ANATOMICAL AND FUNCTIONAL OUTCOME OF COMMINUTED INTRA-ARTICULAR DISTAL RADIAL FRACTURES TREATED WITH VOLAR BUTTRESS PLATING AND ANTI-IMPACTION KIRSCHNER WIRE THROUGH THE RADIAL STYLOID

K. Kumaran Chettiar¹, Mohammed Rafi², Lakshmi Rajamma³

¹Additional Professor, Department of Orthopaedics, Government Medical College, Manjeri Malappuram Hospital, Kerala, India.

²Senior Resident, Department of Orthopaedics, Government Medical College, Manjeri Malappuram Hospital, Kerala, India.

³Senior Resident, Department of Orthopaedics, Government Medical College, Manjeri Malappuram Hospital, Kerala, India.

ABSTRACT

BACKGROUND

Comminuted Colles' fracture is common after accident and fall from height. Residual deformity after treatment adversely affect wrist motion and hand function.⁽¹⁾ Collapse on metaphysis and radial styloid with secondary osteoarthritis of wrist is common with comminution and displacement.⁽²⁾ An anti-impaction K-wire is passed through radial styloid to medial cortex to prevent collapse along with ORIF with buttress plate.⁽³⁾

MATERIALS AND METHODS

This cohort study was to evaluate the functional and anatomical outcome of ORIF with plate and K-wire of Type-C distal radial fracture of 30 patients with intra-articular comminution AO type C1, C2 and C3 fracture between the aged 30 and 50 years. Polytrauma patients are excluded. All patients underwent ORIF through volar approach with buttress plate and anti-impaction care through radial styloid. After 4 weeks, K-wire was removed, and mobilisation started. Repeat x-ray was taken at 6th, 9th and 12th month. Evaluation is done with demerit point system and Gartland and Werley's with Sarmiento modification.

RESULTS

We have got 73.3% excellent and 20% good result. In 66.7%, dorsal tilt is restored to anatomical palmar tilt and radial shortening is restored in 70.3% patient. Radiological evaluation was restored in 76% patients at final follow-up. On subject evaluation, 73.3% had excellent result and 1 poor result due to early spontaneous removal of K-wire loosening.

CONCLUSION

We have obtained 93% anatomical and 93% functional results. Our observation suggested stabilising distal radius fracture with volar plate and anti-impaction K-wire through radial styloid. It is an effective method to prevent collapse and maintaining reduction till union, even when the fracture is comminuted and helps to prevent secondary osteoarthritis of the wrist.

KEYWORDS

Comminuted Distal Radial Fracture, Anti-Impaction K-Wire.

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BACKGROUND

Approximately, 1/6th of all fractures coming into casualty is fracture distal radius⁽⁴⁾ and are common fractures of the upper extremity, encountered in practice and constitutes 17% of all fractures.⁽⁵⁾ Since first described by Abraham Colles in 1814, most physicians have considered distal radial fractures to be a homogenous group of injuries that can be successful non-operatively and results in favourable outcomes. A Colles' fracture as such defined as the complete fracture within the distal 2 cm metaphysis of the radius with dorsal displacement of the distal fragment in post-menopausal women which is different from other intra-articular fractures.⁽⁶⁾

Collapse of the metaphysis, radial styloid shortening and late-onset osteoarthritis of radiocarpal joint due to intra-articular involvement and radial styloid shortening, as more specifically stated in the reports of Leung and co-authors in their review of 100 cases 93% with intra-articular involvement, 73.6% moderate-to-severe comminution and 81.9% marked or severe displacement.⁽⁷⁾

Most common complication associated with distal radial fracture is malunion⁽¹⁾ and most important way to avoid malunion is to prevent dorsal metaphyseal collapse.⁽⁸⁾ Dorsal plating is the best method to prevent distal metaphyseal collapse. We propose another way to prevent metaphyseal collapse by an anti-impaction K-wire passing from distal radial styloid proximally to the medial cortex proximal to the fracture.

To find the anatomical and functional results of anti-impaction Kirschner wire fixation along with volar buttress plating in young adults with intra-articular comminution treated in the Department of Orthopaedics, Medical College Hospital, Kozhikode. The anatomical evaluation by Sarmiento's modification of Lindstrom's criteria and clinical and functional evaluation by Demerit point system of Gartland and Werley with Sarmiento et al modifications.

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Corresponding Author:

Dr. K. Kumaran Chettiar,

Panchami, CC-8/776,

Pipeline Road, Malaparamba,

Kozhikode-673009,

Kerala, India.

E-mail: drchettiar@rediffmail.com

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MATERIALS AND METHODS**Study Design**

Cohort study.

Inclusion Criteria

Intra-articular comminuted distal radial fractures (AO Type C1, C2 and C3 fractures).

Exclusion Criteria

- Patients with ipsilateral forearm or arm injuries.
- Patients with associated carpal bone injuries.
- Patients with pathological fractures.
- Patients with open fractures.

Methods

After receiving Institutional Research Committee approval and written informed consent, the patients are taken up for surgery within the first week once the local oedema and other inflammatory signs subsided. Immediately after admission, the patients are given short arm slab and elevation to reduce oedema. Pre-operative antibiotics (1 gram Reflin) given 1 hour prior to surgery and continued for next 48 hours, a total of six doses will be given. All the surgical procedures are done under axillary block.

Surgical approach- volar Henry's approach- exposing distal articular surface of the radius. Fracture fragments are reduced and fixed with volar buttress plate and anti-impaction K-wire is passed through radial styloid to the medial cortex of the distal radius proximal to the fracture site and its tip will be kept outside. The wound closed in layers and short arm slab given. On tenth postop day, wound inspection and suture removal will be done. Immobilisation will be continued for 3 weeks and anti-impaction K-wire removed at three weeks.

Patients will be followed on third, sixth and twelfth month. Results are assessed using Sarmiento's modification of Lindstrom criteria for anatomical evaluation and demerit point system of Gartland and Werley's with Sarmiento's modification and comparing our results among pre-operative and post-operative cases.

Radiological Assessment

Radiological assessment was done in terms of residual dorsal angulation, radial shortening and loss of radial inclination and the results were graded according to the Sarmiento's modification of Lindstrom criteria.⁽⁹⁾ These parameters were assessed during the follow-up of the patients to assess the quality of reduction and the ability of the technique to maintain the reduction.

Anatomical Evaluation- Sarmiento's Modification of Lindstrom Criteria

	Deformity	Residual Dorsal Tilt	Radial Shortening	Loss of Radial Inclination
Excellent	No or Insignificant	0°	<3 mm	<5°
Good	Slight	1° to 10°	3 to 6 mm	5° to 9°
Fair	Moderate	11° to 14°	7 to 11 mm	10° to 14°
Poor	Severe	At least 15°	At least 12 mm	>14°

Clinical and Functional Assessment

Functional evaluation of the patients was done at the last follow-up according to the demerit point system of Gartland and Werley with Sarmiento et al's modification.

Demerit Point System used to Evaluate End Results of Healed Colles' Fracture

Result	Points
RESIDUAL DEFORMITY	
Prominent ulnar styloid	1
Residual dorsal tilt	2
Radial deviation of the hand	2 to 3
SUBJECTIVE EVALUATION	
Excellent: No pain, disability or limitation of motion	0
Good: Occasional pain, slight limitation of motion, no disability	2
Fair: Occasional pain, some limitation of motion, feeling of weakness in wrist, no particular disability, activities slightly restricted	4
Poor: Pain, limitation of motion, disability, activities more or less markedly restricted	6
OBJECTIVE EVALUATION	
Loss of dorsiflexion	5
Loss of ulnar deviation	3
Loss of supination	2
Loss of palmar flexion	1
Loss of radial deviation	1
Loss of circumduction	1
Loss of pronation	1
Pain in DRUJ	2
Grip strength- 60% or less of opposite side	1
COMPLICATIONS	
Arthritic change	1
Minimum	
Minimum with pain	1

Moderate	3
Moderate with pain	2
Severe	4
Severe with pain	3
Nerve complications (median)	5
Poor finger function due to cast	1 to 3
	1 to 2
END RESULT POINT RANGES	
Excellent	0 to 2
Good	3 to 8
Fair	9 to 20
Poor	21 and above

The objective evaluation is based on the following ranges of motion as being the minimum for normal function: dorsiflexion 45 degrees; palmar flexion 30 degrees; radial deviation 15 degrees; ulnar deviation 15 degrees; pronation 50 degrees; supination 50 degrees.

Statistical Methods- Qualitative variables were summarised as frequency and percentages. Scores were summarised as mean and standard deviation. Wilcoxon Signed Rank Test was used to compare the statistical significance of pre-intervention to post-intervention change in scores. A 'p' value of < 0.05 was considered as statistically significant.

RESULTS

The study comprised a total of thirty patients of fractures of the distal radius presenting to Government Medical College Hospital, Calicut during July 2010 to July 2012.

	Frequency	Percent
Valid fall	28	93.3
RTA	2	6.7
Total	30	100
Mode of Injury		

The mode of injury was fall in 28 cases, road traffic accident in 2 cases.

		Number	Percent
Valid	C1	7	23.3
	C2	5	50
	C3	8	26.7
	Total	30	100
Type of Fracture			

7 fractures were classified as AO type C1, 15 fractures as AO type C and 8 fractures as AO type C3.

	Frequency	Percent
Valid same day	15	50
Within one week	13	43.3
>1 week	2	6.7
Total	30	100
Time of Fixation		

Most of the cases operated on the same day or next day of attending the emergency dept.

Out of the 30 cases, 15 cases (50%) were operated within a week of injury and 13 cases between 8 to 14 days. The delay if any was on the part of the patients presenting late.

Post-Operative Infection

No patients had post-operative wound infection

Anatomical Evaluation

Residual Dorsal Tilt

Dorsal tilt (from a neutral of zero degrees) of the distal radial articular surface varied from 5° to 25°. Post-operatively, the dorsal tilt could be corrected to the anatomical palmar tilt or at least a neutral angle in 20 patients (66.7%). While in 10 patients (33.3%), the dorsal tilt could not be restored even to a neutral angle.

At the final follow-up, 22 patients (73.3%) had excellent results. In 8 patients, (6.4%) of the patients had good result.

	Frequency	Percent
Valid Excellent	22	73.3
Good	6	20.0
Fair	1	3.3
Poor	1	3.3
Total	30	100
RDT		

	RDT Excellent Fair Poor	Total
(RDT) poor count	22 6 1 1	30
% within RDT	73.3 20.0 3.3 3.3	100.0%
Total count	22 6 1 1	30
% within RDT	73.3 20.0 3.3 3.3	100.0%
Cross Tab		

	FU1 (RDT)- RDT	FU2 (RDT)- RDT	RDT-(RDT)
Z	-4.983	-4.983	-4.973
Asymp. Sig. (2 tailed)	.000	.000	.000
Test Statistics*			

*Wilcoxon Signed Rank Test

Radial Shortening

	Frequency	Percent
Valid Excellent	23	76.7
Good	6	20.0
Poor	1	3.3
Total	30	100
(RS)		

	RS Excellent Good Poor	Total
Fair count	3 1 0	4
% within (RS)	75 25	100.0%
(RS) poor count	20 5 1	26
% within (RS)	76.9 19.2 3.8	100
Total count	23 6 1	30
% within (RS)	76.7 20.0 3.3	100.0%
Cross Tab		

	FU1 (RS)- RS	FU2(RS)- RS	RS-(RS)
Z	-4.928	-4.928	-4.910
Asymp. Sig. (2 tailed)	.000	.000	.000
Test Statistics*			

*Wilcoxon Signed Rank Test

Of 30 patients, 23 patients had excellent < 3 mm outcome.

Radial Angle

	FU2-DEF Excellent Good	Total
(LORI) Good count	1	1
% within (LORI)	100	100.0%
Fair count	1 1	2
% within (LORI)	50 50	100
Poor count	19 8	27
% within (LORI)	70.4 29.6	100
Total count	20 10	30
% within (RS)	66.7 33.3	100.0%
Cross Tab		

	LORI Excellent Good Fair Poor	Total
(LORI) good count	1	1
% within	100	100.0 %
Fair count	2	2
% within	100	100.0 %
Poor count	24 1 1 1	26
% within	88.9 3.7 3.7 3.7	100.0 %
Total count	26 2 1 1	30
%within RDT	86.7 6.7 3.3 3.3	100.0%
Cross Tab		

	FU1 (LORI) FU2 -DEF- (LORI)	FU3(LORI) FU3- DEF- (LORI) RS	LORI- (LORI)
Z	-4.886	-4.886	-5.012
Asymp. Sig. (2 tailed)	.000	.000	.000
Test Statistics*			

*Wilcoxon Signed Rank Test

Clinical and Functional Evaluation

Subjective Evaluation

Subjectively, out of 30 patients 22 patients (73.3%) had excellent, 5 patients (14.6%) had good and 2 patients had fair (6.6%) and 1 patient had poor (3.3%) results.

Subjective Evaluation	Number of Patients
Excellent	22
Good	5
Fair	2
Poor	1
Total	30

One poor result was due to the dislodgment of Kirschner wire following alcoholic withdrawal seizures.

	P and D Excellent Good	Total
(P and D) Excellent count	9 13	22
% within	40.9 59.1	100
Good count	5	5
% within	100	100
Fair count	2	2
% within	100	100
Poor count	1	1
% within	100	100
Total count	9 21	30
% within	30 70	100.0%
Cross Tab		

	FU (P and D)- (P and D)	P and D-(P and D)	P and D-(P and D)
Z	-.849	-2.858	-2.065
Asymp. Sig. (2 tailed)	.396	.004	.039
Test Statistics*			

*Wilcoxon Signed Rank Test

	DF NIL Yes	Total
(DF) yes count	29 1	30
% within (DF)	96.7 3.3	100%
Total count	29 1	30
% within (RS)	96.7 3.3	100.0%
Cross Tab		

	DF-(DF)	DF-(DF)	DF-(DF)
Z	-5.196	-4.000	-5.385
Asymp. Sig. (2 tailed)	.000	.000	.000
Test Statistics*			

*Wilcoxon Signed Rank Test

	PF NIL Yes	Total
(PF) Yes count	28 2	30
% within (PF)	93.3 6.7	100%
Total count	298 2	30
% within (PF)	93.3 6.7	100.0%
Cross Tab		

	PF-(PF)	PF-(PF)	PF-(PF)
Z	-5.292	-5.292	-5.292
Asymp. Sig. (2 tailed)	.000	.000	.000
Test Statistics*			

*Wilcoxon Signed Rank Test

	RD NIL Yes	Total
(RD) Yes count	29 1	30
% within (RD)	96.7 3.3	100%
Total count	29 1	30
% within (RD)	96.7 3.3	100.0%
Cross Tab		

	RD-(RD)	RD-(RD)	RD-(RD)
Z	-5.385	-5.385	-5.385
Asymp. Sig. (2 tailed)	.000	.000	.000
Test Statistics*			

*Wilcoxon Signed Rank Test

	UD NIL Yes	Total
(UD) Yes count	29 1	30
% within (UD)	96.7 3.3	100%
Total count	29 1	30
% within (UD)	96.7 3.3	100.0%
Cross Tab		

	UD-(UD)	UD-(UD)	UD-(UD)
Z	-5.385	-5.385	-5.385
Asymp. Sig. (2 tailed)	.000	.000	.000
Test Statistics*			

*Wilcoxon Signed Rank Test

	PR NIL Yes	Total
(PR) Yes count	29 1	30
% within (PR)	96.7 3.3	100%
Total count	29 1	30
% within (PR)	96.7 3.3	100.0%
Cross Tab		

	PR-(PR)	PR-(PR)	PR-(PR)
Z	-5.385	-5.385	-5.385
Asymp. Sig. (2 tailed)	.000	.000	.000
Test Statistics*			

*Wilcoxon Signed Rank Test

	SU NIL Yes	Total
(SU) Yes count	29 1	30
% within (SU)	96.7 3.3	100%
Total count	29 1	30
% within (SU)	96.7 3.3	100.0%
Cross Tab		

	SU-(SU)	SU-(SU)	SU-(SU)
Z	-5.385	-5.385	-5.385
Asymp. Sig. (2 tailed)	.000	.000	.000
Test Statistics*			

*Wilcoxon Signed Rank Test

Objective Evaluation

Loss of dorsiflexion (< 45 degrees)	1
Loss of palmar flexion (< 30 degrees)	2
Loss of ulnar deviation (< 15 degrees)	1
Loss of radial deviation (< 15 degrees)	1
Loss of supination (< 50 degrees)	1

RESULTS

Anatomical Score of Healed Fracture

The scoring was done according to the Sarmiento's modification of Lindstrom's criteria.

Anatomically, 23 patients (76.6%) had excellent restoration of anatomy. 5 patients (16.6%) had good restoration and 1 had fair (3.3%) and 1 had poor (3.3%) restoration of anatomy. Thus, 93.3% patients had excellent-to-good alignment of fragments and good reduction could not be achieved in 6.7% patients resulting in fair or poor results.

Functional End Results of Healed Fracture

The scoring of healed fracture was done according to the demerit point system of Gartland and Werley with Sarmiento et al's modification. Functionally, 26 patients (86.6%) had excellent, 2 good (6.6%), 1 patient had fair (3.3%) and 1 had poor (3.3%) restoration of functions. Poor function correlated with residual displacement and poor patient compliance.

DISCUSSION

There are various treatments for comminuted distal radius fractures.⁽¹⁰⁾ One of them is open reduction and internal fixation with buttress plating.⁽⁷⁾ Surgical treatment plating ensures more consistent correction of displacement and maintenance of reduction of fragments.^(11,2) The technique of fixation depends on fracture displacement, joint involvement, patient's age, bone quality, surgeon's experience, etc.

In 1908, Lambotte suggested single pin placement through radial styloid as a mean of stabilising the distal radius fracture.⁽¹⁾ Raymond et al suggested placement of volar plate is important in the fixation of fragments.⁽¹²⁾ Rate of complication in volar fixation varies between 8% and 30% including infection, wire breakage, prominent implant, tendon rupture, etc.^(13,2) Combined volar and dorsal plate fixation has been suggested by many including Can U et al (2008), but with high rate of complication like complex regional pain syndrome.

In the final evaluation of our study, out of 30 patients 23 had excellent results and 5 had good results and one had fair result. Final one result was due to displacement of K-wire from the withdrawal seizure. We had more excellent functional results (86%) than anatomical results (76.6%). And the poor results were due to poor patient compliance. Our results suggest that the radial styloid collapse and malunion of distal radius can be prevented by anti-impaction K-wire through radial styloid. The disadvantage of our study is that for intra-articular fracture late changes like arthritis is not included.

CONCLUSION

From this study, we have obtained 93% anatomical and 93% functional, excellent-to-good results. Our observations suggest that stabilising distal radial fractures using volar plate fixation and anti-impaction K-wire fixation through radial styloid is an effective method to prevent distal metaphyseal collapse and maintaining the reduction till union, even when the fracture is grossly comminuted/ intra-articular and unstable.

The advantage of our study is that it is a simple method, which is cost effective. Disadvantages include patient has to be immobilised with short-arm slab for a period of four weeks. Since we are keeping the tip of K-wires outside, there are chances of infection and dislodgement of K-wire since the follow-up period is one year and later complications such as arthritis are not studied. This is the limitation of this study.

The technique emphasises that open reduction and internal fixation with volar plating and anti-impaction K-wire through radial styloid has excellent functional outcome with minimal complications. Thus, proving that it is an effective modality of treatment for AO types C1, C2 and C3 fractures of distal radius in patient's age group between 30 and 50 with good bone stock as well as early osteoporotic patients.

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