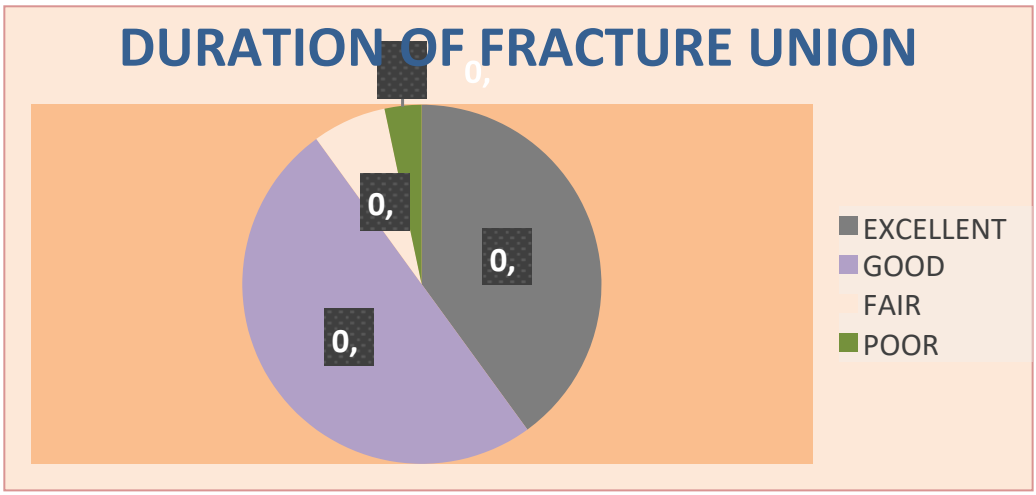


The assessment of results were made using the MODIFIED MAYO SCORE.

MODIFIED MAYO SCORE

SCORE	CASES	PERCENTAGE
90-100	120	26.6%
80-89	150	60%
65-79	20	10%
<65	10	3.3%

Using the MODIFIED MAYO score, we had 80 (26.6%) excellent results, 180 (60%) good results, 30(10%) fair results and 10(3.3%) poor results.



DISCUSSION:

The primary goal in treatment of this injury is to provide good reduction and immediate stability to achieve anatomic fracture union, allow the quick return of hand function, and avoid complications. Fracture healing depends on a minimal gap, adequate stability, and sufficient blood supply[6].

In theory, the locking plate minimizes the compressive forces exerted on the bone to achieve stability, which may prevent periosteal compression and associated impairment of blood supply,and it is favoured for fracture healing

In unstable fractures, re-establishment of inter-articular integrity of the wrist and maintaining the radial length are often not possible with closed methods. In such cases, where an open reduction is required, various surgical methods and fixation materials can be used. A better understanding of wrist

anatomy and functioning through the studies conducted in the recent years, as well as the increasing expectations of patients have expanded the borders of surgical treatment. Besides, improvements in fixation materials have provided new opportunities.
The present study was undertaken to assess the functional outcome of operative management of distal radial fractures using volar locking plate fixation. We evaluated our results and compared them with those obtained by various other studies utilizing different modalities of treatment.

● Age distribution:
In our study the age group ranged from >18years to 70years with mean age of 41.2 which are similar to other studies compared.

Series	Average age in years
Kevin C. Chung et al[7]	45
R.E. Anakwe et al[8]	48
Kilic A et al[9]	45
Present study	41.2

● Complications:
We encountered complications 20 patient had stiffness of joint, 10 patient had extensor pollicis longus tendon irritation due to long screw placement through the cortex.

Series	% of complications
Yukichi Zenke et al[10]	3%
RohitArora et al[11]	36%
Present study	10%

RADIAL INCLINATION
In our study the average radial inclination preoperatively was 7.76±5.8 degrees, the average postoperative radial inclination was 18.2±3.3degrees. The average radial inclination achieved was 10.44 degrees.

Series	Mean average radial inclination
K. Egol et al[12]	17.1±4.7 degrees
YukichiZenke et al[10]	25.9±3degrees
Tamara D et al[13]	22±3degrees
Present study	18.2±3.3 degrees

●VOLAR TILT
In our study the preoperative mean volar tilt was -17.1±7.82degrees and mean postoperative volar tilt was 6.95±4.54degrees the total correction achieved was 19.63±7.56degrees the higher degree of correction achieved was due to the fact that the dorsal tilt was expressed in negative value and hence the correction achieved was greater than the normal range (0-11degrees).

Series	Mean volar tilt (deg)
K .Egol et al[12]	3.2 degrees
YukichiZenke et al[10]	10.7±5.2degrees
Present study	6.95±4.54 degrees

● RADIAL LENGTH
In our study preoperative mean radial length 3.66±1.79mm was observed preoperatively with an immediate postoperative radial length of 9.08±1.65mm , we achieved a mean correction of 6.15±2.66mm during the surgical procedure

Series	Mean radial length(mm)
K . Egol et al[12]	9.3±3mm
Tamara D et al[13]	11±2mm
Marco Rizzo . Brain A. Katt . Joshua T others[14]	11mm
Present study	9.08±1.65mm

● MODIFIED MAYO SCORE

In present study MODIFIED MAYO[5] score at 6months follow up is 87.16±8.73

Series	Score
K .Egol et al[12]	75.0±21.7
Ballal A et al[14]	88±13
Adani R et al[15]	91
Present study	87.16±8.73

● RANGE OF MOTION :

The mean range of motion achieved in our study was as follows palmar flexion of 77±3.10degrees, dorsiflexion of 71.5±3.17degrees, radial deviation of 18.16±5degrees, ulnar deviation of 32.60±4 degrees, supination of 73.75±4.07degrees, pronation of 69.41±3.33degrees. these results were taken at 1 year postoperatively and were compared with the normal side.

Series	Pf(deg)	Df(deg)	Rd(deg)	Ud(deg)	Sup(deg)	Pro(deg)
Tamara D et al[13]	58±13	58±14	22±9	35±6	84±13	85±11
Marco Rizzo.et al.,[16]	64	69	23	34	76	78
Present study	77±3.10	71.5±3.17	18.16±5	32.60±4	73.75±4.07	69.41±3.33

CONCLUSION

Due to aging society, & enormous increase of high speed motor vehicle accidents, the number of distal radial fractures can be expected to increase in the coming decades. In this study, thirty cases of distal radius fractures who were treated with open reduction and internal fixation with volar plate were followed up and functional outcomes were analysed and discussed.

From this sample study, we conclude that volar locking plate fixation provides successful results for the treatment of both extra articular and intra articular unstable fractures of distal radius. This method allows restoration of the anatomy, stable internal fixation, a decreased period of immobilisation and early return of wrist function. This method, which is effective in anatomic realignment, allows early joint motion, owing to its fixation strength..

Volar approach provides both access with minimal surgical trauma on distal radius and fixation with a better adaptation to surrounding tissues. In the subjects of our study, a successful anatomic alignment was acquired with volar approach, regardless of the direction of fracture angulation. The patients who were young adults in majority, went back to their daily activities with 90% recovery. Close placement to joint interface and screwing capability in different orders are biomechanical superiorities of a locking plate .The precontoured anatomical LCP not only provide restoration of radial length but also helps in stabilizing palmar angulation. They maintain intra-articular congruity thus reducing radio carpal arthritis and decrease in grip strength. They also provide quicker recovery and better functional range of movement and provide better fixation in a osteoporoticbone. In our study excellent to good results suggests that stabilizing the fracture fragments with volar locking plate is an effective method to maintain the reduction till union and prevent collapseof the fracture fragments, even when the distal radius fracture is grossly communited intra-articular / unstable and or the bone is osteoporotic. It is a simple and reproducible procedure that improves recovery from this common injury. The technique emphasises that ORIF with volar plating has excellent functional outcome with minimal complications thus proving that it is the prime modality of treatment for distal radius fractures.

In conclusion, we looked at Functional results of volar locking compression plates and found an improved range of movement and radiological outcome at six, twelve and twenty four weeks follow up. Thus, this study demonstrates that with the execution of good surgical techniques, including proper plate position, proper insertion of screws and avoidance of past pointing, and proper patient selection, a satisfactory functional and radiological outcome can be obtained for a great majority of patients with most of the distal radius fractures(incl. Complex intra-articular)by using a volar locking plate fixation.

SUMMARY

Prospective study involving Adults(>18yrs) with distal radius fractures admitted in Department of Orthopaedics, presenting to MVJ Medical college and Research Hospital was included in this study. This study was done from October 2017 to April 2019.

In our study, the age group ranged from >18years to 70years with mean age of 41.2 years. Of the 30 cases injury occurred due to RTA in 180 (60%) patients and fall on outstretched hand in 120(40%) patients. All the patients selected for the study were admitted and examined according to protocol. All the 300 cases, of fractures of the distal radius are treated surgically by Open reduction and internal fixation with Volar locking Plate are evaluated.

- Distal Radius fractures are common in the age group of 31 to 40 years in our study.
- 60 % of patients were male.
- In present study MODIFIED MAYO[5] score at 1year follow up is 87.16±8.73
- In our study, the predominant UNIVERSAL type of fractures involved were type III ,type 2 in the incidence 60% and 30% respectively
- In the present study the functional outcome based on MODIFIED MAYO score was excellent and good were 26.6% and 60% of the patients and 13.3% of patients had Fair and Poor results.
- In the present study of 300 patients, a total of 30 complications, 20 cases of stiffness and 10 cases of extensor pollicis longus tendon irritation occurred.
- Results are best when the operative method results in stable fixation with the execution of good surgical techniques, including proper plate position, proper insertion of screws and avoidance of past pointing, and proper patient selection, a satisfactory functional and radiological outcome can be obtained for a great majority of patients with most of the distal radius fractures (incl. complex intra-articular) by internal fixation with locking plates.

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supination

Pronation

Palmar flexion

Dorsiflexion

Radial deviation

Ulnar deviation

105

VOLAR PLATING CASE 2

PRE OPERATIVE

IMMEDIATE POST OPERATIVE

6 WEEKS FOLLOW-UP

6 MONTH FOLLOW-UP

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