"Role of Locking Compression Plate For Distal Radius Fractures in postmenopausal women "

Dissertation submitted in
Partial fulfillment of the regulations required for the award of
M.S. DEGREE
In
Orthopaedic Surgery Branch - II

THE TAMILNADU
DR. M.G.R. MEDICAL UNIVERSITY
CHENNAI
APRIL 2014

Certificate

CERTIFICATE

This is to certify that this dissertation titled ***"Role of Locking Compression Plate For Distal Radius Fractures in postmenopausal women"*** submitted to the Tamil Nadu Dr. M.G.R. Medical University, Chennai in partial fulfillment of the requirement for the award of M.S Degree Branch - II (Orthopaedic Surgery) is a bonafide work done by ***DR.KARTHIKEYAN.S***, under my direct guidance and supervision in the Department of Orthopaedic Surgery, Coimbatore Medical College Hospital, Coimbatore during his period of study from May 2011-April 2014.

Dr.S.VetrivelChezian,MSOrtho,FRCS, D(Ortho)
Associate Professor,
Department Of Orthopaedics,
Coimbatore Medical College Hospital,
Coimbatore.

Prof. S. Dhandapani, M.S. Ortho, MCh Ortho.
Professor and Head of the Department,
Department of Orthopaedics,
Coimbatore Medical College Hospital,
Coimbatore.

Dr. Vimala, M.D.
Dean,
Coimbatore Medical College Hospital
Coimbatore

Coimbatore Medical College

COIMBATORE, TAMILNADU, INDIA - 641 014

(Affiliated to The Tamilnadu Dr. MGR Medical University, Chennai)

ETHICS COMMITTEE

CERTIFICATE

Name of the Candidate : DR. KARTHIKEYAN . S

Course : M.S. ORTHOPAEDICS

Period of Study : 2011 - 2014

College : COIMBATORE MEDICAL COLLEGE

Dissertation Topic : ROLE OF LOCKING COMPRESSION PLATE FOR DISTAL RADIUS FRACTURES IN POSTMENOPAUSAL WOMEN

The Ethics Committee, Coimbatore Medical College has decided to inform that your Dissertation Proposal is accepted / ~~Not accepted~~ and you are permitted / ~~Not permitted~~ to proceed with the above Study.

Coimbatore - 14.

Date : 30-11-12

Secretary

Ethics Committee

turnitin

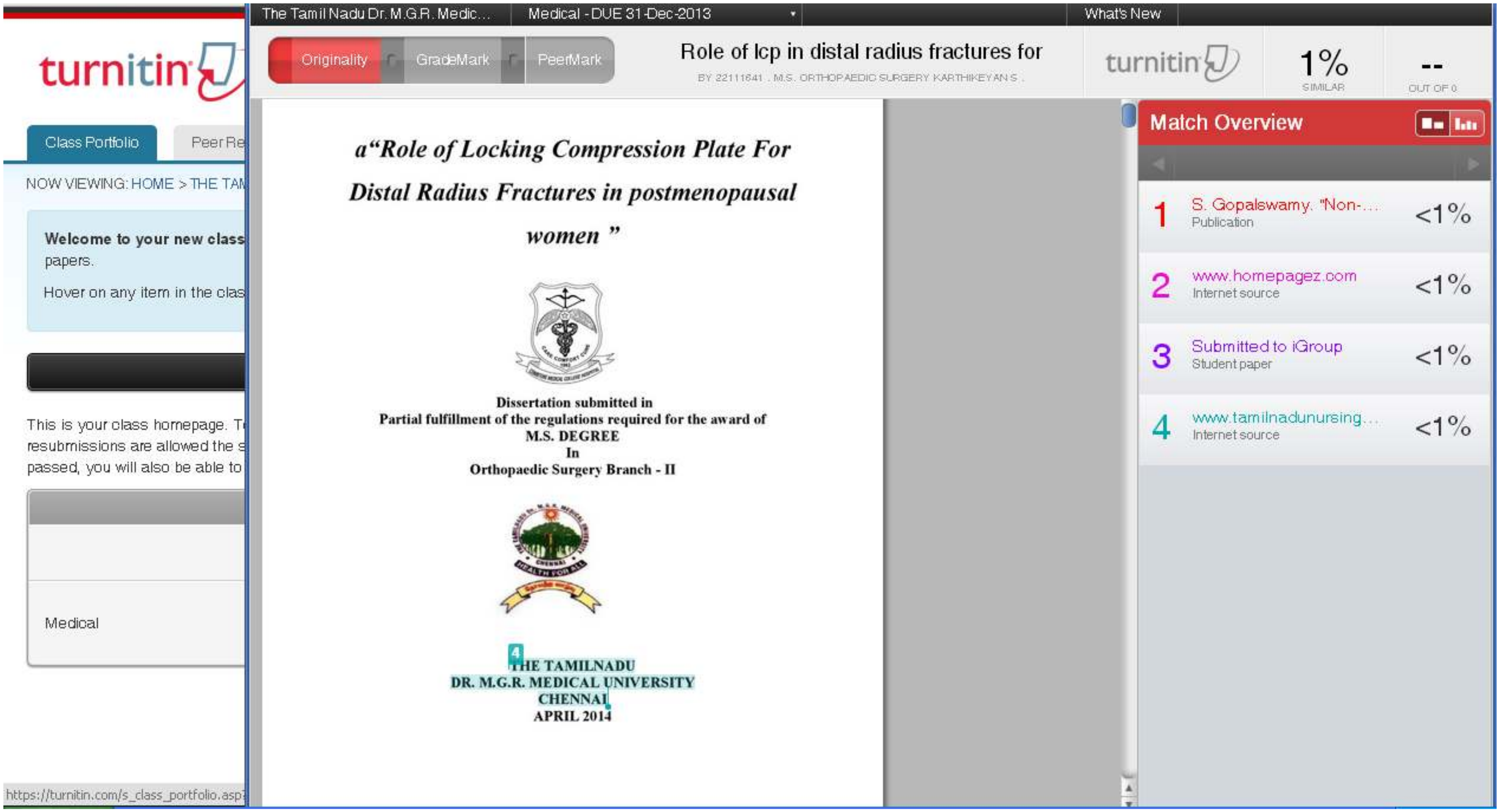
Your digital receipt

This receipt acknowledges that Turnitin received your paper. Below you will find the receipt information regarding your submission.

Paper ID	382716991
Paper title	Role of lcp in distal radius fractures for postmenopausal women
Assignment title	Medical
Author	22111641 . M.s. Orthopaedic Surgery KARTHIKEYAN S . SUNDARAMAHALINGAM
E-mail	karthidr1976@gmail.com
Submission time	29-Dec-2013 09:34AM
Total words	9839

First 100 words of your submission

a"Role of Locking Compression Plate For Distal Radius Fractures in postmenopausal women " Dissertation submitted in Partial fulfillment of the regulations required for the award of M.S. DEGREE In Orthopaedic Surgery Branch - II THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY CHENNAI APRIL 2014 CERTIFICATE This is to certify that this dissertation titled "Role of Locking Compression Plate For Distal Radius Fractures in postmenopausal women" submitted to the Tamil Nadu Dr. M.G.R. Medical University, Chennai in partial fulfillment of the requirement for the award of M.S Degree Branch - II (Orthopaedic Surgery) is a bonafide work done by DR.KARTHIKEYAN. S, under my direct guidance and supervision in...


turnitin
Class Portfolio
Peer Re
NOW VIEWING: HOME > THE TAM
Welcome to your new class
papers.
Hover on any item in the clas
This is your class homepage. T
resubmissions are allowed the s
passed, you will also be able to
Medical
https://turnitin.com/s_class_portfolio.asp?
The Tamil Nadu Dr. M.G.R. Medic...
Medical - DUE 31-Dec-2013
What's New
Originality
GradeMark
PeerMark
Role of lcp in distal radius fractures for
BY 22111641 . M.S. ORTHOPAEDIC SURGERY KARTHIKEYAN S .
turnitin
1%
SIMILAR
--
OUT OF 0
a"Role of Locking Compression Plate For Distal Radius Fractures in postmenopausal women"
Dissertation submitted in
Partial fulfillment of the regulations required for the award of
M.S. DEGREE
In
Orthopaedic Surgery Branch - II
THE TAMILNADU
DR. M.G.R. MEDICAL UNIVERSITY
CHENNAI
APRIL 2014
Match Overview
1 S. Gopalswamy. "Non-... Publication <1%
2 www.homepagez.com Internet source <1%
3 Submitted to iGroup Student paper <1%
4 www.tamilnadunursing... Internet source <1%

Declaration

DECLARATION

I, **Dr.KARTHIKEYAN.S** declare that the Dissertation titled ***"Role of Locking Compression Plate For Distal Radius Fractures in postmenopausal women"*** submitted to the Dr. MGR medical university, Guindy, Chennai is an original work done by me during the academic period from May 2011-April 2014 at the Department of Orthopaedics, Coimbatore Medical College Hospital, Coimbatore, under the guidance and direct supervision of **Dr.S.VetrivelChezian,MS Ortho**,**FRCS, D(ortho)** in partial fulfillment of the rules & regulations of the Dr. MGR Medical university for MS Orthopaedics post graduate degree.

All the details of the patients, the materials and methods used are true to the best of my knowledge.

I assure that this dissertation has not been submitted to or evaluated by any other Medical University.

Dr. KARTHIKEYAN .S

Acknowledgement

ACKNOWLEDGEMENT

My sincere thanks and gratitude to **Dr.Vimala, MD, Dean**, Coimbatore Medical College, for permitting me to utilize the clinical materials of this hospital.

I have great pleasure in thanking my teacher and guide **Dr.S.VetrivelChezian, MS Ortho,FRCS,D(Ortho) Associate Professor**, Department of Orthopaedic Surgery, Coimbatore Medical College for permitting me to use the clinical materials and for his valuable advice and encouragement in preparing this dissertation.

I am very much grateful to **Prof.S.Dhandapani D Ortho, MS Ortho, MCh Ortho, Professor and Head Of the Department,** Department of Orthopaedic Surgery, Coimbatore Medical College Hospital for his valuable support and guidance that he has provided me throughout this study.

I have great pleasure in acknowledging the help rendered by **Prof.S.Elangovan D Ortho., MS Ortho.,** for his valuable advice and guidance.

My sincere thanks to **Dr.P.Balamurugan, Dr.Major.K.Kamalanathan, Dr.K.S.Maheswaran, Dr.M.S.Mugundhan, Dr.R.Prabhakar Singh,** for their suggestion and help during my study.

I am also thankful to all my colleagues and staff members of the Department of Orthopaedics who helped me in all possible ways.

Contents

CONTENTS

S.No	Title	Page No
1.	INTRODUCTION	1
2.	AIM AND OBJECTIVES	4
3.	HISTORICAL ASPECTS	5
4.	REVIEW OF LITERATURE	7
5.	ANATOMY	14
6.	MECHANISM OF INJURY	25
7.	CLASSIFICATION	28
8.	PRINCIPLES OF MANAGEMENT	42
9.	OSTEOPOROSIS	45
10.	IMPLANT FEATURES	47
11.	SPECIFIC SURGICAL CONSIDERATIONS	51
12.	COMPARISION BETWEEN CONVENTIONAL PLATE AND LOCKING COMPRESSION PLATE	54
13.	COMPLICATIONS	56
14.	ADVANTAGES OF LOCKING COMPRESSION PLATING	57
15.	MATERIALS AND METHODS	59
16.	RESULTS	65
17.	DISCUSSION	75
18.	CONCLUSION	80
19.	ANNEXURES	

TITLE: ROLE OF LOCKING COMPRESSION PLATE FOR DISTAL RADIUS FRACTURES IN POSTMENOPAUSAL WOMEN

ABSTRACT:

INTRODUCTION:

One of the most common injuries in postmenopausal and older women is fracture of the distal radius. Osteoporosis is the major underlying cause . In majority of cases, satisfactory reduction by cast will redisplace and reangle in immobilizing cast resulting in a poor functional outcome. The present study was undertaken to assess the functional outcome of operative management of distal radial fractures in postmenopausal women by volar locking compression plate and assessing the functional outcome using modified mayo wrist scoring system.

MATERIALS AND METHODS:

The study was a prospective study with a sample size of 15 in numbers, conducted in the department of orthopaedics, Coimbatore medical college and hospital during the period 2011-2013.

RESULTS:

In our series, we had 46.6% excellent, 39.9% good, 13.3%, fair and no poor results.

Patients, who obtained excellent results, had normal regular activities or pain. Range of motion was within the normal functional range. Their Radial length, volar tilt and articular step-off were within acceptable limits.

Patients with good results had minimal residual deformities, pain and slight limitation. Rest of their findings was within acceptable parameters.

Patients with fair results, along with residual deformity, pain and limitation also had pain in the distal radio-ulnar joint and minimal complications.

CONCLUSION:

Its concluded that volar locking plate is a safe and effective treatment for undisplaced and displaced unstable fractures of distal end of radius in postmenopausal women.

KEY WORDS:

Distal Radius, locking compression plate, postmenopausal women, Osteoporosis, Functional outcome.

TITLE: ROLE OF LOCKING COMPRESSION PLATE FOR DISTAL RADIUS FRACTURES IN POSTMENOPAUSAL WOMEN

ABSTRACT:

INTRODUCTION:

One of the most common injuries in postmenopausal and older women is fracture of the distal radius. Osteoporosis is the major underlying cause . In majority of cases, satisfactory reduction by cast will redisplace and reangle in immobilizing cast resulting in a poor functional outcome. The present study was undertaken to assess the functional outcome of operative management of distal radial fractures in postmenopausal women by volar locking compression plate and assessing the functional outcome using modified mayo wrist scoring system.

MATERIALS AND METHODS:

The study was a prospective study with a sample size of 15 in numbers, conducted in the department of orthopaedics, Coimbatore medical college and hospital during the period 2011-2013.

RESULTS:

In our series, we had 46.6% excellent, 39.9% good, 13.3%, fair and no poor results.

Patients, who obtained excellent results, had normal regular activities or pain. Range of motion was within the normal functional range. Their Radial length, volar tilt and articular step-off were within acceptable limits.

Patients with good results had minimal residual deformities, pain and slight limitation. Rest of their findings was within acceptable parameters.

Patients with fair results, along with residual deformity, pain and limitation also had pain in the distal radio-ulnar joint and minimal complications.

CONCLUSION:

Its concluded that volar locking plate is a safe and effective treatment for undisplaced and displaced unstable fractures of distal end of radius in postmenopausal women.

KEY WORDS:

Distal Radius, locking compression plate, postmenopausal women, Osteoporosis, Functional outcome.

TITLE: ROLE OF LOCKING COMPRESSION PLATE FOR DISTAL RADIUS FRACTURES IN POSTMENOPAUSAL WOMEN

ABSTRACT:

INTRODUCTION:

One of the most common injuries in postmenopausal and older women is fracture of the distal radius. Osteoporosis is the major underlying cause . In majority of cases, satisfactory reduction by cast will redisplace and reangle in immobilizing cast resulting in a poor functional outcome. The present study was undertaken to assess the functional outcome of operative management of distal radial fractures in postmenopausal women by volar locking compression plate and assessing the functional outcome using modified mayo wrist scoring system.

MATERIALS AND METHODS:

The study was a prospective study with a sample size of 15 in numbers, conducted in the department of orthopaedics, Coimbatore medical college and hospital during the period 2011-2013.

RESULTS:

In our series, we had 46.6% excellent, 39.9% good, 13.3%, fair and no poor results.

Patients, who obtained excellent results, had normal regular activities or pain. Range of motion was within the normal functional range. Their Radial length, volar tilt and articular step-off were within acceptable limits.

Patients with good results had minimal residual deformities, pain and slight limitation. Rest of their findings was within acceptable parameters.

Patients with fair results, along with residual deformity, pain and limitation also had pain in the distal radio-ulnar joint and minimal complications.

CONCLUSION:

Its concluded that volar locking plate is a safe and effective treatment for undisplaced and displaced unstable fractures of distal end of radius in postmenopausal women.

KEY WORDS:

Distal Radius, locking compression plate, postmenopausal women, Osteoporosis, Functional outcome.

TITLE: ROLE OF LOCKING COMPRESSION PLATE FOR DISTAL RADIUS FRACTURES IN POSTMENOPAUSAL WOMEN

ABSTRACT:

INTRODUCTION:

One of the most common injuries in postmenopausal and older women is fracture of the distal radius. Osteoporosis is the major underlying cause . In majority of cases, satisfactory reduction by cast will redisplace and reangle in immobilizing cast resulting in a poor functional outcome. The present study was undertaken to assess the functional outcome of operative management of distal radial fractures in postmenopausal women by volar locking compression plate and assessing the functional outcome using modified mayo wrist scoring system.

MATERIALS AND METHODS:

The study was a prospective study with a sample size of 15 in numbers, conducted in the department of orthopaedics, Coimbatore medical college and hospital during the period 2011-2013.

RESULTS:

In our series, we had 46.6% excellent, 39.9% good, 13.3%, fair and no poor results.

Patients, who obtained excellent results, had normal regular activities or pain. Range of motion was within the normal functional range. Their Radial length, volar tilt and articular step-off were within acceptable limits.

Patients with good results had minimal residual deformities, pain and slight limitation. Rest of their findings was within acceptable parameters.

Patients with fair results, along with residual deformity, pain and limitation also had pain in the distal radio-ulnar joint and minimal complications.

CONCLUSION:

Its concluded that volar locking plate is a safe and effective treatment for undisplaced and displaced unstable fractures of distal end of radius in postmenopausal women.

KEY WORDS:

Distal Radius, locking compression plate, postmenopausal women, Osteoporosis, Functional outcome.

TITLE: ROLE OF LOCKING COMPRESSION PLATE FOR DISTAL RADIUS FRACTURES IN POSTMENOPAUSAL WOMEN

ABSTRACT:

INTRODUCTION:

One of the most common injuries in postmenopausal and older women is fracture of the distal radius. Osteoporosis is the major underlying cause . In majority of cases, satisfactory reduction by cast will redisplace and reangle in immobilizing cast resulting in a poor functional outcome. The present study was undertaken to assess the functional outcome of operative management of distal radial fractures in postmenopausal women by volar locking compression plate and assessing the functional outcome using modified mayo wrist scoring system.

MATERIALS AND METHODS:

The study was a prospective study with a sample size of 15 in numbers, conducted in the department of orthopaedics, Coimbatore medical college and hospital during the period 2011-2013.

RESULTS:

In our series, we had 46.6% excellent, 39.9% good, 13.3%, fair and no poor results.

Patients, who obtained excellent results, had normal regular activities or pain. Range of motion was within the normal functional range. Their Radial length, volar tilt and articular step-off were within acceptable limits.

Patients with good results had minimal residual deformities, pain and slight limitation. Rest of their findings was within acceptable parameters.

Patients with fair results, along with residual deformity, pain and limitation also had pain in the distal radio-ulnar joint and minimal complications.

CONCLUSION:

Its concluded that volar locking plate is a safe and effective treatment for undisplaced and displaced unstable fractures of distal end of radius in postmenopausal women.

KEY WORDS:

Distal Radius, locking compression plate, postmenopausal women, Osteoporosis, Functional outcome.

TITLE: ROLE OF LOCKING COMPRESSION PLATE FOR DISTAL RADIUS FRACTURES IN POSTMENOPAUSAL WOMEN

ABSTRACT:

INTRODUCTION:

One of the most common injuries in postmenopausal and older women is fracture of the distal radius. Osteoporosis is the major underlying cause . In majority of cases, satisfactory reduction by cast will redisplace and reangle in immobilizing cast resulting in a poor functional outcome. The present study was undertaken to assess the functional outcome of operative management of distal radial fractures in postmenopausal women by volar locking compression plate and assessing the functional outcome using modified mayo wrist scoring system.

MATERIALS AND METHODS:

The study was a prospective study with a sample size of 15 in numbers, conducted in the department of orthopaedics, Coimbatore medical college and hospital during the period 2011-2013.

RESULTS:

In our series, we had 46.6% excellent, 39.9% good, 13.3%, fair and no poor results.

Patients, who obtained excellent results, had normal regular activities or pain. Range of motion was within the normal functional range. Their Radial length, volar tilt and articular step-off were within acceptable limits.

Patients with good results had minimal residual deformities, pain and slight limitation. Rest of their findings was within acceptable parameters.

Patients with fair results, along with residual deformity, pain and limitation also had pain in the distal radio-ulnar joint and minimal complications.

CONCLUSION:

Its concluded that volar locking plate is a safe and effective treatment for undisplaced and displaced unstable fractures of distal end of radius in postmenopausal women.

KEY WORDS:

Distal Radius, locking compression plate, postmenopausal women, Osteoporosis, Functional outcome.

Introduction

INTRODUCTION

Distal radius fractures are common and produce a major orthopaedic injuries because of the advancing population age and increase in physical activity. Distal radius fractures constitute up to 15% of all extremity fractures. In females the incidence rises sharply. In the age of 40 it is approximately 36.8/10,000. It is estimated at the age 70 years to be 115/10,000. Distal radius is the most common osteoporotic fracture in elderly females it has been linked to estrogen withdrawal. These injuries are sustained overwhelmingly from low energy falls in an increasingly osteoporotic population.

This group of patients expect increased functional demands since they are independent and active. Treating the growing number of these difficult injuries presents a particular challenge for orthopaedic surgeons.

Locking compression plate (LCP) is a new generation plate and screw system for internal fixation of fractures[1,2]. The LCP with combi holes have additional dynamic compression holes providing options for axial compression in addition to locking mechanism. The LCP can be used as a compression plate, a locked internal fixator, or a combination of both, depending on the situation[3,4].

The use of locked volar plates for distal radius fractures is increasingly popular. Proposed advantages of locked volar plating include improved pull out strength even in osteoporotic bone and a volar surgical approach that avoids the need for an extensive dorsal dissection. The plate is positioned in a well padded area beneath pronator quadratus to avoid flexor tendon irritation and it is thought that patients tolerate volar wrist scars better than dorsal ones.

Internal fixation has the advantage of allowing early mobilisation but its application is limited by the degree of comminution and osteoporosis. Loss of reduction and fixation is common due to poor purchase of screws on osteoporotic bone with the conventional plates, delay in postoperative mobilization results in stiffness of the joint which is an indicator of poor outcome.

Screws used in distal radial fractures (3.5mm cortical screws) can also be used in addition to locking screws. Locking plates have advantages such as a decreased incidence of loss of reduction secondary to screw toggling and there is improved bone healing. A locking plate decreases the screw-plate toggle and motion at bone-screw interface and provides more rigid fixation. Rigid fixation is felt to be one key to the successful treatment of these fractures[5,6].

But fixation in osteoporotic and comminuted fractures is difficult to obtain anatomical reduction and adequate purchase. So now with the evolution of locking compression plating for osteoporotic and peri-articular fractures especially for the comminuted intra–articular fractures restoring the anatomical congruity and providing stable fixation with resulting increased stability allowing for early mobilization[7-9].

Aim Of The Study

AIM AND OBJECTIVES

The aim of the study is to analyze the functional outcome of locking compression plate in distal radial fractures in postmenopausal women.

HISTORIAL ASPECTS

In the year 1814, Sir Abraham Colles, a surgeon from Ireland described the fracture pattern affecting the distal radius before the invention of X-rays. Ponteau, a French surgeon is said to have described the same fracture earlier.

Other surgeons notably Smith and Barton also described fractures of distal radius in the nineteenth century.

After the introduction of radiography, Hutchinson described radial styloid fracture and named it as Chauffeur's fracture. Initially surgeons treated distal radius fractures with casts and splints.

Anderson and O'Neil described external fixator for distal radius fractures in 1944. They were the pioneers in using external fixators for management of distal radius fractures. They produced excellent results in most of their patients.

In 1951, Gartland and Werley published their Demerit Point System of functional evaluation of outcome of distal radius fracture.

In 1959, Lindstrom published his study on the end results of the fractures of distal radius in the Journal of Acta Orthopaedica Scandinavia.

In 1967, Frykman introduced his classification. Cole and Obletz described alternative method utilizing pins and plaster.

In 1965, Ellis described volar buttress plate for Barton's fractures.

In 1985, Diego L. Fernandez introduced his system of distal radius fracture classification.

In 1980s and 1990s, articles about open fixation with or without external neutralization were published.

Review of Literature

LITERATURE REVIEW

Cooney W.P. et al.(1980): studied the complications of colles fractures, treated conservatively in 565 patients from 1968-75 had the complication rate as high as 31%[10].

Schutz M, Kolbeck S(2003): In Berlin, published his first clinical experiences of volar plating with the locking compression plate for dorsally displaced fractures of the distal radius. In 24 patients majority of the patients had a good to excellent range of motion and an early return to normal activity[11] .

Wong KK, Chan KW: Between 2001-2003 in Hong Kong, among 54 patients who had unstable distal radial fractures were treated with open reduction and internal fixation using a locking compression plate had excellent to good outcome and concluded that palmar locking compression plating is a safe and effective treatment for unstable distal radial fractures[12].

Köck H, Bandl WD, Chan T: In Germany, Between January 1999 and December 2003 treated 603 patients with a fracture of the distal radius without concomitant injuries with locking compression plate. Because of its permanent retention due to the subchondral fixation of the splints (internal fixation) early mobilization was possible. The volar approach reduced the risk of infections and offered the possibility of not having to remove the plate[13].

Musgrave DS, Idler RS (2005): In Washington, determined whether locking compression plates could be used to treat unstable distal radius fractures. They proved that volar fixed-angle plate fixation with or without radial styloid fixed-angle plate fixation would provide sufficient rigidity to allow early active range of motion without compromising fracture reduction and improve initiation of early functional outcomes[14].

Cognet JM(2006): In US, he analysed plate fixation with locking screw for distal fractures of the radius in 67 patients. He concluded that appropriate fixation method for distal fracture of radius remains a controversial issue, but primary stability achieved with a locking screw in a plate enables early mobilization associated with more rapid recovery of function[15].

Scott M.Levin (2007): In Mineola, USA, stated that fixed angle constructs withstand cyclical loading representing normal physiologic forces encountered during postoperative rehabilitation. They concluded that volar fixed-angle locking plates are an effective treatment for unstable extra-articular distal radius fractures, allowing early postoperative rehabilitation to safely be initiated[16].

Strohm PC(2007): In German, analysed whether locking, 3.5mm volar T-Plate is the implant of choice for displaced distal radius fractures. He concluded that 3.5mm T-LCP is a good implant for the stabilisation of displaced distal radius fractures if the fragments are not too small for the 3.5mm screws[(17)].

Rohit Arora, et al.(2007): In Austria, 114 patients who had displaced, unstable fractures involving the distal radius were treated with ORIF using palmar LCP of 2.4mm size and followed up over a minimum time frame of 12 months. All the data based on the clinical and radiological findings were analyzed at the end of the research period and it was found that fixation with fixed angled plates allowed only a minimal loss of reduction and thereby provided stability to formerly unstable dorsally displaced fractures involving the distal radius[(18)].

RE Anakwe(2010): In UK, Conducted a study on locked volar plating for complex distal radius fractures. Over a 12 month period 21 patients with type C distal radius fractures were treated using locked volar plating and stated that Locked volar plating for complex distal radius fractures produces good results when assessed using patient locked volar plating offers superior outcomes and patient satisfaction compared to external fixation[(19)].

Claudio Roberto Martins Xavier(2011): In Brazil, 64 subjects with distal radius fractures were studied and followed up over a period of six months. Their clinical findings and radiological findings were compiled after they underwent surgery with fixed angled volar locked plates. They concluded Use of volar plates is a treatment method with a low complication rate. However, caution is needed in indicating this for elderly patients, and the patient's activity level and the risks and benefits need to be taken into consideration[20] .

Hanae Minegishi (may 2011): In Japan, a retrospective study of patients with unstable intra and extra articular fractures involving the distal end of radius who were treated with volar locking plates at Tohoku Kosai Hospital was done. Treatment of unstable distal radius fractures with a volar locking plate lead to satisfactory results, provided the operative technique carefully performed to prevent complications[21].

Chris Dillingham et al.(june 2011): In USA, 27 patients with unstable displaced fractures of distal radius were studied and followed up from August 2002 to October 2008.All the subjects were treated with open reduction and fixation using fixed angled volar locking plates. They recommended the use of fixed angled volar locking plates when a rapid recovery and early return to functional activity is desired by the patient[22].

Joideep Phadnis in 2012: In UK, 183 fractures amongst 180 patients of a mean age of 62.4years were retrospectively studied and functional assessment using modified MAYO wrist scores and it was found that results were good to excellent in most of the patients treated with fixed angled volar locking plates and complication rates comparable to alternative lines of treatment be it operative or non-operative[23].

Indian studies in distal radius locking compression plating

Sawalha(2007): In Warrington retrospectively analysed radiological and clinical outcomes of 52 patients treated with locking compression plate.At 14 months follow up,15 out of 52 patients had complications like median nerve compression, hardware related complications, malunion and failure of fixation. They concluded volar locking compression plate for distal radius is associated with high complication rate and they recommended cautious use of distal radius locking compression plate(24).

Shetty.M.S (Nov 2011): In Andhra, he conducted a prospective study from March 2008 to September 2009, 23 cases of intra-articular distal radius fractures were included in the study to assess the ability of volar locking plates to maintain fracture reduction when used to treat dorsally displaced intra-articular distal radial fractures and to assess the patient-related outcome. All these fractures underwent open reduction and internal fixation with 2.4 volar locking distal radius plates. He concluded Volar locking plate is a viable option for treating intra-articular distal radius fractures(25).

Agarwala(2012): In Mumbai, he retrospectively analysed 25 cases of distal radius fracture treated with locking compression plate and obtained 88% of excellent to good result as assessed by Mayo wrist score. They concluded locking compression plate allows early functional mobility with minimal complications[26].

Nagesh Naik and Deshpande Shrikant Balakrishna(2012): In Sangli, they studied 25 cases of dorsally displaced distal radius fracture treated with volar locking compression plate. They obtained 80% excellent to good results as assessed by Lidstrom's anatomical criteria. They concluded that volar locking plate is an effective and safe method of treatment for unstable distal radius fracture[27].

Anatomy

ANATOMY

The distal radius consists of

(1) metaphysis,

(2) scaphoid facet,

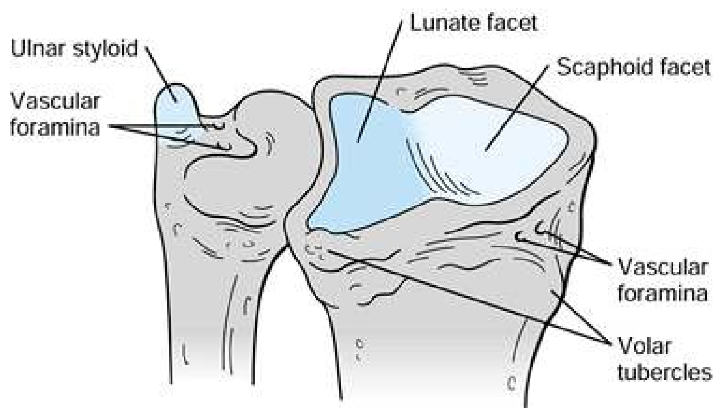
(3) lunate facet, and

(4) sigmoid notch.

The anatomy of the radius is unique. The bone has a cylindrical contour proximally turning flatter distally with a concave contour on the dorsal and ventral aspect .The distal articular end is triangular in shape and is lined with hyaline cartilage. A ridge divides the distal articular surface into a triangular facet for the scaphoid laterally. Medially it articulates with the lunate over an articular surface that is shaped like a quadrilateral(28).

The distal end articulates with the ulna medially. The medial articular surface is semilunar and is lined with hyaline cartilage.

Laterally the distal end of radius provides attachment to the brachioradialis muscle via an elongated process called the radial styloid.



ANTERIOR DISTAL END OF RADIUS AND ULNA.

The metaphysis is flared distally in both the AP and the lateral planes with thinner cortical bone lying dorsally and radially. The significance of the thinness of these cortices is that the fractures typically collapse dorsoradially. In addition, the bone with the greatest trabecular density lies in the palmar ulnar cortex[29]. The fact that this bone is thicker even in osteoporotic cadaver specimens may explain the success of internal fixation techniques, which take advantage of this superior bone. Distally the radius has a somewhat trapezoidal shape. The radial styloid rotates palmarly 15 degrees off the axis of the radius, which makes capture difficult from a dorsal approach.

In the anteroposterior plane the strongest bone is found under the lunate facet of the radius. The line of force passes down the long finger axis through the capitolunate articulation and contacts the radius at this location. The “palmar ulnar corner” is often referred to as the keystone of the radius. It serves as the attachment for the palmar distal radioulnar ligaments and also for the stout radiolunate ligament. Displacement of this fragment is associated with palmar displacement of the carpus and also with loss of forearm rotation[30]. The result is loss of rotation as well as a step-off in the articular surface.

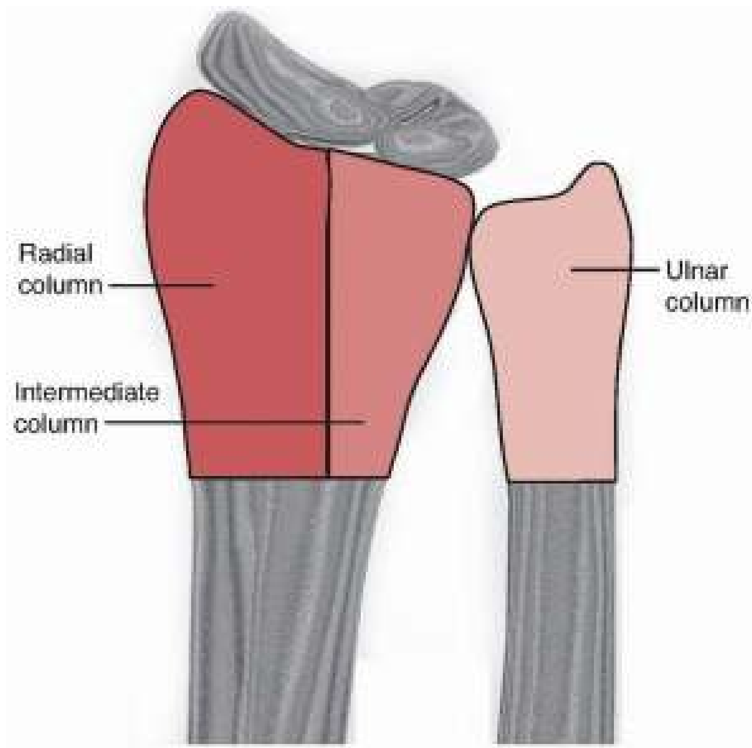
Ligamentous Anatomy: The extrinsic ligaments of the wrist play a major role in the use of indirect reduction techniques. The palmar extrinsic ligaments are attached to the distal radius, and it is these ligaments that are relied on to reduce the components of a fracture using closed methods.

There are two factors about these ligaments that make them significant for reduction: First the orientation of the extrinsic ligaments from the radial styloid is oblique relative to the more vertical orientation of the ligaments attached to the lunate facet.

The second significance of the ligamentous anatomy is because of the relative strengths of the thicker palmar ligaments when compared to the thinner dorsal ligaments. In addition, the dorsal ligaments are oriented in a relative “z” orientation, which allows them to lengthen with less force than the more vertically oriented palmar ligaments. The significance is that distraction will result in the palmar ligaments becoming taut before the dorsal ligaments.

Thus the palmar cortex is brought out to length before the dorsal cortex. It is for this reason that it is difficult to achieve reduction of the normal 12 degrees of palmar tilt using distraction alone .

Applied Anatomy



The three column concept

The forearm consists of 3 columns:

a) Radial column-It comprises the radial styloid and the scaphoid fossa.

b) Intermediate column-It consists of the lunate fossa and the sigmoid notch.

c) Ulnar column-It is formed of the distal radio-ulnar distal ulna (DRUJ) with the triangular fibrocartilaginous complex (TFCC).

a. Radial column: Because of the radial inclination of 22 degreees, impaction of the scaphoid on the articular surface results in a shear moment on the radial styloid causing failure laterally at the radial cortex. The radial column, therefore, is best stabilized by buttressing the lateral cortex.

b. Intermediate column:

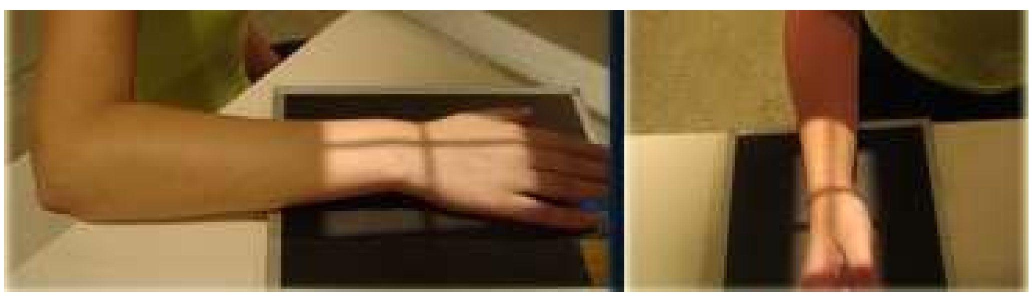
The intermediate column consists of the lunate fossa and the sigmoid notch of the radius. The intermediate column may be considered the cornerstone of the radius because it is critical for both articular congruity and distal radioulnar function. Failure of the intermediate column occurs as a result of impaction of the lunate on the articular surface with dorsal comminution. The column is stabilized by a direct buttress of the dorsal ulnar aspect of the radius.

c. Ulnar column: The ulnar column consists of the ulna styloid but also should include the TFCC and the ulnocarpal ligaments.

Triangular Fibrocartilage Complex: The complex is attached by its base to the medial margin of the distal radius and by its apex to the lateral side of the base of the ulnar styloid. It is biconcave and articulates with the distal ulna proximally and with the proximal carpal row, primarily the triquetrum, on its distal surface. The triangular fibrocartilage is reinforced anteriorly and posteriorly by fibrous bands that extend into the anterior and posterior capsule of the distal radioulnar joint. This capsule is only minimally reinforced and provides only minor support to the joint. The TFCC is at maximum tension in approximately mid-position between pronation and supination.

IMAGING TECHNIQUES FOR DISTAL RADIUS FRACTURES

RADIOGRAPHY: For fractures involving the distal end of radius-rays are taken in postero-anterior (PA) and lateral views.



Positioning for PA view-

The patient is positioned such that the wrist and elbow are at the level of the shoulder in the transverse plane so that they are perpendicular to the plane of the X ray beams. If the arm is lowered, the radius crosses over the ulna resulting in alteration in measurement and also the two bones are parallel to each other when held in the described position[31].

Lateral view positioning- The elbow adducted to the side with shoulder, elbow and wrist in one plane (sagittal plane) such that this view is perpendicular to PA view.

In the postero anterior view, for an extra articular fracture distal radius, the following are noted.

1) Radial shortening

2) Ulnar variance

3) Radial angulation

4) Comminution

5) Ulnar styloid fracture location

In the lateral view, for an extra articular fracture distal radius, following are noted.

1) Palmar tilt

2) Extent of metaphyseal comminution

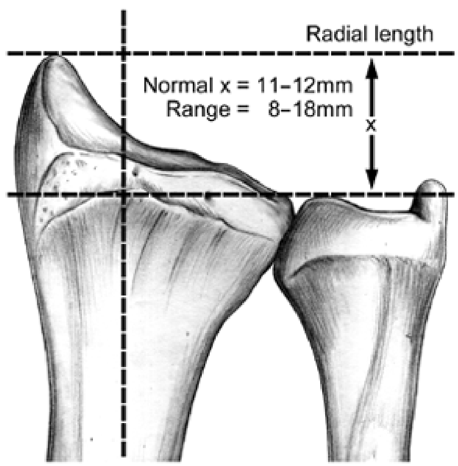
3) Displacement of volar cortex

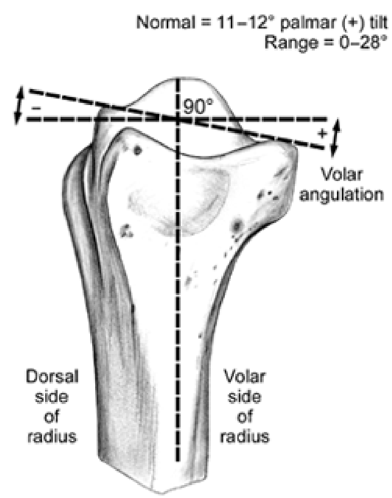
4) Position of distal radio ulnar joint.

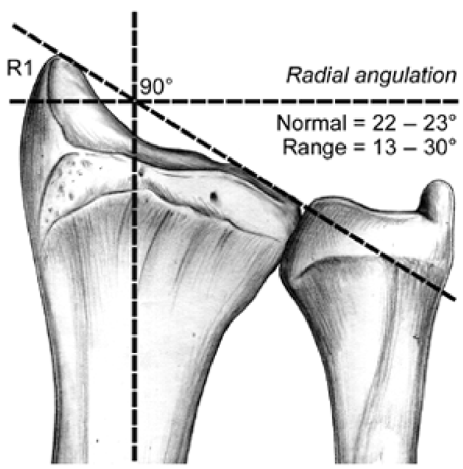
A 5º rotational change produces 1.6º change in palmar tilt in conventional lateral view. An oblique view may be useful to assess comminution in an extra articular fracture. Postero anterior and lateral views are taken also for contralateral wrist to assess the patient's normal radiological parameters.

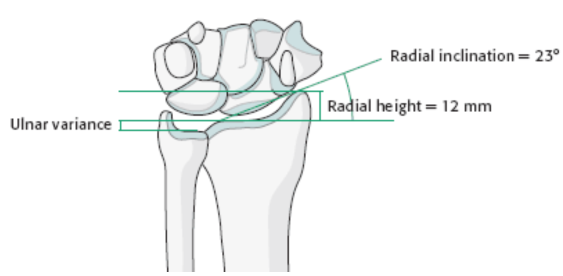
NORMAL RADIOLOGICAL PARAMETERS

Measurement of normal average radial angulation, radial length, and palmar angulation.









Dorsal/Palmar Tilt

Volar tilt=11°.On a true lateral view a line is drawn connecting the most distal points of the volar and dorsal lips of the radius. The dorsal or palmar tilt is the angle created with a line drawn along the longitudinal axis of the radius.

Radial Length

Radial length is measured on the PA radiograph. It is the measured in millimeters between two lines,one line drawn perpendicular to the long axis of the radius and tangential to the most distal point of the ulnar head and the other line drawn perpendicular to the long axis of the radius and at the level of the tip of the radial styloid . Average radial length from the tip of the radial styloid to the ulna head is 12 mm, although the variance can be considerable .

Ulnar Variance

Ulnar variance -0.6mm. This is a measure of radial shortening and is different from measurement of radial length. It is the vertical distance between a line parallel to the medial corner of the articular surface of the radius and another line drawn parallel to the most distal point of the articular surface of the ulnar head, both of which are perpendicular to the long axis of the radius.

Radial Inclination

On the PA view the radius inclines towards the ulna. This is measured by the angle between a line drawn from the tip of the radial styloid to the medial corner of the articular surface of the radius and a line drawn perpendicular to the long axis of the radius. There is normally an average of 23° of radial angulation in the anteroposterior plane.

Carpal Malalignment

Two types of carpal malalignment are associated with fracture of the distal radius. The most common is malalignment that compensates for the tilt of the distal radius which is extrinsic to the carpus[32]. On a lateral view one line is drawn along the long axis of the capitate and one down the long axis of the radius. If the carpus is aligned, the lines will intersect within the carpus. If not, they will intersect outwith the carpus. Carpal malalignment can also be caused by associated carpal ligament disruption.

KINEMATICS

The motors of the wrist are attached to the metacarpals. Capitate is the centre of rotation of wrist joint.

Wrist flexion – extension occur equally through radio carpal and midcarpal joints.

Radial – ulnar deviations occur 60% through midcarpal joint and 40% through radio carpal joint.

Normal range of Movements

Movements	Normal range
Flexion	0 to 70-90º
Extension	0 to 70-90º
Radial deviation	0 to 15-25º
Ulnar deviation	0 to 25-35º
Supination	0 to 70-90º
Pronation	0 to 70-90º

Normally, 82% of the axial load at the wrist is borne by Radius and 18% by Ulna.

MECHANISM OF INJURY

Distal radius fractures are usually as a result of fall on an outstretched hand is. There are multiple factors that determine the pattern of the fracture that include-

1) Velocity
2) Position of hand and wrist at impact
3) Degree of rotation of forearm
4) Bone quality and density

When an individual falls forward fall on pronated forearm with the hand and wrist in extension, bending of the metaphyseal bone because the weight of the body is transmitted along the long axis of the radius. Also the hard diaphyseal bone causes impaction of cancellous metaphyseal bone that result in metaphyseal collapse. During the fall, compressive forces over the dorsal cortex and tensile stress acting over the volar cortex result in volar and dorsal cortical bone disruption. When there is a supination of distal end of radius with respect of the radial diaphysis, a dorsal displacement fracture occurs. In about fifty to sixty percent of distal radius fractures, associated ulnar styloid fractures. Also ulnar styloid fractures may be associated with triangular fibrocartilage disruption which may sometimes be an isolated finding.

Three main theories have been developed;

• The theory of compression impaction

• The avulsion theory

• The incurvation theory.

The Theory of Compression Impaction:

When the wrist is in extension the carpal bones are in contact with the surface of the impact. At the same time, the radial head is in compression against the humerus. This force is then automatically transmitted to the distal end of the radius. It is at this moment that the fracture occurs.

It is therefore a mechanism of compression impaction and crush; the wrist is an anvil on which the radius is crushed. This theory is based on the very important fact that all distal radial fractures are compression fractures and the fall occurs on a wrist in extension-pronation. Tensile forces act on the anterior part and compression forces on the posterior part. The posterior constraint forces are very high.

The Avulsion theory: The indirect forces presented by the body weight are transmitted through the humerus, the ulna, the interosseous membrane, the distal radius and then the volar wrist ligaments to the point of impact of the hand. The distal radial fracture is then caused by an avulsion mechanism applied by the tensile forces transmitted by the volar wrist ligaments.

The Incurvation theory: This theory stated that fractures are produced by bending forces. The fracture line is affected by three factors.

- The position of the hand;
- The extent of the area of impact;
- The magnitude of the applied force.

If tension increases at the level of the ulnar collateral ligament when the radial fracture occurs, an ulnar styloid process fracture will occur at the same time.The skin is usually not lacerated at the palm, implying that the hand has not slipped but was blocked on the floor. The body continues to go forward, moved by kinetic energy or inertia, and the volar wrist ligaments become tense because the wrist is placed in a hyperextended position[(33)].

If these ligaments resist, the forces are transmitted to the radiocarpal joint and the radius is in compression against the articular facets of the bones of the first carpal row. If the scaphoid and lunate are not crushed, the forces end at the level of the radius to produce a fracture at the weakest part of this bone. The dorsomedial fragment that separates due to this impact is called the die punch fragment[(34)].

CLASSIFICATION

Various classification systems are available for distal radius fractures.

These classifications have been based on; 1) Radiographic appearance of fracture displacement direction.

a) The AO classification

b) The Sarmiento classification

c) The Lidstorm classification.

2) The mechanism of injury.

a) The Casting classification

b) The Fernandez classification

c) The Lincheid classification.

3) Articular joint surface involvement.

a) The Mayo classification

b) The McMurty and Jupiter classification

c) The Melone classification.

4) The degree of comminution:

a) The Gartland and Werley classification.

b) The Jenkins classification

c) The Older classification.

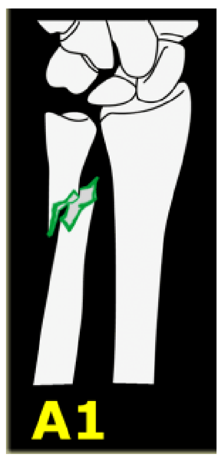
The **OTA/AO classification** emphasizes the increasing severity of the bony injury. It is based on the location of the fracture line(s), the displacement of the distal fragment, the extent of articular involvement, and the presence of an ulnar styloid fracture[35].

Type A - Extraarticular fracture. Subgroups are based on direction of displacement and comminution.

TypeA1, - .1 Styloid process Extraarticular fracture of ulna, radius intact

.2 Metaphyseal simple

.3 Metaphyseal multifragmentary



Type A2, - Extraarticular fracture of radius, simple & impacted

.1 Without any tilt

.2 With dorsal tilt(pouteau-colles)

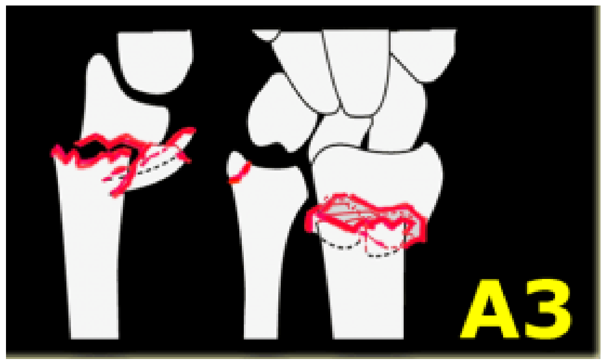
.3 With volar tilt(Goyrand-smith)

Type A3, - Extraarticular fracture of radius, multifragmentary

.1 - Impacted with axial shortening

.2 - With a wedge

.3 - complex



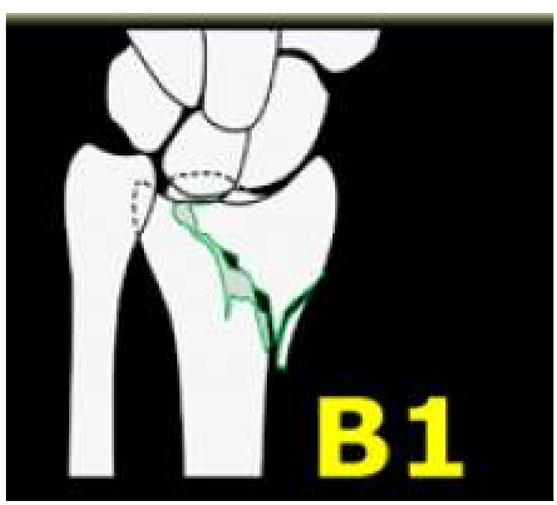
Type B - Partial articular fracture. Subgroups are based on lateral (radial styloid) palmar or dorsal fragments.

Type B1 - Partial articular fracture of radius, saggital

.1 - Lateral simple

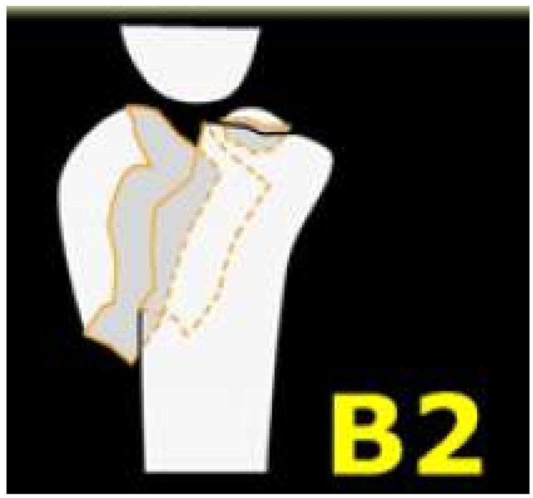
.2 - Lateral multifragmentary

.3 - medial



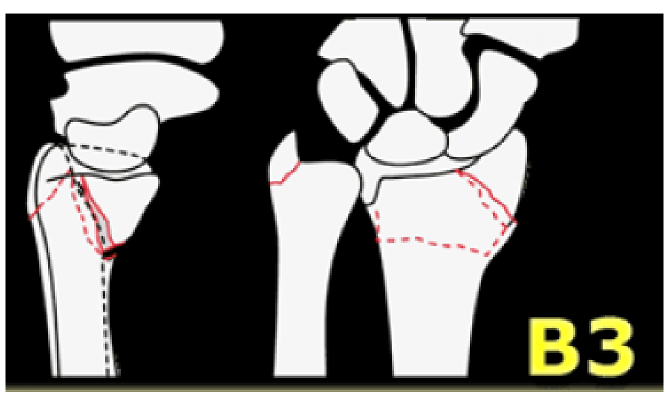
Type B2 - Partial articular fracture of radius, dorsal rim

- .1 - simple
- .2 - With lateral saggital fracture
- .3 - With dorsal dislocation of the carpus



Type B3 - Partial articular fracture of radius, volar rim

- .1 - Simple, with a small fragment
- .2 - Simple, with a large fragment
- .3 - multifragmentary



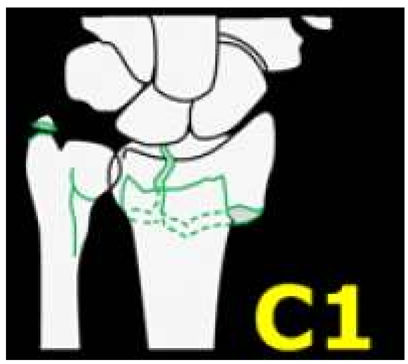
Type C - Complete articular. Subgroups are based on the degree of comminution of the articular surface and the metaphysis.

Type C1 - Complete articular fracture of radius, articular and metaphyseal simple

.1 - Posteromedial articular fragment

.2 - Saggital articular fracture line

.3 - Frontal articular fracture line

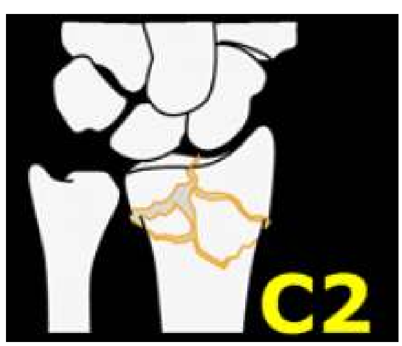


TypeC2 - Complete articular of radius, articular simple and metaphyseal multifragmentary

.1 - Saggital articular fracture line

.2 - Frontal articular fracture line

.3 - Extending in to diaphysis

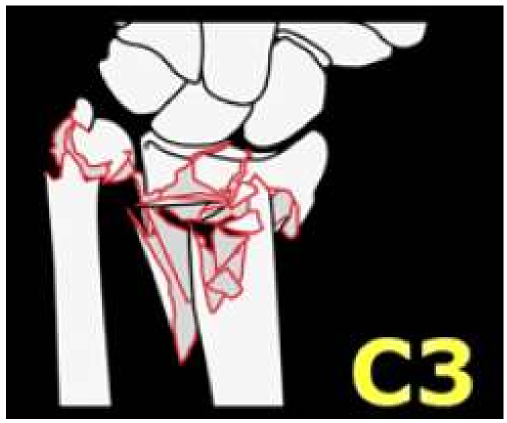


Type C3 - Complete articular of radius, multifragmentary

.1 Metaphyseal simple

.2 metaphyseal multifragmentary

.3 Extending in to diaphysis



Frykman established in 1967, a classification that incorporated individual involvement of the radiocarpal and radioulnar joints as well as the presence or absence of a fracture of the ulnar styloid.

Frykman's classification is the most popular but does not provide treatment options or prognosis. Classification of unstable fractures became more necessary as the importance of fracture displacement, instability; excess dorsal angulation and shortening were recognized. These radiographic parameters were major factors in predicting unsatisfactory results. Although the Frykman classification could be considered beneficial because a majority of practitioners were familiar with it, it also had weaknesses because it did not make a distinction between displaced and nondisplaced intra-articular fractures for which treatment modalities vary widely. The previously ignored ulnar styloid fracture also became important, and fractures entering the distal radioulnar joint were observed to have a high incidence of complications.

Type I: Extra-articular fracture

Type II: Extra-articular fracture with ulnar styloid fracture

Type III: Radiocarpal articular involvement

Type IV: Radiocarpal involvement with ulnar styloid fracture

Type V: Radioulnar involvement

Type VI: Radioulnar involvement with ulnar styloid fracture

Type VII: Radioulnar and radiocarpal involvement

Type VIII: Radioulnar and radiocarpal involvement with ulnar styloid fracture.

Gartland and Werley proposed in 1951 a classification system that assessed the three basic components of these injuries:

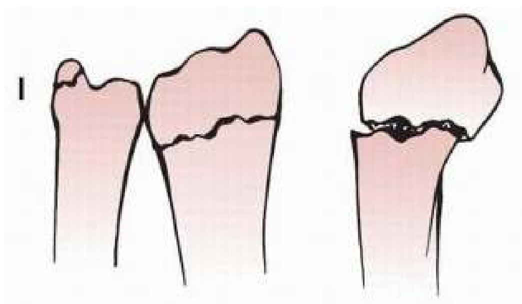
(1) metaphyseal comminution,

(2) intra-articular extension, and

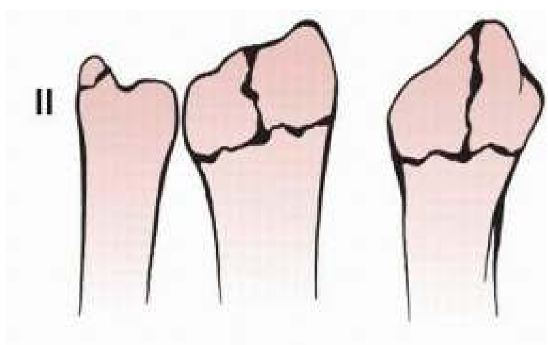
(3) displacement of the fragments.

Their classification system (which follows) has been accompanied by one of the first clinically useful outcomes scores.

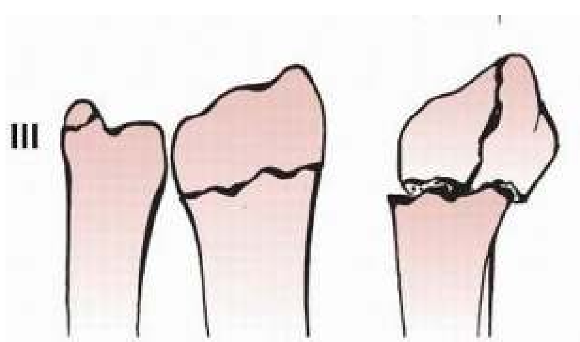
Group I - Simple Colles' fracture with no involvement of the radial articular



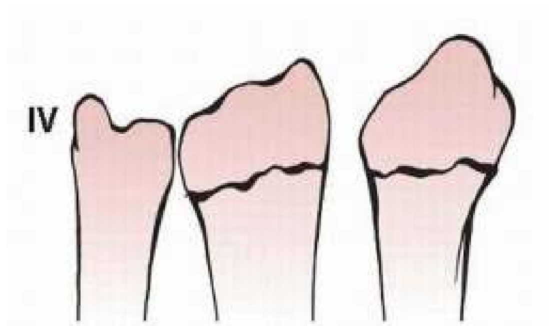
Group II - Comminuted Colles' fractures with intra-articular extension without displacement



Group III - Comminuted Colles' fractures with intra-articular extension with displacement

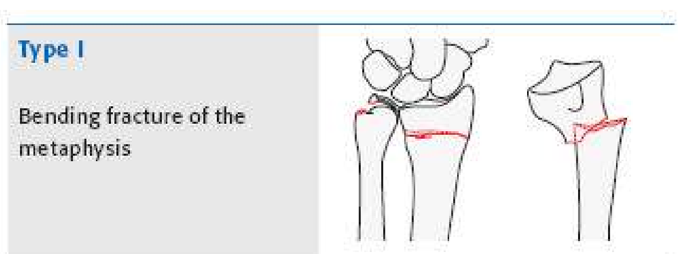


Group IV - Extra-articular, undisplaced

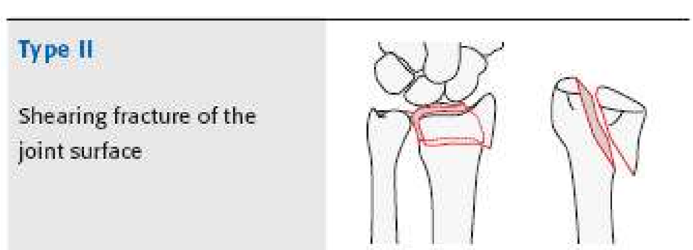


In 1993 **Fernandez** proposed a mechanism-based classification system that would address the potential for ligamentous injury and thereby assist in treatment recommendations.

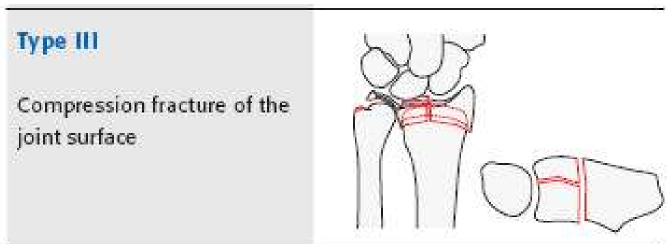
Type I: Metaphyseal bending fractures with the inherent problems of loss of palmar tilt and radial shortening relative to the ulna (DRUJ injuries)



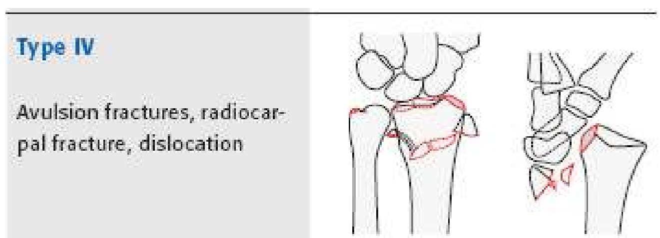
Type II: Shearing fractures requiring reduction and often buttressing of the articular segment



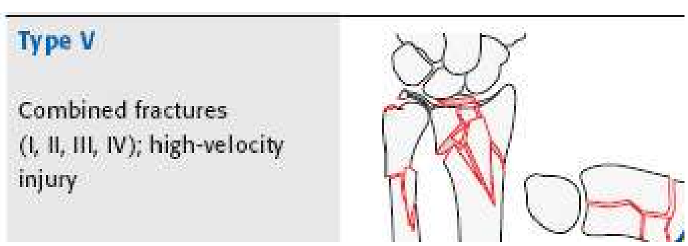
Type III: Compression of the articular surface without the characteristic fragmentation; also the potential for significant interosseous ligament injury



Type IV: Avulsion fractures or radiocarpal fracture Dislocations



Type V: Combined injuries with significant soft tissue involvement because of the high energy nature of these fractures



McMURTRY AND JUPITER CLASSIFICATION (1991):

They defined intra-articular fractures on the basis of the number of their parts.

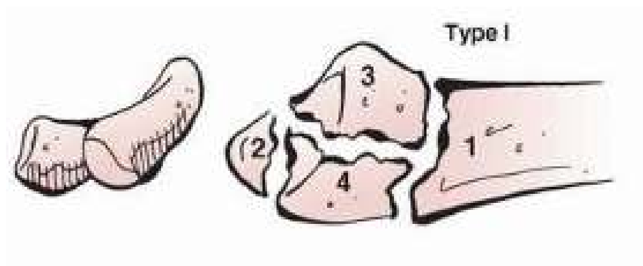
Two parts	-	The opposite portion of the radiocarpal joint remains intact. (Dorsal or palmar Barton, Chauffeur and "die punch" fractures).
Three parts	-	The lunate and scaphoid facets separate from each other and the proximal portion of radius.
Four parts	-	Same as three parts except the lunate facet is further fractured into dorsal and volar fragments
Five parts or more	-	Including wide variety of comminuted fragments

Melone emphasized the effect of the impaction of the lunate on the radial articular surface to create four characteristic fracture fragments.

Further refinement of the classification for intra-articular fractures was proposed by Melone, who recognized that many intra-articular fractures not only had instability but specific patterns of displacement. He identified that most intra-articular distal radius fractures have three or four part fracture components (1: shaft; 2: radial styloid; 3: dorsal medial; 4:

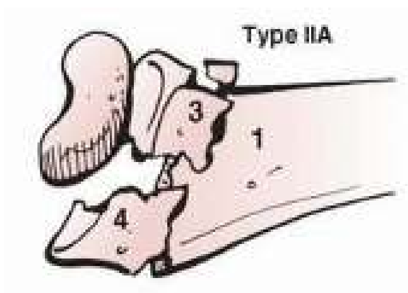
Palmar medial) and that certain displacements (types 3 and 4) are not easily reduced and have a poor prognosis.

Type I - Stable fracture without displacement. This pattern has characteristic fragments of the radial styloid and a palmar and dorsal lunate facet

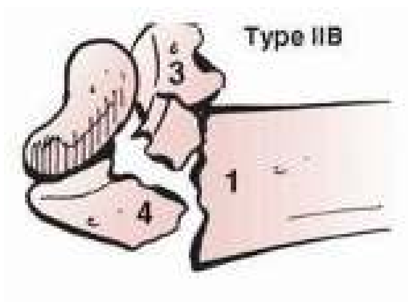


Type II - Unstable "die punch" with displacement of the characteristic fragments and comminution of the anterior and posterior cortices

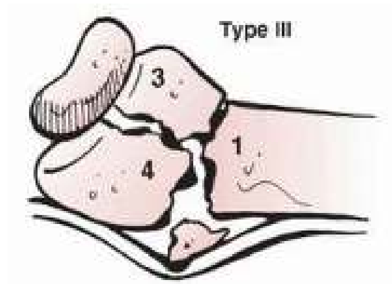
TypeIIA Reducible



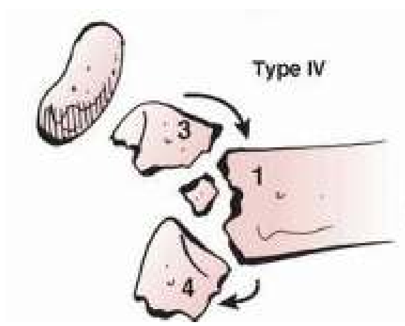
TypeIIB - Irreducible (central impaction fracture)



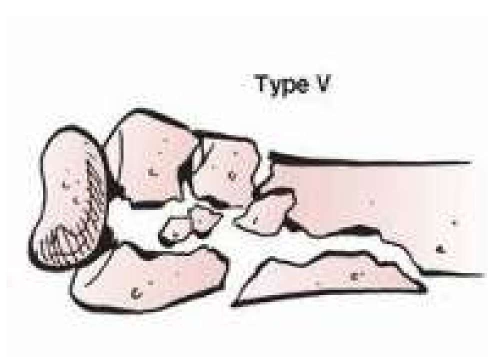
Type III - "Spike" fracture. Unstable. Displacement of the articular surface and also of the proximal spike of the radius



Type IV - "Split" fracture. Unstable medial complex that is severely comminuted with separation and or rotation of the distal and palmar fragments



Type V - Explosion injury



TREATMENT MODALITIES OF DISTAL RADIUS FRACTURES

I) CONSERVARTIVE:

Different types and positions of immobilization of the wrist and hand have been described; straight, in flexion-ulnar deviation, in extension; with or without permanent cast, with a below or over the elbow cast; with the forearm pronated or supinated. It seems that redisplacement during healing is not correlated with the type of immobilization but only with the dorsal comminution and the initial displacement.

II) SURGICAL :

- percutaneous direct pinning
- elastic intra focal or extra focal pinning
- external fixation
- external fixation and direct pinning
- orif with buttress plate
- orif with locking compression plate.
- bone grafting
- wrist arthroscopy

PRINCIPLES OF MANAGEMENT OF DISTAL RADIAL FRACTURES

Goals of Treatment

The goals of treatment are to restore maximum function, maintain strength, limit the development of post-traumatic arthritis, and avoid complications. Achievement and maintainance of a satisfactory reduction until healing occurs, followed by rehabilitation of the wrist to restore motion and strength is the ultimate goals of treatment of radial fractures.

Signs of DRUJ injury:

- fracture at the base of the ulnar styloid,
- widening of the DRUJ space seen on the P/A xray,
- $>20°$ of dorsal radial angulation, and
- >5 mm of proximal displacement of the distal part of the radius.

1mm-2mm sagital CT - best to view articular depression fracture.

MRI if TFCC or scapholunate ligment tears suspected.

Acceptable Reduction:

- $<15^0$ dorsal and $<20^0$ palmar tilt
- $>15^0$ radial inclination
- <5mm radial shortening

- Ulnar variance negative or neutral
- Articular gap<2mm
- Articular step<1mm

Evaluation of operation results On radiographic examination (PA view), the normal radius shows the following.

1. The bistyloid line (BSL) is tilted at +10-15 on the horizontal line;
2. The radial angulation (RA) is tilted at +21-24 on the horizontal line;
3. The ulnar variance (UV) is normally equal to 0 to -2mm

An imperfect reduction is characterized radiographically by the following;

1. The bistyloid line (BSL) becomes horizontal or inverted to negative values (-10°);
2. Radial angulation (RA) also tends to be horizontal or even inverted, to a measurement of -10°;
3. The ulnar variance (UV) becomes positive (+4), indicating a compression of the distal part of the radius onto the proximal radius;
4. A radio-ulnar diastasis may be noted eventually, indicating a rupture or a tearing of the triangular fibrocartilage[36].

On lateral radiographs the normal criterion is;

• Palmar tilt (PT) is +15°. The articular surface of the radius is oriented downwards and slightly forwards.

An imperfect reduction is characterized by ;

• Tilting to neutral or with dorsal angulation. The measurement of the palmar tilt (PT) is -10°, which indicates a dorsal or posterior tilt. Even a zero value for the palmar tilt indicates a posterior tilt; and when the UV becomes positive, it allows measurement of the degree of compression of the distal fragment.

OSTEOPOROSIS

Bone strength is determined by the mass and quality of the bone. Osteoporosis is a condition that is characterized by a marked reduction is bone strength and subsequently results in an increased frequency of fractures due to microarchitectural disorientation. The oldest documentation dates back to 990 BC from Egypt.

A major failure of fractures that occur amongst postmenopausal women are attributed to osteoporosis. Hip, spine and wrist fractures occur at a higher frequency although any bone may be affected. However unlike fractures that occur in otherwise healthy bones, fractures involving osteoporotic bones result in higher morbidity.

The patients are usually asymptomatic until fractures occur as a result of trivial falls or in some cases as a result of bumps or stress. It is now believed that it is a preventable condition that occurs as a result of suboptimal bone development during childhood and adolescence that is later followed by bone loss during adulthood. Also osteoporosis if already set in can be controlled by slowing its progression.

WHO defines osteoporosis by gender matched comparison of bone mineral density. A T score less than -2.5 is the gold standard of diagnosis. T scoring is done at the following sites:

- Neck of femur
- Lumbar spine
- Distal end of radius

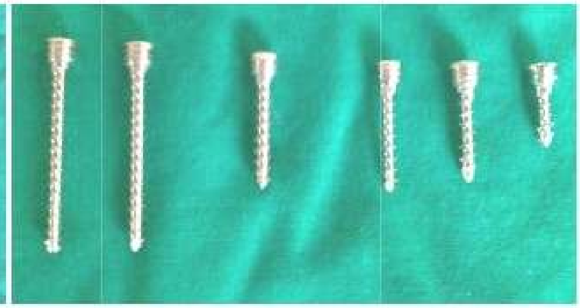
Although T score is the gold standard method, BMD using Dual energy X-ray absorptiometry at hip and lumbar spine is widely used.

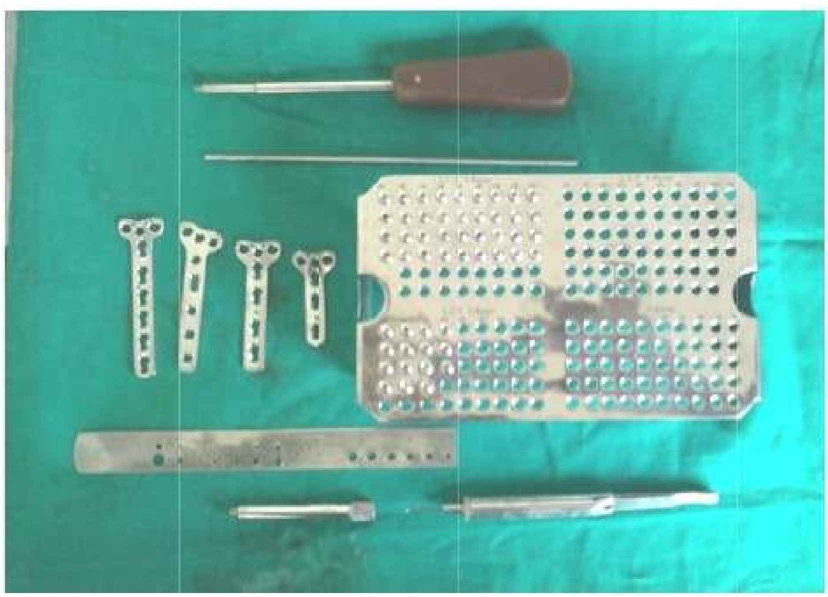
IMPLANT FEATURES:

The volar distal radius locked compression plates combines the advantages of locked plating with the flexibility and benefits of traditional plates and screws utilizing both locking and non locking screws. The LCP plates allows for the creation of construct that resists angular collapse and also functions as an effective fracture reduction aid. A simple, intutitive instrument set featuring standardized drill bits, screws drivers and drill guides helps make the locking system efficient and easy to use.

The precise screws trajectories, anatomic contour and locking capabilities of the volar distal radius locking compression plates provide a stable construct for predictable reconstruction of complex fractures of distal radius.

PLATE: The LCP distal radius plate is a 3.5mm low profile stainless steel plate with a 26° distal volar tilt that allows for optimal anatomic fracture reduction and restoration of radial inclination.

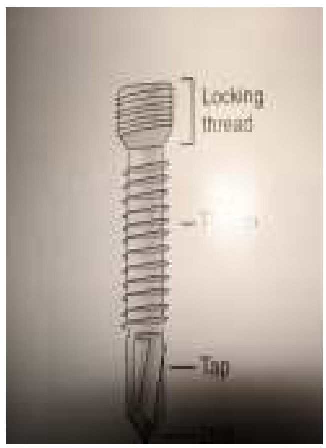
The distal articular end of the plate consists of 3 locking holes for 3.5mm locking screws angled at 15°.

• The shaft of the plate consists of combiholes for insertion of 3.5mm locking or cortical screws.

• The plates are available in 3, 4, 5, 6, 7, 8 hole shaft length.

SCREWS :

• The screws are 3.5mm stainless steel self tapping and locking screws. Threaded conical head locks securely into the threaded holes in the plate to provide angular stability.



• Locked screws allow unicortical screw fixation and load transfer to near cortex.

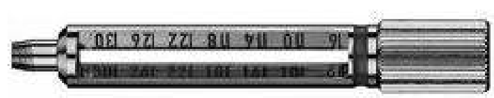
• Available in 6mm to 30mm lengths (2mm increments).

DRILL BIT :

• A 2.8mm regular drill bit is used for all the screws.

THREADED LCP DRILL GUIDE :

• The 3.5mm threaded LCP drill guide centers the 2.8mm drill bit to ensure the engagement of the locking screw in the threaded hole in the plate.



SPECIFIC SURGICAL CONSIDERATIONS FOR TREATING FRACTURES IN AN OSTEOPOROTIC BONE

Multiple factors must be taken into consideration when deciding on a line of management for fractures in older patients as the functional demands of older individuals vary from that of younger patients. In the elderly it is important to achieve a stable fracture fixation thereby reducing pain and facilitating mobilization.

A common obstacle while dealing with osteoporotic patients is fixation of the device to the bone which occurs as a result of a higher frequency of bone failure which is attributed to reduced bone mass resulting in brittle bones and altered bone structure which may even include medullary expansion. The above characteristics must hence be taken into consideration while planning lines of management. It must also be duly noted that patients with osteoporotic bones generally have proportionately lower physical demands. Also there is a documented reduction in the life expectancy amongst individuals with osteoporosis.

A more conservative line of management such as immobilization using casts may present with a different set of hurdles such as:

a) Joint stiffness

b) No control over bone shortening

c) Poor bone fixation especially when the skin is loose

Hence internal fixation is required to provide stability and maintain reduction. Immobilization in casts has the disadvantage of immobilizing the joints adjacent to the fracture often leading to joint stiffness. Furthermore, a cast does not control fracture shortening which is often seen in osteoporotic bone; and if the subcutaneous tissue is very mobile, as it often is in the elderly, cast fixation will not provide adequate fracture fixation. Metaphyseal fractures in osteoporotic bone are associated with specific fixation problems as the metaphyseal fragment is often very small. The major problem in osteoporotic fracture treatment is fixation of the device to the bone as bone failure is much more common. Problems in osteoporotic fractures are,

1. Purchase will be poor.
2. Unstable fractures.
3. Needs splinting with plaster.
4. Early mobility is compromised.

Because the distal radius is important in the kinematics of the radiocarpal and radioulnar joints, open reduction of the articular surface and restoration of the radial length, volar angulation, and radial inclination are the prerequisites for good clinical outcome. To improve fixation and resist bending forces a screw and plate construct with a locked angle between the plate and metaphyseal screw is often used. Recently locked plates have been introduced threaded screw holes in the plates, which create angular stability between the screws and the plates.

Volar application of a locking compression plate for dorsally displaced distal radial fracture in postmenopausal women is a safe alternative. It provides stable fixation to dorsally displaced fractures of the distal radius with excellent radiographic and functional results and minimal complications. Locking screws provides fixed angle construct and improved fixation in osteoporotic bones.

Locked plates are a good option as they have threads in the holes that provide angular stability between the screw and plate hence allowing good maintenance of reduction and better quality fixation. These are good option in case of metaphyseal fractures seen in osteoporotic bones where the metaphyseal fragments are usually small making fixation with locked plates advantageous.

COMPARISION BETWEEN CONVENTIONAL PLATE AND LOCKING COMPRESSION PLATE

Conventional plates must be perfectly contoured prior to application. Fracture reduction can be lost from axial loads causing excessive shear forces on the construct that are greater than the frictional loads between the bone-plate-screw construct. Screw loosening and loss of plate-bone fixation occurs as a result of toggling of cortical screws . Each screw works independently; the construct depends on a single screw's stiffness or pullout strength[37].

The biomechanical goals of the LCPs are to increase the stiffness of the construct in a biological environment. The LCP is a fixed angle construct that does not rely on screw purchase in bone. The fixed-angle converts shear stress into compressive stress at the screw-bone interface once the screw is locked into the plate. The load is now perpendicular to the screw axis. In order for the construct to fail under an axial load, the bone must collapse in compression. Therefore, the strength in the LCP is the sum of all the screw and plate interfaces[38,39].

Locking screws does not generate compression between the plate and the bone since they are designed with smaller threads. They have a larger core diameter that ensures greater bending and shear strength and dissipate the load over a larger area of bone. They have self- retaining head(stays on the screw driver without a holding device) and allows 65% greater insertion torque than conventional hexagonal drivers. The locked screw has a conical, double-lead thread design that facilitates alignment with the threaded plate hole.

In vitro studies in bone models do show that locked screw constructs fail at higher loads than cortical screws and their advantage is magnified in osteoporotic bone.

The primary indications for LCPs :

1. Poor quality bone as in osteoporosis
2. Complex periarticular fractures where contouring is difficult in the metaphyseal area
3. Inability to get minimal number of conventional cortical screw purchase
4. Periprosthetic fractures
5. Nonunions due to screw stripping or back out
6. Polytrauma cases (complex fractures that cannot be anatomically reconstructed).

COMPLICATION AFTER LOCKING COMPRESSION PLATING

- Median nerve irritation is common. Generally, symptoms are mild and disappear with elevation. Persistent paresthesia may be due to median neuropraxia at the site of fracture, or acute carpal tunnel syndrome.
- Hard-ware related complications
- Skin irritation at the wrist as a result of a prominent plate.
- Loss of alignment and fracture malunion may occur. In the elderly, small degrees of malunion are tolerated well and result in minimal disability. Severe malunion may result in reduced grip strength, cosmetic deformity, stiffness, restriction of forearm rotation, and pain.
- Complex regional pain syndrome
- Infection
- Failure of fixation, due to separation of the distal radius bony fragment from the plate may result.

ADVANTAGES OF LOCKING COMPRESSION PLATING

LCP volar column plates have the following attributes:

1) It enables the surgeon to address individual fragments separately
2) Anatomical reduction depending on the pattern of fracture may be done and stabilization may be provided by using k-wires temporarily as the plate is applied.
3) Plates are provided with elongated holes that make it convenient to make adjustments in the position of the plates.
4) Universal anatomical shape eliminates need for anatomical contouring of plate based on variations in bone anatomy.
5) Stable Fixation : As the system is versatile, it allows stabilization of even complex fractures. In complex fractures treated based on the tree column theory, radius and ulnar fragments may be separately dealt with. Also there are a variety of locking options which is beneficial in fractures near distal radio-ulnar joint where additional screws may be used to support the styloid process.
6) Preservation of Blood Supply: The plates are specifically designed with a low profile cross sectional design with undercuts and rounded edges reducing chances of soft tissue irritation and ensuring good periosteal blood supply.

7) Early Mobilization : A combination of AO technique during surgery and the plate when used allow faster healing and early mobilization[40].

Materials and Methods

MATERIALS AND METHODS

The study was conducted in the department of orthopaedics, Coimbatore medical college and hospital, Coimbatore. The number of patients in the study group was fifteen. The period of study was between July 2011- May 2013. All the postmenopausal women with distal fractures were investigated for our study. The age group was between 47 to 75 years. Minimal period of study was 6 months. Functional outcome was evaluated using modified mayo wrist score.

MODIFIED MAYO WRIST SCORE	
I. PAIN	
No Pain	-25
Mild Occasional Pain	-20
Moderate, Tolerable Pain	-15
Severe to intolerable Pain	-0
II. ACTIVITY	
Returned to Regular Activities	-25
Regular Activities with Some Restrictions	-20
Low Demand Activities	-15
Unable to work / play /engage in sports	-0
III. RANGE OF MOTION (Supination and Pronation)	
$>145^0$	-25
130^0-144^0	- 20
110^0-129^0	-15

80^0-109^0	-10
40^0-79^0	- 5
0^0-39^0	- 0
IV GRIP STRENGTH (Percentage of Normal)	
90-100%	-25
75-89%	-15
50-74%	-10
25-49%	-5
0-24%	-0
FINAL RATING (From Total Point Scored)	
Excellent	- 90-100 Points
Good	- 80-89 Points
Fair	- 65-79 Points
Poor	- < 65 Points

Inclusion criteria:

1. Fracture distal radius in the Postmenopausal women.

2. All the women in the study group was independent to take care of their activities of daily living.

3. Fractures occurring at or within 2cms of distal radius.

Exclusion criteria:

1. women in menstrual age group

2. Undisplaced distal radial fractures

3. Patients not willing for internal fixation.

Patients admitted with distal radius fractures will be classified under AO and Gartland and Werley classfication.

Detailed informed consent was obtained from all the persons in the study group.

The procedure performed under supraclavicular block/axillary block. Our standard practice, preoperative prophylactic intravenous cefotaxime and bipolar diathermy for haemostasis.

INSTRUMENTS AND IMPLANTS USED:

- Locking compression plates of varying length
- 3.5mm LCP drill bit and sleeve system
- Hand drill / power drill
- Tap for 3.5mm cortical screws and 3.5mm depth gauge
- Hexagonal screw driver for 3.5mm cortical screws and locking screw driver
- General instruments like retractors, periosteal elevators, reduction clamps, bone levers etc.
- Pneumatic tourniquet.

OPERATIVE PROCEDURE

Description:

By volar Henry approach: The radial styloid fragment was approached initially using an incision centered longitudinally over the flexor carpi radialis tendon and then dissected between the flexor carpi radialis tendon and radial artery.

The parona's space underneath the flexor tendons developed and the distal and radial borders of pronator quadratus were lifted and retracted ulnarly. Image intensifier used in theatre to assist the evaluation of fracture reduction and fixation. Patients with unstable fractures, the wrist immobilised in a below elbow splint for 2 weeks.

Volar Henry approach

1. Skin incision

Fig. 1

2. Flexorcarpi radialis retracted medially and radial artery laterally to expose pronator quadrates

Fig. 2

3. Pronator quadratus erased, elevated medially and distal radius exposed

Fig. 3

4. Sleeve fixed in the threads of locking compression plate after temporary stabilizing of plate with K-wires

Fig. 4

Fig. 5

5. Fracture reduced and LCP fixed

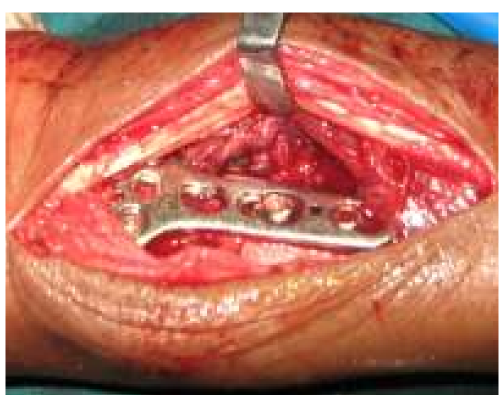


Fig. 6

PER OPERATIVE PROTOCOL:

Unstable fractures were immobilized with plaster of paris support for a period of 2 weeks.

POST OPERATIVE PROTOCOL:

Post operative data will include time to full wrist movements, post operative complications such as median nerve compression symptoms, malunion, failure of fixation, wound infections and complex regional pain syndrome (CRPS).

Patients will be allowed to start wrist movements at an average of three weeks post operatively.

After the discharge, patient will be followed at regular intervals 6weeks , 6 months and 1year.

Subjective and objective functional results were graded using modified mayo scoring system.

Results

RESULTS

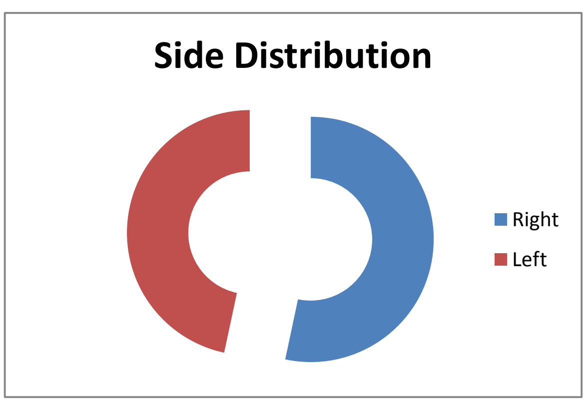
Fifteen cases of postmenopausal women with distal radius fractures were treated surgically by locking compression plate in Coimbatore medical college Hospital treated between July 2011 to may 2013. All cases were followed up periodically during the period July 2011 to may 2013. Average age in our study was 59.9 years.

We evaluated our results and compared the functional outcome with various other studies.

Involved side :

The right side (dominant wrist) was involved in 8 of the cases in our study series and 7 involved in left side.

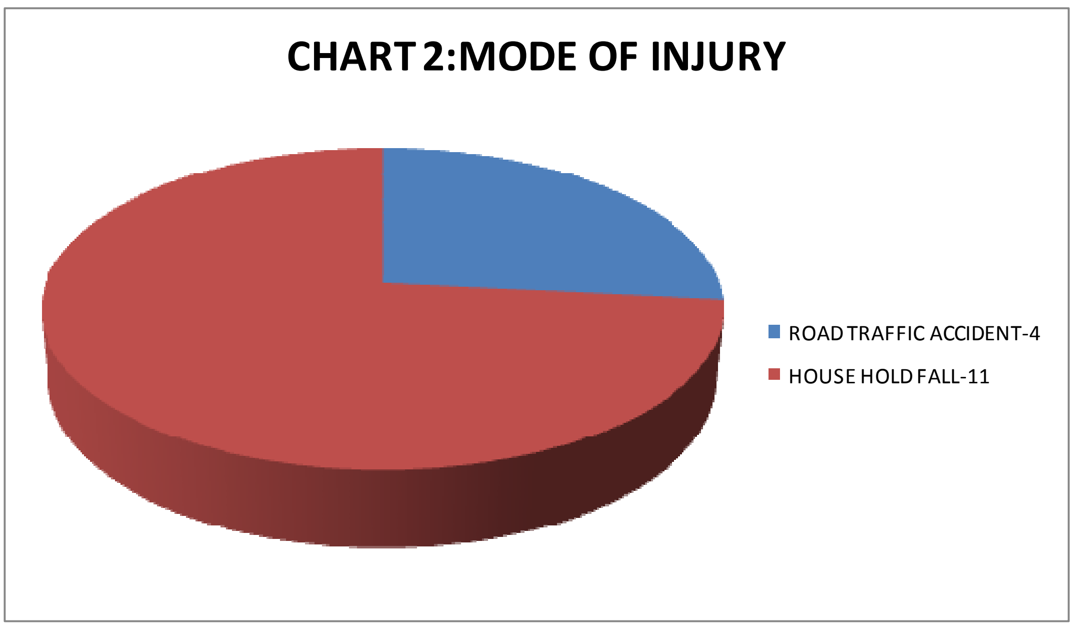
Side	No of cases	Percentage
Right	8	53.3
Left	7	46.6



Mode of injury :

In our study 26.6% of the patients had road traffic accident and 73.3% had a house hold fall.

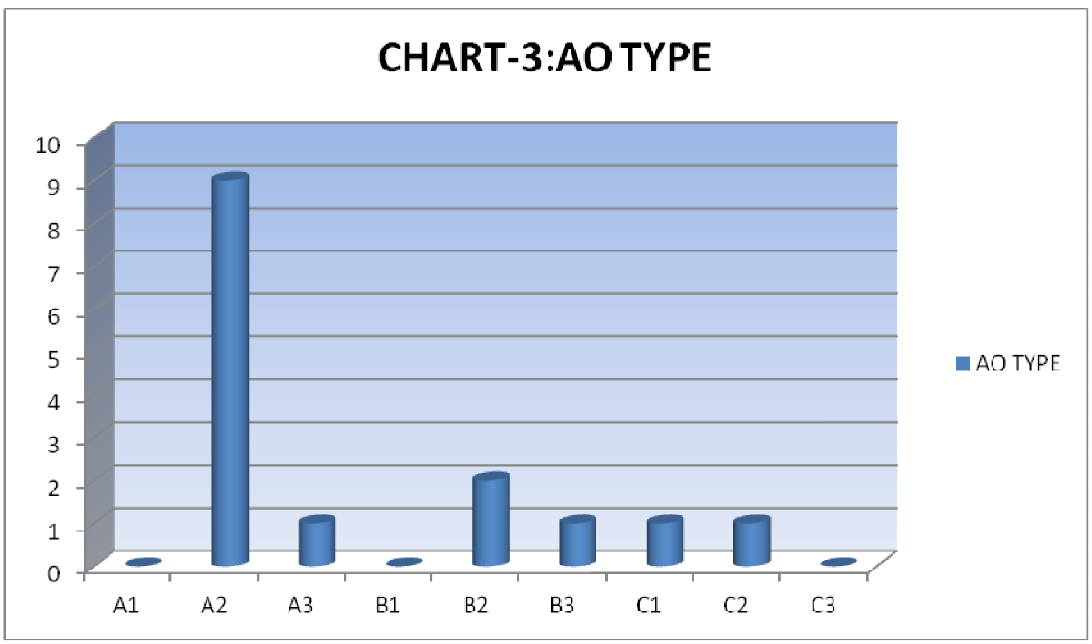
Mechanism of injury	**No. of cases**	**percentage**
Road traffic accident	4	26.6
House hold fall	11	73.3



Type of fracture:

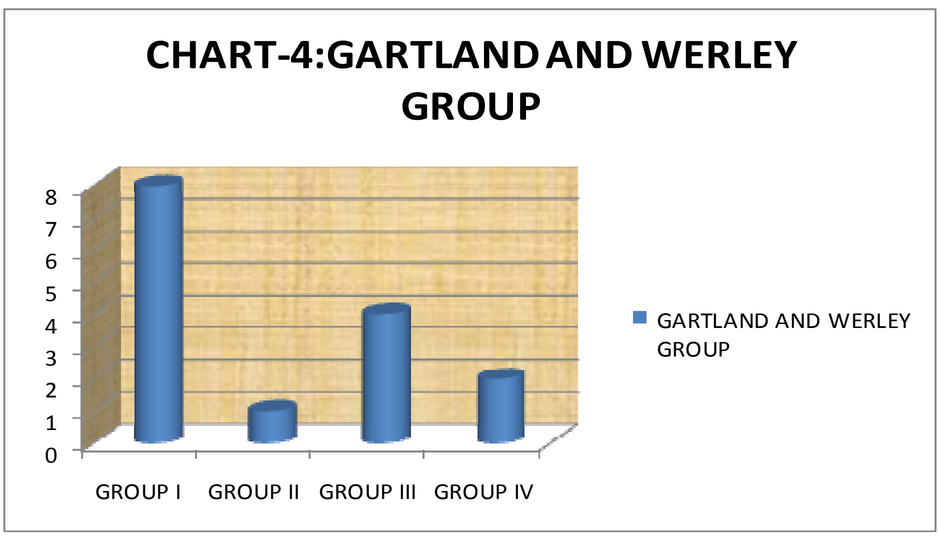
Based on AO and Gartland and Werley classification

AO Type	Number of cases
A2	9
A3	1
B2	2
B3	1
C1	1
C2	1



Groups as per Gartland and Werley classification

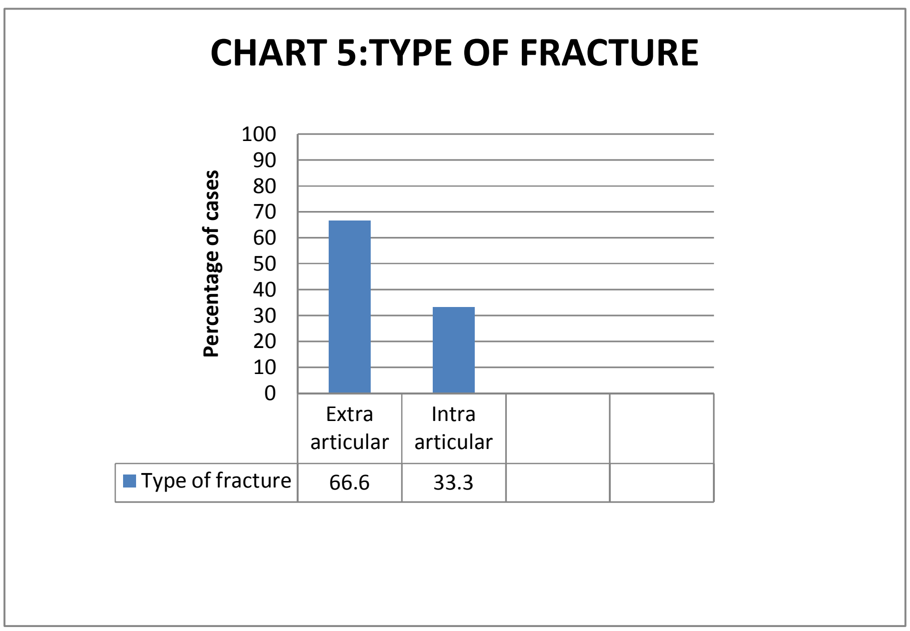
Type of Groups	Number of cases
Group I	8
Group II	1
Group III	4
Group IV	2



__**Extra articular and intra articular fracture:**__

Type	No. of cases	Percentage
Extraarticular fractures	10	66.66
Intra articular fractures	5	33.3

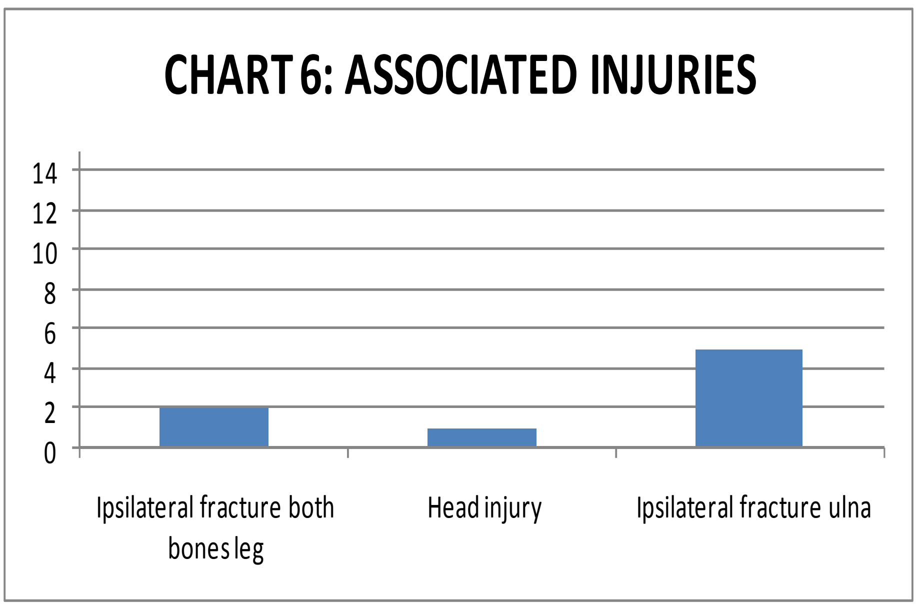
Out of 15 cases, 10 of the fracture were of extra articular type and 5 were intra articular fractures.



Associated injuries in our study group:

Associated injuries	**No. of cases**	**percentage**
Ipsilateral fracture both bone leg	2	13.3
Head injury	1	6.6
Ipsilateral distal ulna fractures	5	33.3
Total	**8**	**53.3**

Out of 15 cases 8 (53.28%) patients had associated injuries.



Surgical waiting period:

Duration	No. of cases	Percentage
1-5 days	8	53.3
6-15 days	7	46.6

Surgery was done between 1-5 days in 8 (53.3%) patients as an elective procedure. Surgery was delayed upto the 14th day in 7 (46.6%) because those patients had history of ischaemic heart disease, diabetes mellitus, associated head injury and surgery was done after clearance from respective specialities.

Fracture union data:

Time of Union	No.of Cases	Percentage
2-3 months	12	79.9
3-4 months	3	19.9

The present study 12 (79.9%) patients had union within 2-3 months and 03(19.9%) patients had union in 3-4 months. There was no case of delayed union.

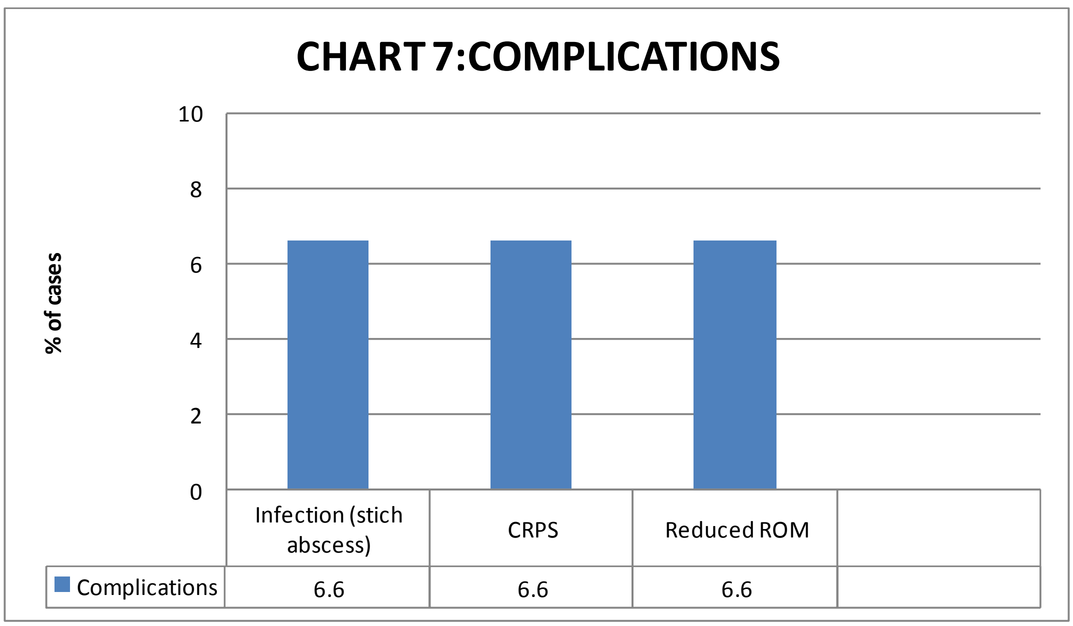
Range of movements:

Movements (within normal functional range)	No.of Cases	Percentage
Dorsiflexion	14	93.2
Palmar flexion	14	93.2
Pronation	13	86.5
Supination	14	93.2
Radial deviation	13	86.5
Ulnar deviation	12	79.9
Pain in distal radioulnar joint	3	19.9
Grip strength	2	13.3

In our study, 14 (93.2%) patients had dorsiflexion within the normal functional range, 14 (93.2%) had palmar flexion within the normal functional range, 13 (86.5%) had pronation within the normal functional range, 14 (93.2%) had supination within the normal functional range, 13 (86.5%) had radial deviation within the normal functional range and 12(79.9%) patients had ulnar deviation within the normal functional range. 13(86.5%) patients had grip strength more than 60% compared to the opposite side. 2(13.3%) had significant loss of grip strength. 3 (19.9%) patients had pain in the distal radioulnar joint.

Complications in our study:

Complications	No.of Cases	Percentage
Infection (stich abscess)	1	6.66
ComplexRegionalpain Syndrome(CRPS)	1	6.66
Reduced ROM	1	6.66
Total	**3**	**20**



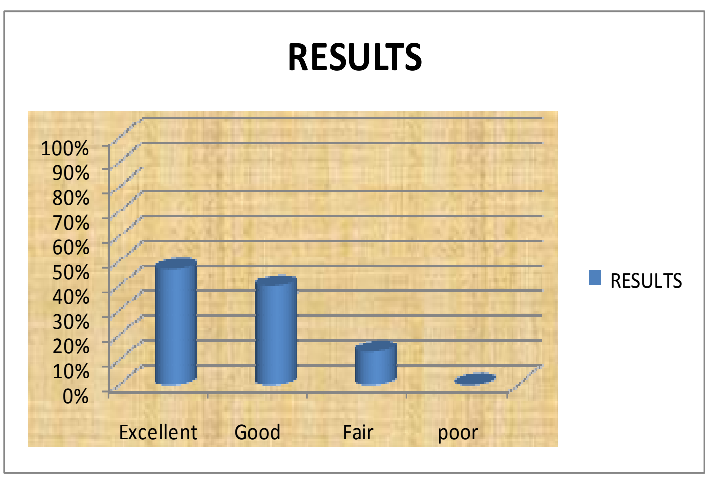
We encountered a complication rate of 20%, out of which 1 (6.6%) was due to infection (stich abscess) and another 1(6.6%) developed reduced range of movements and another 1(6.6%) developed complex regional pain syndrome (CRPS).

Evaluation of results:

The assessment of results were made using the modified mayo wrist score based on pain, activity, range of motion (supination & pronation) and hand grip strength.

Results	No. of cases	Percentage
Excellent	7	46.6
Good	6	39.9
Fair	2	13.3
Poor	**0**	**0**

In our series, we had 46.6% excellent, 39.9% good, 13.3%, fair and no poor results.



Discussion

DISCUSSION

A combination of an improved understanding of distal radial anatomy, patient demands and the new fixation devices have changed the management of distal radial fractures. Locking plates are preferred in osteoporotic and in multiple complex fractures. During the recent years, volar approach has become more popular. Use of locking compression plate was first published by Chan KW in HongKong, in 2003 for distal radius fractures. In India, the locking compression plate for distal radius fractures was published in 2007.

Our results are compared with various other studies, in various parameters like involved side, mode of injury, type of fractures etc.,

1) Involved side:

In our study the right side (dominant wrist) was involved in 8 of the cases and left side involvement was 7. In Arora Rohit et al., (2007) right side involvement was 70 and left was 44, Ayhan Kilic et al., (2009) right side involvement 14 and left side was 13, R.E. Anakwe et al.,(2010) right side involvement was 15 and left side was 6, Sanjay Agarwala(2012) right side involvement was 11 and left side was 14. All the above series had increased involvement of the right wrist in their series which was also the case in our series.

2) **Mode of injury:**

In our study 26.6% (4 cases) of the patients had road traffic accident and 73.3%(11 cases) had a house hold fall.

In Ayhan Kilic et al (2009) road traffic accident was 13 and house hold fall was 14 , Arora Rohit et al (2007) road traffic accident was 40 and house hold fall was 60, R.E. Anakwe et al.,(2010) road traffic accident was 14 and house hold fall was 7and Sanjay Agarwala(2012) Road traffic accident reported was 7 and house hold fall was 17.

All the above series had increased house hold fall than road traffic accidents. In our series also house hold fall is the more common mode of injury.

3) **Type of fracture:**

Based on AO classification, we had 9(59.4%) cases were A2(Extraarticular fracture of radius, simple & impacted) type fractures,1(6.6%) was A3(Extraarticular fracture of radius, multifragmentary), 2(13.2%) cases were B2(Partial articular fracture of radius, dorsal rim), 1(6.6%) case was B3(, Partial articular fracture of radius, volar rim), 1(6.6%) case was C1(Complete articular fracture of radius, articular and metaphyseal simple), and 1(6.6%)case was C2 (Complete articular of radius, articular simple and metaphyseal multifragmentary) fractures.

Based on AO classification Arora Rohit et al., (2007) reported 39 cases by A2, 16 cases by A3, 24 cases by C1, 30 cases and by C2, 5 cases by C3 .

Based on AO classification Ayhn Kilic et al., (2009) reported 3 cases by B2, 2 cases by B3, 2 cases by C1,14 cases by C2 and 6 cases by C3.

Based on AO classification R.E. Anakwe et al., (2010) reported 4 cases by C1, 8 cases by C2 and 9 cases by C3.

Based on AO classification Sanjay Agarwala(2012) reported 1 case by A1, 5 cases by A2, 7 cases by A3, 7 cases by B2, 3 cases by B3, 1 case each by C2 and C3.

In our series the majority of the cases were of A2(extraarticular) type.

4) Complications:

We encounterd three complications (20%) in our study. One being stich abscess, another developed reduced range of movements and another developed CRPS.

Arora Rohit et al., (2007) reported a complication rate of 57%.

Ayhn Kilic et al., (2009) reported a complication rate of 11.1%.

R.E. Anakwe et al., (2010) reported a complication rate of 4.8% and Sanjay Agarwala(2012) reported a complication rate of 4%.

5) Results compared with other studies:

In our series, we had 46.6% excellent, 39.9% good, 13.3%, fair and no poor results.

Patients, who obtained excellent results, had normal regular activities or no pain. Range of motion was within the normal functional range. Radial length, volar tilt and articular step-off were within acceptable limits. They underwent earlier physiotherapy.

Patients with good results had minimal residual deformities, pain and slight limitation.

Patients with fair results, along with residual deformity, pain and limitation also had pain in the distal radio-ulnar joint and minimal complications. Few of their movements were less than that required for normal function.

Rohit Arora et al., (2007) had 31 excellent, 54 good , 23 fair and 6 poor results based on functional outcome.

R.E. Anakwe et al., (2010) system outcome was assessed using clinical examination grip strength measures, radiographs and PRWE (patient related wrist evaluation) scoring. In his series 95% patient very high level of satisfaction, good functional outcome and increased grip strength.

Sanjay Agarwala(2012) used mayo modified wrist score for interpreting results, which showed 100% of excellent results after one year followup.

Our series is comparable to that of Ayhan Kilic et al., (2009) who had 44.4% excellent, 44.4% good, 11.2% fair.

Conclusion

CONCLUSION

In India, osteoporosis is an epidemic problem. Hence the women in the postmenopausal age will have fractures due to trivial injury. A fall on a outstretched hand is the common mode of injury causing distal radius fractures among postmenopausal women. Distal radial fractures which occur due to road traffic acidents (high energy trauma) are mostly intra-articular, displaced and unstable Gartland and Werley group II and III and AO type B2, B3, C1 and C3.

The results are evidence that locked plates are good implant in the treatment of intra-articular unstable fractures of distal radius. It allows effective anatomic realignment and early wrist mobilization. It is biomechanically superior due to closer joint interface placement and better screwing capability in different orders. A successful anatomic alignment was made possible regardless of the direction of fracture angulation with volar locking plate. 90% the patients went back to their daily activities with good recovery.

Use of locked compression plates in distal radius fractures provide good to excellent results and are effective in the correction and maintenance of distal radius anatomy. By using these plates, joint motions and daily functioning is recovered in a shorter time. Hence locking compression plate is a useful implant in stabilizing in osteoporotic distal radius fractures in postmenopausal women.

Our study is the first study of distal radius among postmenopausal women in India. Our study is a smaller one in terms of number of cases. A large multicentric study is needed to confirm our results.

Illustrative Cases

Annexures

ANNEXURE-I

ILLUSTRATIVE CASES:

CASE : 1

Parvathy,52yrs, IP.No:49264, H/O House hold Fall and injured her left wrist.

Pre-op **Immediate post-op**

1 year follow-up

Range of Movements – 1 Year follow up

Palmar flexion

Dorsiflexion

Supination

Pronation

CASE :2

Deivathal, 75yrs, F,IP.No:55886, H/O House hold Fall and injured her left wrist.

Pre-op **Immediate post-op**

1year follow-up

Range of Movements – 1 Year follow up

Palmar flexion

Dorsiflexion

Pronation

Supination

CASE : 3

Ruckmani, 47yrs, F, IP.No:50582, H/O House hold Fall and injured her left wrist.

Pre-op

Immediate post-op

1 year follow-up

Range of Movements – 1 Year follow up

Palmar flexion

Dorsiflexion

CASE : 4

Pachainayagi, 55yrs, F, IP.No:7576, H/O House hold Fall and injured her left wrist.

Pre-op

Immediate post-op

1 year follow-up

Range of Movements – 1 Year follow up

Palmar flexion

Dorsiflexion

CASE : 5

Janaki, 56yrs, F,IP.NO. 5916 H/O House hold Fall and injured her right wrist.

Pre op

Immediate post op

6 months follow up

1 year follow up

Range of Movements – 1 Year follow up

Palmar flexion

Dorsiflexion

Bibliography

ANNEXURE-II

BIBLIOGRAPHY

(1). Bagby GW. Compression bone-plating:historical considerations. J Bone Joint surg Am.1977;59:625-631.

(2). Helfet DL, Haas NP, Schatzker J, et al. AO philosophy and principles of fracture management-its evolution and evaluation. J Bone Joint surg Am. 2003;85:1156-1160.

(3). FRIGG, R.: Development of the Locking Compression Plate.

Injury, 34 Suppl. 2: B6-10, 2003

(4). PERREN, S. M.: Backgrounds of the technology of internal fixators. Injury, 34 Suppl. 2: B1-3, 2003.

(5). Egol KA, Kubiak EN, Fulkerson E, et al. Biomechanics of locked plates and screws.J Orthop Trauma. 2004;:488–93.

(6). Haidukewych GJ. Innovations in locking plate technology.J Am AcadOrthop Surg. 2004;12:205–212.

(7). Chan KW, Kwok TK, Mak KH. Early experience with locking compression plate in the treatment of distal radius fracture. Hong Kong J Orthop Surg. 2003;7:88–93.

(8). Leung F, Zhu L, Ho H, Lu WW, Chow SP. Palmar plate fixation of AO type C2 fracture of distal radius using a locking compression plate: a biomechanical study in a cadaveric model. J Hand Surg. 2003;28B:263–6.

(9). Orbay JL, Fernandez DL. Volarfixed-angle platefixation for unstable distal radius fractures in the elderly patient. J Hand Surg. 2004;29A:96–102.

(10) Cooney WP III, Dobyns JH, Linscheid RL. Complications of colles' fractures. J Bone Joint Surg 1980; 62-A: 613.

(11). Schütz M, Kolbeck S, Spranger A, Arndt-Kolbeck M, Haas NP. Palmar plating with the locking compression plate for dorsally displaced fractures of the distal radius--first clinical experiences Zentralbl Chir. 2003 Dec;128(12):997-1002.

(12). Wong KK, Chan KW, Kwok TK, Mak KH, Volar fixation of dorsally displaced distal radial fracture using locking compression plate**.** J Orthop Surg (Hong Kong). 2005 Aug;13(2):153-7

(13). Köck H, Bandl WD, Chan T.,Experiences and results with the locked compression plate for 603 fractures of the distal radius. Handchir Mikrochir plast chir. 2005 oct;37(5):303-8.

(14). Musgrave DS, Idler RS., Volar fixation of dorsally displaced distal radius fractures using the 2.4-mm locking compression plates. J Hand Surg Am. 2005 Jul;30(4):743-9.

(15). Cognet JM, Geanah A, Marsal C, Kadoch V, Gouzou S, Simon P. Plate fixation with locking screw for distal fractures of the radius ,Rev Chir Orthop Reparatrice Appar Mot. 2006 Nov;92(7):663-72.

(16). Scott M. Levin,Cory O. Nelson,Jonathan D. Botts, Glenn A. Teplitz, Yong Kwon, and Fred Serra-Hsu Biomechanical Evaluation of Volar Locking Plates for Distal Radius Fractures J Orthop Surg Received April 2, 2007; Accepted June 20, 2007.

(17). Strohm PC, Müller CA, Helwig P, Mohr B, Südkamp NP. Is the locking, 3.5 mm Palmar T-Plate the implant of choice for displaced distal radius fractures. Orthop Unfall. 2007 May-Jun;145(3):331-7.

(18). Arora R, Lutz M, Hennerbichler A, Krappinger D, Espen D, Gabl M. Complications following internal fixation of unstable distal radius fracture with a palmar locking-plate. J Orthop Trauma. 2007 May;21(5):316-22.

(19). RE Anakwe, LAK Khan,RE Cook, and JE McEachan Locked volar plating for complex distal radius fractures: Patient reported outcomes and satisfaction J Orthop Surg Res. 2010; 5: 51.

(20). Claudio Roberto Martins Xavier, Danilo Canesin Dal Molin, Rafael Mota Marins dos Santos, Surgical treatment of distal radius fractures with a volar locked plate: correlation of clinical and radiographic results, Rev Bras Ortop. 2011;46(5):505-13.

(21). Hanae minegishi, Osamudohi, Soukanan & Hidetsugu sato, Treatment of unstable distal radius fractures with the volar locking plate. Upsala Journal of Medical Sciences. 2011; 116: 280–284.

(22). Chris Dillingham, MaryBeth Horodyski, Aimee M. Struk, and Thomas Wright, Rate of Improvement following Volar Plate Open Reduction and Internal Fixation of Distal Radius Fractures. SAGE-Hindawi Access to Research Advances in Orthopedics Volume 2011, Article ID 565642,4pages doi:10.4061/2011/565642.

(23). Joideep Phadnis, Alex Trompeter, Kieran Gallagher, Lucy Bradshaw, David S Elliott and Kevin J Newman, Mid-term functional outcome after the internal fixation of distal radius fractures Phadniset al. Journal of Orthopaedic Surgery and Research2012,7:4.

(24). S Sawalha, P Kumar.Complications of Volar Locking Plates for Distal Radius Fractures: Experience of a District General Hospital. The Internet Journal of Orthopedic Surgery. 2007 Volume 9 No 1.

(25). Shetty MS, Kumar MA, Kiran K, Kini AR. Locking distal radius plate-early results from India. J Trauma. 2011 Nov;71(5):1359-63.

(26). Sanjay Agarwala, Ganesh S Mohrir, Shreyans D. Functional Outcome in Distal Radius Fractures Treated with Locking Compression Plate. Gadiya Bombay Hospital Journal, Vol. 54, No. 2, 2012 .

(27). Nagesh Prabhakar Naik, Deshpande Shrikant Balkrishna. Management of dorsally displaced distal radius fracture by volar fixation using locking compression plate. Indian Journal of Basic & Applied Medical Research; December 2012: Issue-5, Vol.-2, P. 419-425.

(28). Brunelli F, Pagliei A, Smussi C. Anatomy of the distal radius. In Saffar P, Cooney WP III Edts. Fractures of the distal radius : London: Martin Dunitz Ltd, 1995. p1-11.

(29). Gausepohl T, Worner S, Pennig D, et al. Extraarticular external fixation in distal radius fractures Pinplacement in osteoporotic bone. Injury 2001;32(Suppl 4):SD79-SD85

(30). Apergis E, Darmanis S, Theodoratos G, Maris J. Beware of the ulno-palmar distal radial fragment. J Hand Surg Br 2002;27:139-145.

(31). Metz M, Gilula LA. Imaging techniques for distal radius fractures and related injuries - Distal radius fractures. Orthop Clin of N-Am 1993; 24(2): 217-228.

(32). Constantine KJ, Clawson MC, Stern PJ. Volar neutralization plate fixation of dorsally displaced distal radius fractures. Orthopedics 2002;25:125-128.

(33). Semaan I, Saffar P. Pathomechanism of intra-articular distal radial fractures. In Saffar P, Cooney WP III Edts. Fractures of the distal radius: London: Martin Dunitz Ltd, 1995. P19-27.

(34). Szabo RM. Comminuted distal radius fractures.Orthop Clin of NAm1992;23: 1-5.

(35). Saffar P. Current trends in treatment and classification of distal radial fractures. In Saffar P, Cooney WP III Edts. Fractures of the distal radius: London: Martin Dunitz Ltd, 1995. P12-18.

(36). Kapandji AI. Treatment of non-articular distal radial fractures by intrafocal pinning with arum pins. In Saffar P, Cooney WP III Edts. Fractures of the distal radius : London: Martin Dunitz Ltd, 1995. p71-83.

(37). Stoffel K, Dieter U, Stachowiak G et al: Biomechanical testing of the LCP-how can stability in locked internal fixators be controlled? Injury 34: S-B-11- S-B19

(38). Wagner M. General principles for the clinical use of the LCP. Injury. 2003; 34(suppl 2):B31-42.

(39). Ricci W, Zheng, Z, Jones, B, Cartner, J. Does Locked Plating Provide Improved Fatigue Properties over Nonlocked Plating and

Does Bone Quality Matter? OTA Annual Meeting Poster Presentation Boston, MA; 2007.

(40). M.E. Müller, M. Allgöwer, R. Schneider, and H. Willenegger (1991) AO Manual of Internal Fixation, 3rd Edition. Berlin: Springer.

Proforma

ANNEXURE-III

PROFORMA

Case No.	:	I.P.No.	:
Name	:	Hospital	:
Age/Sex	:	Date of admission	:
Occupation	:	Date of surgery	:
Address	:	Date of discharge	:

HISTORY

Presenting complaints:

Side affected:

Pain in the wrist:

* Onset ,Duration ,Type /Severity and Aggravating/Relieving factors

Swelling:

* Onset ,Duration and Progress

Restriction of movements:

Deformity:

Mechanism of injury:

* Fall on outstretched hand
* Road traffic accident
* Assault
* Miscellaneous injury

Associated soft tissue and skeletal injury:

History of presenting illness:

* Immediate treatment of injured hand
* Duration between the injury and first visit

FAMILY HISTORY:

PERSONAL HISTORY:

EXAMINATION

1. General physical examination:

Vitals -Pulse_____ Beats/min Temp______ ^{o}C

B.P ______ mm of Hg R.R. ______ Cycles/min

2. Systemic examination:

CVS PA

RS CNS

3. Local Examination:

Inspection:

Attitude:

Deformity:

* Closed dinner fork deformity
* Garden spade deformity
* Radial deviation of hand
* Ulnar deviation

Swelling, Scars / sinuses and Other findings:

Palpation:

* Local rise of temperature
* Tenderness
* Swelling
* Crepitus
* Abnormal mobility
* Step sign
* Deformity and Other findings

Range of movements:

* Palmar flexion (0-90)
* Dorsiflexion (0-90)

* Radial deviation (0-25)
* Ulnar deviation (0-35)
* Supination (0-80)
* Pronation (0-75)
* Circumduction

Measurements: Rt. Lt.

* Linear measurement
* Circumferential measurement

Associated complaints:

* Neurological - Ulnar nerve
  Median nerve
  Radial nerve
* Vascular -
* Other bone injuries - In the injured hand In the body

INVESTIGATIONS:

Blood : Hb% TC: DC:

ESR:

Urine : Albumin: Sugar: Micro :

RBS: Blood urea: Serum creatinine:

HIV: HBsAg:

ECG:

X-ray wrist - PA Type of fracture
- Lateral (Gartland and werley /AO classification)
- Oblique

Special investigations:

TREATMENT:

1. Pre-operative:

* Below elbow POP slab with sling
* Antibiotics
* Analgesics

2. Surgical procedure:

* Type of anaesthesia - GA/brachial block
* Type of fixation
* Duration of surgery
* Tourniquet time
* Operative findings
* Operative Complications - Excessive bleeding
Difficult reduction
Stable/Unstable

3. Post-operative:

* Immobilisation
* Antibiotics
* Suture removal
* Complications

4. Duration of hospital stay:

5. Follow up:

Follow up	Radio graph	**Movements**						**Functional** score	**Remarks**
		PF	DF	RD	UD	S	P		
1ST Month									
6th Month									
1 year									

6. Radiological follow-up:

* Radial shortening
* Dorsal angulation
* Radial inclination
* Ulnar variance

7. Assessment of results:

MODIFIED MAYO WRIST SCORE

I. PAIN

No Pain	-25
Mild Occasional Pain	-20
Moderate, Tolerable Pain	-15
Severe to intolerable Pain	-0

II. ACTIVITY

Returned to Regular Activities	-25
Regular Activities with Some Restrictions	-20
Low Demand Activities	-15
Unable to work / play /engage in sports	-0

III. RANGE OF MOTION (Supination + Pronation)

$>145^0$	-25
130^0-144^0	- 20
110^0-129^0	-15
80^0-109^0	-10
40^0-79^0	- 5
0^0-39^0	- 0

IV GRIP STRENGTH (Percentage of Normal)

90-100%	-25
75-89%	-15
50-74%	-10
25-49%	-5
0-24%	-0

FINAL RATING (From Total Point Scored)

Excellent - 90-100 Points
Good - 80-89 Points

Fair - 65-79 Points

Poor - < 65. Points

8. Complications

Consent Form

ANNEXURE - IV

CONSENT FORM

FOR OPERATION/ANAESTHESIA

I ___________________ Hosp. No.____________ in my full senses hereby give my complete consent for ________________ or any other procedure deemed fit which is a diagnostic procedure / biopsy / transfusion / operation to be performed on me / my son / my daughter / my ward __________ aged __________ under any anaesthesia deemed fit. The nature and risks involved in the procedure have been explained to me to my satisfaction. For academic and scientific purpose the operation/procedure may be televised or photographed.

Date: signature/Thumb impression of patient/Guardian

Name:

Designation:

Guardian

Relationship

Full address

ANNEXURE - V

ABBREVIATIONS:

BMD	-	Bone mineral density
BSL	-	Bistyloid line
CRPS	-	Complex regional pain syndrome
DRUJ	-	Distal radioulnar joint
DF	-	Dorsiflexion
LCP	-	Locking compression plate
MRI	-	Magnetic resonance and imaging
ORIF	-	Open reduction internal fixation
OTA	-	Orthopaedic trauma association
P	-	Pronation
PA	-	Palmar angulation
PF	-	Palmar flexion
POP	-	Plaster of paris
PT	-	Palmar tilt
RA	-	Radial angulation
RD	-	Radial deviation
S	-	Supination
TFCC	-	Triangular fibro cartilaginous complex
UD	-	Ulnar deviation
UV	-	Ulnar variance

Master Chart

ANNEXURE – VI

MASTER CHART

Case No	Name	Age (yrs)	Side	Mode of Injury	Fracture type Gartland /AO	Associated Injuries	Surgical waiting period (days)	Surgical procedure	Duration Of Follow up months	Radiological Findings			Deformity	Range of motion						Compli cations	Modified Mayo score	Results
										Radial Length (mm)	Palmar tilt (^{O})	Articular step-off (mm)		PF	DF	RD	UD	S	P			
1	Parvathy	52	L	Fall	III/C1	# distal left Ulna	8	ORIF+LCP	24	9	8	0	-	80	85	20	30	80	90	-	90	Excellant
2	Ruckmani	47	L	Fall	I/A2	-	12	ORIF+LCP	24	9	8	0	-	75	80	20	25	85	80	-	95	Excellant
3	Deivathal	75	L	Fall	I/A2	# distal left Ulna	4	ORIF+LCP	24	9	7	0	-	75	85	20	25	85	90	-	90	Excellant
4	chinnakutty	75	R	RTA	II/B2	#Both bone right leg	5	ORIF+LCP	12	10	8	0	-	65	70	20	20	75	75	-	85	Good
5	Janaki	56	R	Fall	I/A2		2	ORIF+LCP	18	10	9	0	-	75	80	15	20	70	75	-	90	Excellant
6	Saraswathi	48	R	Fall	I/A2	#distal right ulna	4	ORIF+LCP	12	8	10	0	-	70	60	15	20	70	80	-	80	Good
7	Pongiammal	55	R	Fall	IV/A2	-	13	ORIF+LCP	18	8	9	0	-	60	65	20	25	70	80	-	85	Good
8	sarasammal	65	R	RTA	III/C2	-	8	ORIF+LCP	6	10	-5	3	-	25	45	5	10	40	45	Reduced ROM	70	Fair
9	Ruckmani	65	R	RTA	IV/A2	Head injury	2	ORIF+LCP	12	9	7	0	-	70	75	20	25	80	75	-	95	Excellant
10	Manimegalai	55	L	Fall	I/A3	-	9	ORIF+LCP	12	9	8	0	-	80	85	15	30	90	80	-	80	Good
11	Abirami	50	L	Fall	I/A2	#distal left ulna	4	ORIF+LCP	18	9	5	1	-	70	75	15	25	75	80	-	95	Excellant
12	Pankajavalli	55	R	Fall	I/A2	-	11	ORIF+LCP	12	7	6	1	-	75	80	15	10	65	70	-	85	Good
13	Pachainayaki	55	L	Fall	I/A2	# distal left Ulna	5	ORIF+LCP	10	9	8	0	-	60	65	15	25	75	70	Stich abscess	90	Excellant
14	kuppamal	64	L	RTA	III/B3	#Both bone left leg	14	ORIF+LCP	12	7	6	2	-	50	55	10	10	60	45	CRPS	65	Fair
15	vanathai	52	R	Fall	III/B2	-	9	ORIF+LCP	12	13	10	0	-	70	60	15	20	70	80	-	85	Good