DOI: http://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20171495

Original Research Article

Surgical management of fractures of distal end radius using uniplanar external fixator augmented with percutaneous kirschner wire fixation

H. B. Shivakumar, T. S. Channappa*, Sushma C., Manju Jayaram

Department of Orthopaedics, Kempegowda Institute of Medical Science and Research Centre, Bengaluru, India

Received: 21 March 2017
Revised: 29 March 2017
Accepted: 30 March 2017

***Correspondence:**
Dr. T.S. Channappa,
E-mail: drchannappa@yahoo.co.in

ABSTRACT

Background: Distal end radius fractures is one of the most common fractures of the upper limb especially in the elderly population, accounting for about 17% of all upper limb fractures. Surgical stabilization of these fractures remains a challenge even today. Although the recent trend is towards internal fixation with locking plates, the external fixator itself has its own advantages in the treatment of these fractures.
Methods: This study is a prospective, time bound, hospital based study conducted in Kempegowda Institute of Medical Sciences and Research Center, Bangalore, between November 2014 to April 2016. The study included 30 cases of distal end radius fractures that were operated with the closed reduction and uniplanar external fixator augmented with k-wire for distal end radius by the principle of ligamentotaxis.
Results: In our study, 14 (46.6 %) patients had excellent results. Whereas, 11 (36.7%) patients had good results and 3 (10%) had fair and only 2 (6.7%) patients had poor results. Most of the fractures united by 12 weeks. Complications associated with the study was stiffness, malunion, sudeck's osteodystrophy and pin tract infection.
Conclusions: The uniplanar external fixator augmented with k-wire is a good choice in the treatment of distal end radius fractures in terms of providing a good functional outcome if proper preoperative planning, good reduction and surgical technique are followed, leading to high rate of bone union, minimal soft tissue damage and complications.

Keywords: Distal end radius, Uniplanar external fixator, Modified Green O'Brien score

INTRODUCTION

Distal end radius fractures are the most common fractures of the upper extremity encountered in practice, and constitute 17% of all fractures and 75% of all forearm fractures.[1]

There is an increase in the incidence of distal end radius fractures and its complications in the general population due to the increase in the lifespan of the population, in whom osteoporosis is frequently encountered.[2]

The complex anatomy of the wrist contributes to an equally complex variety of traumatic injuries, many of which permanently compromise the wrist function.

These fractures have a bimodal distribution characterized by two groups.[4,5]

1) Mostly female patients in their 5th and 6th decade of life who sustained fractures in low energy falls (osteoporosis-related fractures), and

2) Younger, mostly male patients who are injured in high-energy trauma such as motor vehicle collisions or fall from height.[6]

Close reduction and cast immobilization has been the mainstay of treatment of these fractures but malunion and subluxation / dislocation of distal radioulnar joint resulting in poor functional and cosmetic results is the usual outcome.[7] The residual deformity of wrist adversely affects wrist motion and hand function. It may cause pain, limitation of forearm motion, and decreased grip strength as a result of arthritis of the radiocarpal and distal radioulnar joints.[8]

In this study, we study the functional outcome of surgical management of distal end of radius treated with uniplanar external fixator, augmented with percutaneous K- wire based on the principle of ligamentotaxis.

Objective of the study

- To study the advantages and disadvantages associated with external fixator application.
- To study the functional outcome following the use of external fixator.

METHODS

Source of data

This study was a prospective, time bound, hospital based study conducted in Kempegowda Institute of Medical Sciences and Research Centre, Bangalore, between November 2014 to April 2016.

Sampling procedure

Study design: Prospective study

Sample design: Purposive sampling

Study place: KIMSH & RH

Sample size: 3O cases

Inclusion criteria

Age group of 20-70 years, fresh fractures <1week, compound fractures, communited fractures, unstable extra articular distal radius fracture, two part or selective three part intra-articular fractures without displacement of intermediate fragment.

Exclusion criteria

Barton's fracture, ipsilateral upper limb fractures, fracture of distal end radius with associated neurovascular injury, severe metaphyseal communition, disrupted volar carpal ligaments/radiocarpal dislocations, ipsilateral fracture shaft of 2nd and 3rd metacarpal.

Preoperative evaluation

Patients meeting inclusion and exclusion criteria are selected for the study after obtaining written and informed consent.

Clinical assessment

Detail history of the patient was taken. Below elbow slab was applied to alleviate pain. X-RAY: AP & LAT Views were taken to assess the fracture pattern. The patients were worked up for surgery. All patients were started on IV antibiotics prophylactically.

Operative procedure

All fractures were treated using closed reduction and external fixator application augmented with percutaneous k wire application.

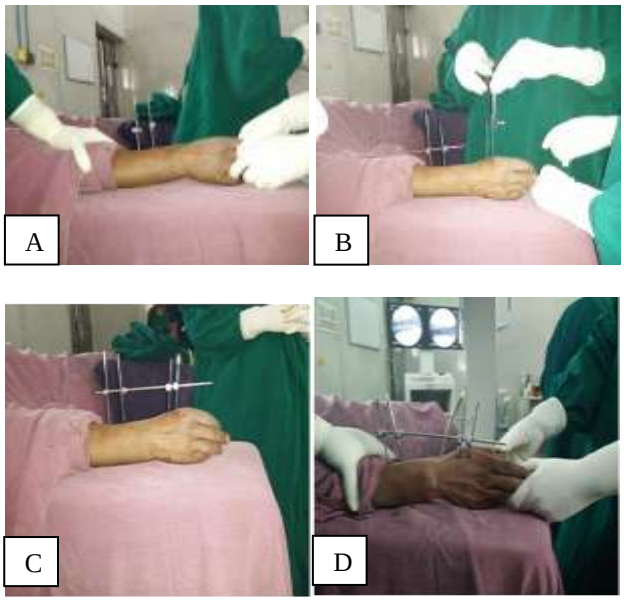

Figure 1: Operative procedure.
A=Insertion of radial schanz pin, B=Insertion of metacarpal schanz pin, C=External Fixator after Reduction, D=Insertion of K-Wire.

Postoperative period

IV Antibiotics were continued at 12 hourly intervals for 2 days, and switched over to oral till the 5th day post-operatively. Post-operative radiograph was taken the next day after surgery. Finger, elbow and shoulder movements were begun on the second day after surgery. Patients were assessed by using the modified Green O'Brien score at the follow- ups.

Follow up

Assessment was made at each follow up visit at 6th, 12th, and 24th week. Patient was assessed at each visit for the clinical outcome using modified Green O'Brien score.

Statistical methods

This is a hospital based prospective study. Data collected was Tabulated in Microsoft excel and analyzed using SSPS 16.0. Microsoft word was used to generate graphs/charts and tables.

Extended Mantel-Haenszel Chi square for linear trend was evaluated to assess the improvement based on modified Green Obrien score and P- value was determined.

Table 1: Modified Green O'brien score for functional outcome.

Category	Score	Description
Pain	25	None
	20	Mild
	15	Moderate
	0	Severe
Functional Status	25	Same Job
	20	Restricted Employment
	15	Able To Work
	0	Unable To Work
Palmarflexion-Dorsiflexion Arc	25	>Or 1200
	15	91-1190
	10	61-900
	5	31-600
	0	30^0 Or <
	0	300 Or <
Grip Strength	25	100
	15	75-99
	10	50-74
	5	25-49
	0	0-24
	0	0-24

Final Results: Excellent – 90-100, Good – 80-89, Fair – 65-79, Poor - <65.

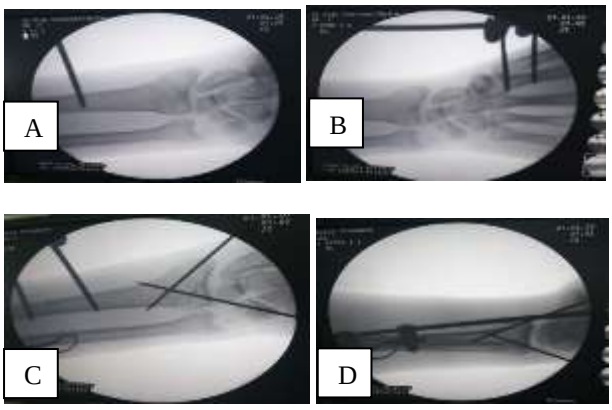

Figure 2: Fluroscopy pictures.
A=Pre reduction- insertion of radial schanz pin, B=Insertion of metacarpal shanz pin, C, D=Post reduction fluoroscopy image with k-wire in situ.

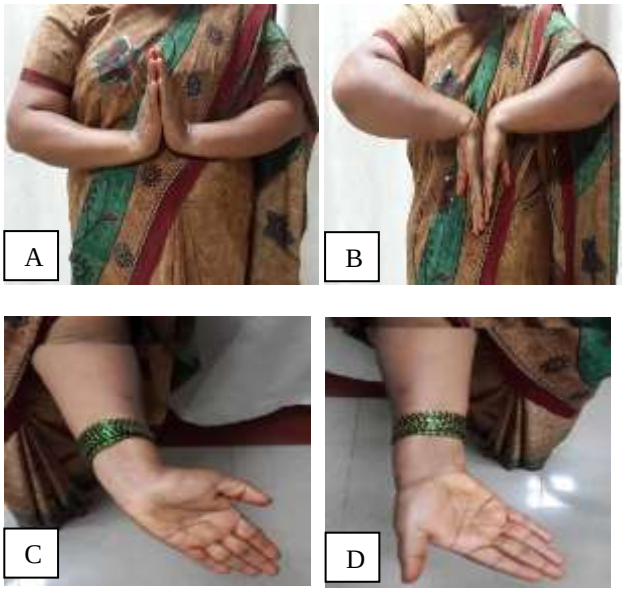

Figure 3: Clinical picture of case-1.
A=Dorsiflexion, B=Palmarflexion, C=Radial Deviation, D=Ulnar Deviation.

Figure 4: X-ray picture of case-1.
A=Pre Op X Ray, B=Immediate Post Op X Ray, C=6 Weeks Follow Up, D= 24 Weeks Follow Up.

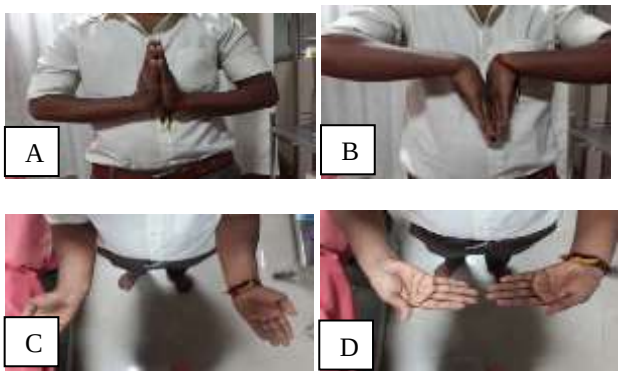

Figure 5: Clinical picture of case-2.
A=Dorsiflexion, B=Palmarflexion, C=Radial Deviation, D=Ulnar Deviation.

Figure 6: X-ray report of case-2.
A=Pre Op X Ray, B=Immediate Post Op, C= 6 Weeks Follow up, D=24 Weeks Follow up.

Figure 7: Complication (stiffness).
A=Dorsiflexion, B=Palmar flexion, C=Radial deviation, D=Ulnar deviation.

RESULT

Age

In our study, the mean age of patients was 40.1 years, with the youngest being 21 years and the oldest being 68 years.

Table 1: Age distribution.

	Mean	Std dev	Min	Max
Age (years)	40.1	14.1	21	68

Sex distribution

In our study, 20 were males, while 10 were females.

Table 2: Sex distribution.

Sex	No. of patients	Percentage
Female	**10**	**33.3%**
Male	**20**	**66.7%**
Total	**30**	**100%**

Side affected

In our study, right side was affected in 14 cases, while left side was affected in 16 cases.

Table 3: Side affected.

Side affected	No. of patients	Percentage
Left	**16**	**53.3%**
Right	**14**	**46.7%**
Total	**30**	**100%**

Mode of injury

In our study, 18 injuries were caused by high velocity injury (road traffic accident), while rest 12 were due to self-fall.

Table 4: Mode of injury.

Mode of injury	No. of patients	Percentage
Road traffic accident	18	60%
Self fall	12	40%
Total	30	100%

Type of fracture

In our study, 20 were simple fractures and 10 were compound fractures. Out of which, compound type 1 was 5 cases, type 2 was 3 cases and type 3a was 2 cases. There were no type 3b and 3c compound fractures.

Table 5: Type of fracture.

Type of injury	No. of patients	Percentage
Simple	20	66.7 %
Compound	10	33.3%
Compound type 1	5	16.6%
Compound type 2	3	10%
Compound type 3a	2	6.7%
Total	30	100%

Associated co-morbidities

In our study, 50% (n= 15) patients had other associated medical co-morbidities. Hypertension and diabetes mellitus predominated in co-morbidities. 26.6% (n=4)

had hypertension while 26.6% (n=4) patients had diabetes mellitus type 2. 20% (n=3) patients had both hypertension and diabetes. 13.3% (n=2) had COPD. 6.6%% (n=1) patients had ischemic heart disease. 6.6%% (n=1) patients had htn and ischemic heart disease.

Table 6: Associated comorbidities.

Comorbidities	No. of patients	Percentage
None	15	50%
Hypertension	4	26.66%
Diabetes mellitus	4	26.66%
HTN + DM	3	20%
COPD	2	13.33%
Ischemic heart	1	6.6%
HTN + IHD	1	6.6%
TOTAL	30	100%

Duration of hospital stay

Mean duration of hospital stay was 7.57 days with minimum duration being 3 days and maximum being 19 days.

Table 7: Duration of hospital stay.

	OBS	MEAN	MIN	MAX
Duration of hospital stay	30	7.57	3	19

Type of fracture pattern (Frykmann classification)

In our study, type i was 1 cases , type ii was 2 cases, type iii was 2 , type iv was 1 case, type v was 2 cases, type vi was 12 cases, type vii was 2 cases, and type viii was 8 cases.

Table 8: Type of fracture pattern- frykmann classification.

Frykmann Classification	Frequency	Percentage
Type i	1	3.3%
Type ii	2	6.7%
Type iii	2	6.66%
Type iv	1	3.33%
Type v	2	6.66%
Type vi	12	40%
Type vii	2	6.7%
Type viii	8	26.7%
Total	30	100.00%

Type of anaesthesia

In our study, 17 of the patients were given general anaesthesia while 13 were given supraclavicular block.

Duration of surgery

In our study, the mean duration of surgery was 29 minutes with a standard deviation of 9.50 minutes.

Table 9: Type of anaesthesia.

	Number	Percentage%
General anaesthesia	17	56.7
Supraclavicular block	13	43.3
Total	30	100

Estimated blood loss

The mean blood loss volume was 10.66 ml with a standard deviation of 3.88 ml. with the maximum being 20ml.

Intra-operative complications

There were no intra-operative complications

Time for union

In our study, the mean time for union was 14 weeks with a standard deviation of 2.87 weeks with most fractures uniting by 12th week and the longest being 18th week.

Table 10: Time taken for union.

No. of weeks	Frequency	Percentage
0-6 weeks	0	0
7-12 weeks	20	66.66
13-18weeks	10	33.33
19-24 weeks	0	0
>24 weeks	0	0
Total	30	100

Complications

24 patients had no complications. 2 patients had malunion, 2 had stiffness, 1 had pin tract infection and 1 patient had Sudeck's osteodystrophy.

Table 11: Complications.

Complications	Number	%
None	24	80
Malunion	2	7
Stiffness	2	7
Pin tract infection	1	3
Sudeck's osteodystrophy	1	3
Total	30	100

Functional outcome according to Green O'brien score

In our study, 14 patients had excellent results. Whereas 11 had good, 3 had fair and only 2 patients had poor results.

Table 12: Functional outcome according to modified Green O'brien score.

Modified green and O'brien score	24 weeks	
	Number	% percentage
Excellent	14	46
Good	11	37
Fair	3	10
Poor	2	7
Total	30	100

Improvement in modified Green O'brien score

All patients had poor results at the end of 6 weeks. Most of the patients improved to better scores at the end of 24 weeks. Only 2 patients had poor results even at the end of 24 weeks.

Table 13: Modified Green O'brien score at 6, 18 and 24 weeks among the study participants (n=30).

Modified green and O'brien	6 weeks		18 weeks		24 weeks	
	No	%	No	%	No.	%
Excellent	0	0	9	30.0	14	46.8
Good	0	0	6	20.0	11	36.6
Fair	0	0	12	40.0	3	10
Poor	30	100	3	10.0	2	6.6
Total	30	100	30	100	30	100

DISCUSSION

Over the past 30 years, the surgical treatment of distal radius fracture has shifted from cast immobilization to numerous surgical options such as the use of external fixation and locking plates. There are obvious benefits and disadvantages of these two surgical techniques, but there is insufficient evidence regarding which procedure has the best outcome

Distal radius is important in the kinematics of radiocarpal and radioulnar joints and that is why a good reduction is the "conditio sine qua non" for a good clinical outcome. Reconstruction of the articular congruity and a stable fixation allow early functional rehabilitation and reduce post-traumatic osteoarthritis which is a debilitating condition.

Hence, it is important to achieve a good anatomical reduction and a high rate of union which can be brought about by the use of external fixators.

Age distribution

In our study, the mean age of patients was 40.1 years which is comparable with the studies of Deepak et al, Pieterse et al, D'anca et al and Yalavarthi et al.[10-13]

Table 14: Comparison of age distribution.

Study	Sample size	Mean age (years)
Present study	30	40.1
Deepak C D (2014)[10]	20	35.2
D'Anca (1984)[11]	87	55
Pieterse (1991)[12]	132	35.3
Yalavarthi(2015)[13]	33	31.5

Sex distribution

In our study there was a male predominance with 66.7 % which was also same in the studies done by Steffen et al, Riccardi et al, Pieterse et al, Deepak et al.[10,12-15]

Table 15: Comparison of sex distribution.

Study	Sampl	Percentage	Percentage of
Present	30	66.7%	33.3%(n=10)
Steffen (1994)[14]	55	69%(n=37)	31%(n=18)
Pieterse (1991)[12]	132	67%(n=71)	33%(n=44)
Riccardi (1984)[15]	48	60%(n=29)	40%(n=19)
Deepak C D (2014)[10]	20	90%(n=18)	10%(n=2)

Side affected

Our results were similar to findings in other studies like Pieterse et al, D'anca et al, Chung Ma et al and Barbu et al where Right side was commonly affected.[11,12,16,17]

The most common mechanism of injury of distal end radius fractures is a fall on the outstretched hand. Hence, the dominant hand is more involved as the person tries to protect themselves from the injury.

Table 16: Comparison of side affected.

Study	Sample size	Right (%)	Left (%)
Present series	30	53.3 %	46.7%
Pieterse (1991)[12]	132	62%	38%
D'Anca (1984)[11]	87	82%	18%
Barbu (2007)[16]	36	58%	42%
Chung Ma (2016)[17]	123	44.8%	55.2%

Mode of injury

Fractures of distal end of radius have a bimodal distribution, where, elderly female patients sustain an injury due to self-fall and the younger male patient sustains fractures due to road traffic accident.

Table 17: Comparison of mode of injury.

Study	Sample size	Percentage of cases RTA	Percentage of cases Self fall
Present study	40	60%	40%
Barbu (2007)[16]	36	24%	76%
Clyburn (1987)[20]	29	75.8%	24.2%
Deepak CD(2014)[10]	20	60%	40%

In our study Road traffic accident was the most common cause of injury (60%) which was comparable with the studies of Deepak CD, Clyburn where as in the study done by Barbu, Self fall was the commonest cause (76%).[10,16,20]

Type of fracture pattern (frykmann classification)[19]

Type of fracture pattern was similar to other similar studies showing an increased incidence in type V to type VIII fracture.[11,14,16]

Table 18: Comparison of the type of fracture pattern.

Study	Type I and II (%)	Type III and IV (%)	Type V and VI (%)	Type VII and VIII (%)
Present series	10%	10%	46.6%	33.4%
Steffen (1994)[14]	14%	19%	11%	56%
D'Anca (1984)[11]	0%	9%	18%	73%
Barbu (2007)[16]	0%	10%	15%	75%

Removal of external fixator

In our study, the external fixator and k-wires were removed at 6 weeks post-operative period in accordance with other similar studies of Barbu, D'Anca and Chung Ma.[11,16,17]

Increased incidence of stiffness and sudeck's osteodystrophy has been seen in patients whom the external fixator was removed after 3 months.

Increased incidence of loss of radial height and volar tilt has been documented in patients in whom external fixator was removed at an earlier date i.e. before 6-8 weeks.

Table 19: Comparison of removal of external fixator.

Study	Removal of ex-fix
Present series	6 weeks
Barbu (2007)[16]	4-6 weeks
D'Anca (1984)[11]	6 weeks
Chuang Ma (2016)[17]	6weeks
Pieterse (1991)[12]	8 weeks

Table 20: Time taken for union

No. of weeks	Frequency	Percentage
0-6 weeks	0	0
7-12 weeks	20	66.66
13-18 weeks	10	33.33
19-24 weeks	0	0
>24 weeks	0	0
Total	30	100

Table 21: Comparison of functional outcome.

Study	Sample size	Excellent +good (%)	Fair + poor (%)
Present series	30	83.4%	16.6%
D'Anca (1984)[11]	87	94%	6%
Cooney (1979)[20]	60	87%	13%
Steffen (1994)[14]	55	75%	25%
Pietersen (1991)[12]	115	83	17

Time for union

In our study, the Mean time for union was 14 weeks with a standard deviation of 2.87 weeks with most fractures uniting by 12th week and the longest being 18th week.

The functional outcome in our study showed excellet+good results in 83.4% which was comparable with the studies done by cooney, steffen and others.[11,12,14,20]

CONCLUSION

Distal end radius fractures are a very common entity encountered by orthopaedicians worldwide in the emergency department. Although these fractures have been studied extensively for over 200 years now, there is still no treatment free of complications.

Even though the recent trend is towards open reduction and internal fixation, the external fixator itself has its own advantages and indications for surgery.

In our study, 83.4% (n= 25) patients had good to excellent results according to the Green O'Brien score.

Hence, we like to conclude that the fractures of the distal end radius can be managed with the uniplanar external fixator augmented with k-wires, if proper preoperative planning, good reduction and surgical technique are followed, leading to high rate of bone union, minimal soft tissue damage and complications.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the institutional ethics committee

REFERENCES

1. Colles A. On the fracture of the carpal extremity of the radius. Edinburgh Med Surg. 1814;10:182–6.
2. US Department of Commerce EaSA, Bureau of the Census. Bureau of the Census: Statistical abstract of the United States. 1995.
3. Melton L. Epidemilogy of fractures. In: Riggs BL ML, editor. Osteoporosis: etiology, diagnosis, and management. New York: Raven Press; 1988: 133-154.
4. Solgaard S, Petersen VS. Epidemiology of distal radius fractures. Acta Orthop Scand. 1985;56:391-3.
5. Larsen CF, Lauritsen J. Epidemiology of acute wrist trauma. Int J Epidemiol. 1993;22:911-6.
6. Bacorn RW, Kurtzke JF. Colles' fracture; a study of two thousand cases from the New York States Compensation. J Bone Joint Surg Am. 1953;35(3):643-58.
7. Fernandez DL: Correction of post traumatic wrist deformity in adults by osteotomy, bone grafting and internal fixation. J Bone Joint Surg. 1982;64:1164-78.
8. Zemel NP. The prevention and treatment of complications from fractures of the distal radius and ulna. Hand Clin. 1987;3:1-11.
9. DePalma AF. Comminuted Fractures of the Distal End of the Radius Treated by Ulnar Pinning. J. Bone and Joint Surg. 1952;34:651-62.
10. Deepak CD, Gopalakrishna G, Ravoof A, Vijay C, Mohan JA. Surgical management of distal end radius fractures by ligamentotaxis. Int J Health Sci Res. 2014;4(4):106-10.
11. D'Anca AF, Sternlieb SB, Byron TW, Feinstein PA. External fixator management of unstable Colles' fractures: an alternative method. Orthopedics. 1984;7:853-9.
12. Jakim I, Pieterse HS. External fixator for intra articular fracture of the distal radius. J Bone Joint Surg. 1991;73-B:302-6
13. Yalavarthi RK. Outcome of management of distal radius fractures by ligamentotaxis. IOSR. 2015;14(7):33-7.
14. Steffen TH, Eugster T, Jakob RP. Twelve years follow-up of fractures of the distal radius treated with the AO external fixator. Injury. 1994;25:44-54.
15. Ricciardi L. The external fixation treatment of distal articular fractures of the radius. Orthopedics. 1984;7(4):637-41.
16. Barbu D, Popescu GH, Putineanu D. The value of external fixator in distal radius fracture. Am J Clin Med. 2007;2(3):207-13.
17. Ma C, Deng Q, Pu H, Cheng X, Kan Y, Yang J, et al. External fixation is more suitable for intra articular fractures of the distal radius in elderly patients. Bone Res. 2016;4:1601-7.
18. Clyburn TA. Dynamic External Fixation for Comminuted Intra-Articular Fractures of the Distal End of the Radius. J Bone and Joint Surg. 1987;69:248-54.
19. Frykman GK. Fracture of the distal radius including sequelae shoulder hand finger syndrome. Disturbance in the distal radioulnar joint and impairment of nerve function. A clinical and experimental study. Acta Orthop Scand Suppl. 1967;108:1–155.
20. Cooney WP, Linscheid RL, Dobyns JH. External Pin Fixation for Unstable Colles' Fractures. J Bone Joint Surg. 1979;61:840.

Cite this article as: Shivakumar HB, Channappa TS, Sushma C, Jayaram M. Surgical management of fractures of distal end radius using uniplanar external fixator augmented with percutaneous kirschner wire fixation. Int J Res Orthop 2017;3:354-61.