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"Evaluation of radiological and clinical outcome of volar locking compression plate (VLCP) in fractures of distal end of radius".

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***Abstract**: Distal Radius fractures commonest fractures of the human skeleton. By the usual plaster cast method deformity upto 60% and unsatisfactory results in upto 32% of the patients are reported. Open reduction of the articular surface, stable reduction, restoration of the radial length, volar angulation and radial inclination reduces the frequency of secondary osteo-arthritis and allows early functional rehabilitation.[9] Treatment options include closed reduction and pinning, bridging and non-bridging external fixation and open reduction with dynamic compression plate (DCP), precontoured locking and non locking plates and screw fixation through a variety of approaches. In present study twenty five patients, approaching to a tertiary institute of Punjab, having fracture of distal end of radius grouped as per A. O. Classification were treated by volar locking compression plates (VLCP). The primary outcomes instrument for measuring patients rated hand performance in the patient study was the **Michigan hand outcomes feedback form** All patients achieved radiological union till six months of follow up and there was no cases of nonunion. Radiologically there was no significant change in fixation in term radial inclination, volar angle, radial height and ulnar variance after postoperative and at six months follow up. Complications noted in present series were, superficial infection in two patients (08%) which was managed with appropriate antibiotics, one patient operated late developed Sudeck's Osteodystrophy, one patient (4%) with inadvertent intra-articular screw placement, which was managed conservatively.*

***Key Words:** Distal Radius fracture, volar locking compression plate (VLCP), Sudeck's Osteodystrophy*

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I. Introduction

Distal Radius fractures commonest fractures of the human skeleton.[1]The percentage of these fractures, well thought-out unstable requiring surgical fixation have been reported to be as high as 40 to 49%.[2,3] Traditionally, the fracture has all along been treated conservatively by closed reduction and POP cast immobilization. The assumption was always been that a good outcome will be achieved whatever may be the facade of reduction.[4]This may be tolerable in the elderly, osteoporotic patients with low demands on the wrist but there is a clear distinction between this group and those with higher demands, with a comportment in mind that these may not necessarily be younger.[5,6] **Lafontaine, Hardy and Delince** recognized the predictors of instability such as geriatric patients over 70 years, an intra articular fracture, dorsally comminuted, with dorsal angulations more than 20^{o}, associated ulnar fracture.[7] Distal end radius fractures account for 17% of all upper limb injuries.[8] By the usual plaster cast method deformity upto 60% and unsatisfactory results in upto 32% of the patients are reported. Open reduction of the articular surface, stable reduction, restoration of the radial length, volar angulation and radial inclination reduces the frequency of secondary osteo-arthritis and allows early functional rehabilitation.[9] The volar locking compression plate (VLCP) can provide a safe and effective implant for treatment of dorsally displaced fractures of distal radius.[20] The present study is proposed to evaluate the end result of locking compression plate in treatment of fractures of distal end of radius.

Treatment options include closed reduction and pinning, bridging and non-bridging external fixation and open reduction with dynamic compression plate (DCP), precontoured locking and non locking plates and screw fixation through a variety of approaches.[10] New concept of biological osteosynthesis with new implant such as volar locking compression plate (VLCP) is introduced.[11] Locking minimizes the compressive forces exerted by the plate on the bone. Precise anatomical contouring of a plate is no longer compulsory. This prevents the loss of primary reduction of fracture fragments caused by inadequate contouring of a plate.[12] It also

avoids possible deprivation of blood supply to the distal metaphyseal fracture fragments, a main plus in distal radius fractures, and also useful in the deterrence of secondary displacement of the unstable fractures in the elderly with osteoporotic bone.[13] The options for open reduction internal fixation include dorsal or volar fixation (or both) but dorsal fixation today is viewed less constructively because of complication related to implant loosening, tendon rupture and wrist stiffness.[14,15,16] Anatomically designed fixed-angle implants, including the distal volar radius system, are now available for the distal part of the radius, and their use is increasingly becoming popular.[17,18] Volar fixation is being used positively a days. There are several theoretical advantages of a volar approach as with this more space is available, the flexor tendons are farther from the bone and pronator quadratus is interposed. The volar cortex is less comminuted, which makes open reduction of fracture easier. Volar scars are better tolerated as they are less obvious and the blood supply to the radius is less likely to be disturbed. Implants with angular stability make it easier to reduce the fracture by fixing it to the distal fragment first, before fixation to the more proximal fragment.[19] Polyaxial locking plates allow variation in the angle of insertion of each screw, which allows the surgeon to respond to any variation in the normal bony anatomy and to target specific bone fragments. The application of locking compression plate (LCP) through volar approach avoids injuries and irritation of extensor tendons, irritation of median nerve and provide good to excellent range of motion of the injured wrist which results in an early return to pre-injury activity. The volar locking compression plate (VLCP) can provide a safe and effective implant for treatment of dorsally displaced fractures of distal radius.[20]

The present study was proposed to evaluate the end result of locking compression plate in treatment of fractures of distal end of radius.

CLASSFICATION

1. AO Classification[21]

Type A: Extra-articular fracture. Subgroups are based upon angulation and comminution.
Type B: Partial articular fracture. Subgroups are based upon lateral (radial styloid) palmar or dorsal fragments
Type C: Complete articular. Subgroups are based on the articular surface's degree of comminution and the metaphysis.

2. **Universal Classification[21]**

Type I : Nonarticular, undisplaced
Type II : Nonarticular, displaced
- A. Reducible stable
- B. Reducible unstable
- C. Irreducible

Type III : Articular, undisplaced.
Type IV : Articular, displaced
- A. Reducible stable
- B. Reducible unstable
- C. Irreducible
- D. Complex

Gartland and Werley (1951)[22]:

Type I - A: Extra - articular undisplaced
I - B: Extra - articular displaced
Type II : Intra-articular undisplaced
Type III : Intra-articular displaced.

4. **Frykman's classification (1967)[23]:**

Fracture	Distal ulna fracture	
	Absent	Present
A. Extra-articular	I	II
B. Intra-articular Only radiocarpal joint involvement	III	IV
Only radioulnar joint involvement	V	VI
Both radiocarpal & radioulnar joint involvement	VII	VIII

5. **Melone's Classification[24]:**

I. Non displaced, minimal comminution.
II. Die punch fractures with comminution (anterior / posterior),
III. Radial shaft fracture in addition to above.
IV. Transverse split of articular surfaces with rotation.

Other Classifications suggested for Colles' fracture were Lidstroms (1959), Older (1965), Sarmiento et al al (1980), Solgaard (1985), Jenkins (1989), Fernandez Classification (1993).

II. Aims And Objectives

To evaluate the radiological and clinical outcome of volar locking compression plate (VLCP) in fractures of distal end of radius.

III. Material And Methods

Twenty five patients, approaching to a tertiary institute of Punjab, having fracture of distal end of radius grouped as per A. O. Classification were treated by volar locking compression plates (VLCP).

Inclusion criteria

All patients having fracture of distal end of radius were grouped as per A. O. classification with age over 18yrs were incorporated in this study.[21]

Exclusion criteria

Patients with concomitant upper extremity injuries (carpal bone, proximal forearm, elbow, or humeral fracture), systemic, multiple-organ, or head injuries, Patients who were managed surgically for more than three weeks i.e. old fractures, bilateral fractures, fractures associated with neurovascular injuries, inflammatory arthritis, open fractures and malunited fractures.

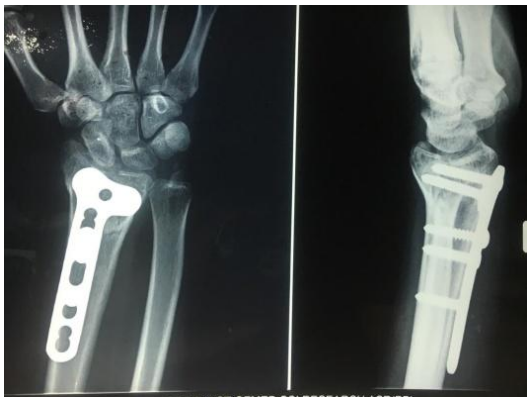
Informed consent was taken. Type of anaesthesia was decided by anesthesiologist. The patient was placed in the supine position with affected limb positioned to expose the surgical site. Following standard operative procedures for painting and draping of the part, open reduction & volar fixation of distal radius fracture was performed through Henry's Approach with locking compression plate, guided by C-arm image intensifier.[20] Removable volar plaster splint was given for six weeks & were allowed to perform activities of daily living while wearing the splint. They were given once a week structured hand therapy programme that included active and passive finger movements, hand and wrist edema control, and active wrist motion exercises. Strengthening exercises were initiated six weeks after the surgical procedure. Postoperatively, patients were assessed clinically and radiologically (at one week to ten days) and then at six, nine and twelve weeks as well as six months after surgery. The commonly used hand function test included test of hand strength (grip test), lateral pinch test range of motion. Range of motion of wrist was evaluated by recording flexion, extension and radioulnar deviation with standard goniometer. Grip strength test was measured with dynamometer and value was compared with contra lateral extremity. Antero-posteior and lateral radiograph were taken at each follow up visit. Fracture was considered united when osseous bridging across the fracture site was seen in radiographic views. Radial height, radial inclination, and volar tilt was measured in the immediate post-operative period (ten days after surgery) and at the time of the last follow up (six months after treatment).

OUTCOMES EVALUATIONS

The primary outcomes instrument for measuring patients rated hand performance in the patient study was the **Michigan hand outcomes feedback form**.[25] it included (1) overall hand function, (2) activities of daily living (3) pain, (4) work performance, (5) aesthetics, and (6) patient satisfaction. The Michigan hand outcomes feedback form was self- administered by the patient at each follow up visit.

At each scheduled follow- up visit, the patients were evaluated for the presence of postoperative complications, including infection, neuropathy, tendon injury, loss of reduction, malunion, non union, chronic regional pain syndrome (CRPS), implant loosening, implant-site discomfort, or refracture, patients requiring additional intervention were identified and their treatments were recorded.

Pre and post op. x ray case III



Post op. x ray case IV

OBSERVATIONS AND RESULTS

TABLE 1
SEX DISTRIBUTION

Sex	No. of cases	%
Males	20	80
Females	05	20

- Males were affected four times more than the females

TABLE 2
AGE DISTRIBUTION

Age in years	No. of cases	%
18-30	10	40
31-50	12	48
>50	03	12

- Most of the persons affected were in age group of 31-50 due to nature of their job.

TABLE 3
SIDE INVOLVED

Side	No. of cases	%
Right	14	56
Left	11	44

- Dominant side was slightly more affected than the non dominant side.

TABLE 4
NATURE OF FRACTURE

	No. of cases	%
Open	-	0
Closed	25	100.00

- All fractures were closed ones.

TABLE 5
MECHANISM OF INJURY

	No. of cases	%
Fall on outstretched hand	10	40.00
Road Traffic Accident	15	60.00

- Road traffic accidents contributed a major chunk of these fractures.

TABLE 6
OTHER ASSOCIATED INJURIES

Injuries	No. of cases
Fracture clavicle	2
Fracture Shaft Femur	5
Fracture shaft tibia	5
Ulnar styloid fracture	2

- In 44% of the cases it was an isolated fracture.

TABLE 7
COMPLICATIONS

Complications	No. of cases
Superficial infection	2
Painful wrist	1
Sudeck's osteodystrophy	1
Deformity	1
Screw pull out	1
Intra-articular Screw placement	1

- Approx. 68% of the cases were without any complications

TABLE 8
TYPE OF ANESTHESIA

Type of Anesthesia	No. of cases	%
General Anesthesia	12	48
Brachial block	13	52

TABLE 9
POSTOPERATIVE HAND FUNCTION ON INJURED SIDE

Test	**12 weeks (n=25)**		**6 months (n=25)**	
	Raw mean	**Percentage of values for contralateral side**	**Raw mean**	**Percentage of values for contralateral side**
Grip strength (kg)	18.52 + 4.7	53.2	23.36 + 5.7	69.3
Lateral pinch (kg)	9.16+1.2	81.2	10.0+1.2	89.7
Jebsen-Taylor test (s)	36.88 + 2.5	86.8	30.8+ 2.3	91.46

TABLE 10
POSTOPERATIVE WRIST RANGE OF MOTION ON INJURED SIDE

Test	**12 weeks (n=25)**		**6 months (n=25)**	
	Raw mean	**Percentage of values for contralateral side**	**Raw mean**	**Percentage of values for contralateral side**
Flexion	55.4+ 6.5	74	58.8+ 7.3	79
Extension	57.8+ 5.5	78	61.6+ 6.2	86
Ulnar deviation	31.4+ 4.6	81	33.6+ 3.7	91
Radial deviation	19.2+ 4.8	85	20.2+ 4.05	91
Pronation	73.6+ 3.7	94	75.2+ 4.0	96
Supination	72.4+ 4.3	89	77+ 4.1	95

TABLE 11
RADIOGRAPHIC OUTCOMES

Radial height (mm)	
Immediate Postoperative	11
Six months	11.5
Change	0.5
Radial inclination (deg)	
Immediate Postoperative	22
Six months	21
Change	1.0
Volar tilt (deg)	
Immediate postoperative	3.0

Six months	4.0
Change	1.0
Ulnar variance	
Immediate postoperative	-1.0
Six months	-1.2
Change	0.2

TABLE 12
POSTOPERATIVE MICHIGAN HAND OUTCOMES QUESTIONNAIRE SCORES FOR INJURED SIDE

Test	12 weeks (n=25)		6 months (n=25)	
	Raw mean	Difference	Raw mean	Difference
Overall	72 + 4.8	-28 + 4.8	80.4 + 4.5	-19 + 4.5
Activities of daily living	83.2+ 5.2	-16.8 + 5.2	89.4 + 5	-10.6 + 5.1
Work	74.2 + 8.3	N.A	86.8 + 8.2	N.A
Pain	24.4 + 6.3	-24.4 + 6.4	14.6 + 6.6	-14.6 + 6.11
Aesthetics	77.7 + 13.9	-22 + 13.9	85 + 10.7	-15 + 10.7
Satisfaction	73.2 + 8.7	-26.8 + 8.7	77.4 + 8.30	-22.6 + 8.3

IV. Discussion

Interest in distal radius fractures stems not only from its high incidence but also from developing understanding of outcome variables and influence of technology in evaluation and treatment.[25] **Trumble et al**.[26] stated that the degree to which articular step-off, gapping between fragments, and radial shortening can be improved with surgery correlates strongly with improved outcome.

Most of the patients in this study were in age group of 31-50 years with a mean age of 36.28 years.

In the present series, the 20 males and 5 females, right sided fractures were more common than the left sided. Of 20 male patients, 15 cases were because of RTA and 5 cases were due to fall from outstretched hand, of 5 female patients 2 were due to RTA and rest 3 patients were due to fall on outstretched hand. Out of 25 patients, 10 (40%) patients sustained fracture due to fall on outstretched hand & 15 (60%) sustained fracture due to road side accident. More than 50% female patients sustained fracture after fall on out stretched hand as compared to male patients which is well supported by literature.

Author	Total number of patients	Females patients
Kevin C Chung[27]	87	50 (57%)
Present Study	25	5(20%)

In the present study, 12(48%) patients out of 25 had associated skeletal injuries like fracture clavicle in two patients, fracture ulna styloid in two patients, fracture shaft femur in five patients, fracture tibia in five patient. Most of the authors in the literature also reported associated skeletal injuries with distal radius fracture:

Author	No. of patients
Frankie Leung[28]	5
Present study	12

General Anesthesia (12) 48% was given in present series, brachial block was administered in 13(52%) patients. In the present study, most of the patients operated within 72 hours of sustaining injuries, 4 patients were operated late due to delay in reporting to hospital. One patient had more than two week old fracture with deformity at wrist, gross swelling and stiffness of fingers. Out of 25 patients, one patient developed Sudeck's osteodystrophy and had fair functional outcome. All the patients were operated with standard volar approach of Henry as used by various authors.

Author	Number of patients
K. Egol[29]	57
Kevin C Chung[28]	161
Present Study	25

In present study, Reduction was done using indirect method like ligamento-taxis, traction supplemented with direct manipulation of the fracture fragment. Average operating time was 45 minutes. In our study the post operative physiotherapy was started from next day of surgery and post operative wrist splint was applied after surgery till seven days.

All patients were assessed radiologically at one week, three months and six months after surgery. All patients achieved radiological union till six months of follow up and there was no cases of nonunion.

Radiologically there was no significant change in fixation in term radial inclination, volar angle, radial height and ulnar variance after postoperative and at six months follow up.

Complications noted in present series were, Superficial infection in two patients (08%) which was managed with appropriate antibiotics, one patient operated late developed Sudeck's Osteodystrophy, one patient (4%) with inadvertent intra-articular screw placement, which was managed conservatively. There was no distal neurovascular complication. A few patients have occasional painful wrist after heavy exertion, but were able to perform daily activities without any complaint.

The functional outcome was assessed according to Grip strength, Jebsen taylor test, wrist range of motion, and the Michigan hand outcomes feedback form.

In the literature the grip strength after operative fixation as assessed by different authors is

Author	Grip strength at 6 months
Kevin C Chung[27]	72%
K Egol[29]	85%
F Leung[28]	91%
Present study	69.3%

There has been a distinct shift in the surgical techniques for distal radial fracture fixation over a period of time. There are many possible influences, and the transform is probably multifactorial. This dramatic shift may have been due to introduction and reported good results for volar locking plates (VLCP) for the treatment of distal radial fractures. Surgeons believe that open reduction with locked volar locking plates provides more stable fixation and allows earlier range of motion than percutaneous fixation does.[30] The literature, on outcome after distal radial fractures, is controversial with only few comparative studies. **Wright et al**. performed a case control study of 32 patients in which use of volar fixed angle plate was compared with external fixation; significantly better radiographic outcome were found in association with use of plates but no difference between the groups in terms of patient based outcome. **Leung et al**. reported that those who had been managed with plate fixation had a better cosmetic result and function at two years[28].

We would like to accentuate the importance of vigilant case selection, surgery in clean cases & early physiotherapy to give better functional ending.

In summary, continued use of the volar locking plating system (VLCP) is supported by the excellent outcomes data presented in the current study.

V. Summary And Conclusion

1. Several studies clearly show that restoration of normal anatomy after distal radial fractures provide more optimal function.
2. As surgical treatment, Plating in particular, ensures more consistent correction of displacement and maintenance of reduction, there has been a trend toward operative treatment of these fractures in both the elderly and the young population.
3. In comminuted distal radial fractures open reduction with volar locked plates (VLCP) accompanied with early physiotherapy provide better function and stability because of stable construct, better surgeon friendly implant inventory and reduces irritation to flexor tendons and chances of complications.
4. Delayed surgical intervention in intra-articular fracture distal radius leads to poor functional outcome.
5. Whether plate placement and newer locking devices have given open reduction methods a better outcome for the patients has yet to be determined.
6. Volar locking compression plate (VLCP) is a good device to stabilize the fractures of the distal end of the radius. Irrespective of the type and grade of fracture, it allows earlier return to activity and good functional and radiological outcome.

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