8
Original Article
DOI:

A STUDY OF OUTCOMES OF DISTAL END RADIUS FRACTURES MANAGED BY EXTERNAL FIXATOR

Authors:
Dr. Nadeem A. Lil [1], Dr. Prashant C. Bhingradiya [2], Dr. Arjav R. Patel [3], Dr. Vipul R. Makwana [3]
[1] Professor And Head Of Unit, [2] Third Year Resident, [3] Assistant Professor,
Department Of Orthopaedics, Smt. NHL Municipal Medical College, Ahmedabad, Gujarat, India.
Corresponding Author: Dr. Nadeem A. Lil E-mail: nadeemlil@yahoo.com

ABSTRACT

BACKGROUND: Fractures of the distal radius continue to be the most common skeletal injuries treated by the orthopedic surgeon. Unstable fractures of the distal part of the radius have shown an inherent tendency towards loss of reduction after non-operative treatment. External skeletal fixation has been popular for the treatment of displaced, unstable fractures of the distal part of the radius because it combines a minimally invasive procedure with reduction by ligamentotaxis.

METHOD: A retrospective study of 70 patients of fracture of distal end radius treated with external fixator came to OPD at tertiary care hospital during the study period of 2 years from July 2020 to June 2022, were included in the study after obtaining permission from institutional review board.

RESULT: All 70 patients were assessed in the form of the functional and radiological outcome based on Subjective evaluation by Modified Demerit Point System of Gartland and Werley (Functional) and Lidstorm and Frykman Criteria modified by Sarmiento (Anatomical). We obtained "excellent" results in 47.15%; "good" in 35.72% cases; "fair" in 14.28% and "poor" in 2.85% cases with a mean G & W score of 6.35.

CONCLUSION: Finding of this study shows that external fixator is an easy, cost effective, reliable and most suitable treatment in treating intraarticular and unstable extraarticular distal end radial fractures by the principle of ligamentotaxis.

KEY WORDS: Distal end radius fracture, External fixator, Ligamentotaxis

INTRODUCTION:

Fractures of the distal radius continue to be the most common skeletal injuries treated by the orthopedic surgeon. In fact, these injuries are the most common fractures of the upper extremity and account for approximately 1/6th (16%) of all fractures seen and treated in emergency rooms [1,2,3]. Current data suggest that distal radius fractures in the elderly may represent an insufficiency fracture associated with all of the risk factors for osteoporosis [4].

In 1814, Abraham Colles, Prof of anatomy and surgery of Trinity college of Dublin clearly defined the fracture and outlined the treatment modality, and devised plaster of paris cast still commonly used called "Colle's cast". In 1977, external fixator method gained popularity among orthopaedicians with Vidal Jacques described original method of treatment of these fractures with ligamentotaxis [5].

Since their description by Colles in 1814, distal radial fractures remain a therapeutic challenge [6]. The method of immobilization that maintains the reduction with the least amount of surgical morbidity is the ideal treatment. Unstable fractures of the distal part of the radius have shown an inherent tendency towards loss of reduction after non-operative treatment. Preservation of the articular congruity is the primary prerequisite for successful recovery [7]. It has been recognized that the ultimate functional result will depend on the anatomical restoration of the fractured radius.

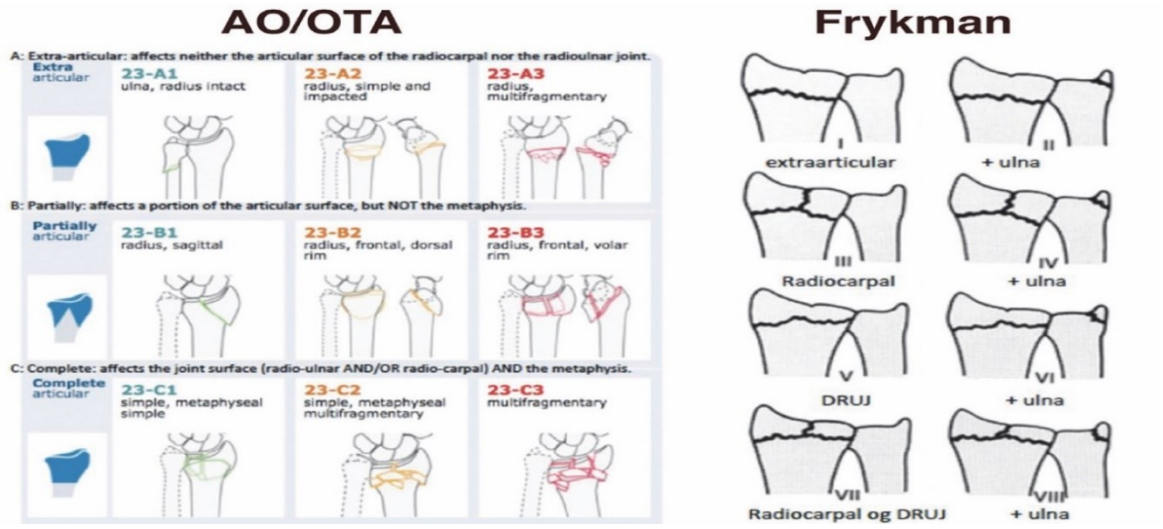

Figure 1: AO/OTA Classification and Frykman classification

External skeletal fixation has been popular for the treatment of displaced, unstable fractures of the distal part of the radius because it combines a minimally invasive procedure with reduction by ligamentotaxis [8]. The moulding of fracture fragments into alignment by traction force applied across the fracture through the surrounding soft tissue is known as ligamentotaxis. Although the capsular and ligamentous structures generally are preserved following comminuted fractures of the distal radius, they can be injured at the time of fracture.

Böhler employed uniplanar ligamentotaxis in the form of skeletal traction to maintain length during fracture healing. Anderson and O'Neil were first to maintain fracture reduction with an external fixator using the same principle of ligamentotaxis. External fixation is generally accepted as superior to plaster immobilization in young patients with intra-articular comminuted displaced distal radius fracture [9,10,11]. Clinical and anatomic studies show that ligamentotaxis is the basic principle used by external fixation through prolonged distraction by the fixator, tension is provided by the capsuloligamentous structures.

AIM AND OBJECTIVES

To evaluate the results of external fixator with ligamentotaxis in distal end radius fracture.

To assess the functional and radiological outcome in distal end radius fractures treated with external fixator.

MATERIALS AND METHODS

We carried out a retrospective study of 70 patients with fracture of distal end radius treated with external fixator at our institute. These patients were followed up in our outpatient department during the study period of 2 years from July 2020 to June 2022.

The inclusion criteria for all patients were: 1) Skeletally Mature Individuals (Age >18 Years), 2) Closed Unstable Extra Articular Fractures, 3) Intra Articular Fractures, 4) Polytrauma with Distal Radius Fractures, 5) AO classification (23-A2/A3/B1/B2/B3/C1/C2/C3), 6) Open Fractures (OG I, OG II, OG III-A, OG III-B), 7) Frykman type I to VIII.

The exclusion criteria were: 1) Open Fractures Grade 3-C (OG III-C), 2) AO classification (23-A1), 3) Associated ipsilateral upper limb fractures, 4) Patients with neurovascular deficit.

On admission assessment of fractures of distal end radius was done with reference to skin condition (closed / open fracture), peripheral circulation, neurologic examination, distal radioulnar joint stability, compartment syndrome and other associated injuries. Radiographs of injured wrist taken including postero-anterior view and lateral view. In the pre operative period splintage with POP slab and elevation was carried out which facilitate the fracture reduction and precision of pins while applying external fixator. All the patients were operated as early as possible once the general condition of the patient was stable and was fit for surgery.

Under the effect of anesthesia longitudinal traction was given with manual moulding of the fracture fragments back into a more normal alignment (severe hyper-flexion or hyperextension is avoided). The lateral border of radius was drilled and two 3.5mm schanz pin were fixed 4 cm apart. Two 2.5mm schanz pin were inserted in lateral border of 2nd metacarpal 3 cm apart, at least 6 cortices in normal bone and in osteoporotic bone at least 8 cortices were pierced. Then a 4mm connecting rod was fixed to the schanz pins with the clamps and the external fixation device is tightened. Augmentation of external fixation the reduction carefully assessed clinically and under guidance of IITV. Below elbow slab was given post operatively.

Post operative care and rehabilitation included check X -rays in both Antero-posterior and lateral views on post-operative day. The patient was taught physiotherapy post operatively. The external fixator and K wires were removed at 6-8 weeks. Patient was followed up at 3rd, 4th and 6th week and fracture union was assessed clinically by absence of tenderness and radiologically by bridging callus formation. Final assessment was done at the end of 6 months. The data was retrieved from case record forms and hospital information software. The results were evaluated as per 1) Subjective evaluation by Modified Demerit Point System of Gartland and Werley (Functional) [12] [Table:1&2], 2) Lidstorm and Frykman Criteria modified by Sarmiento (1980) were used for evaluation anatomic results [13] [Table:3]

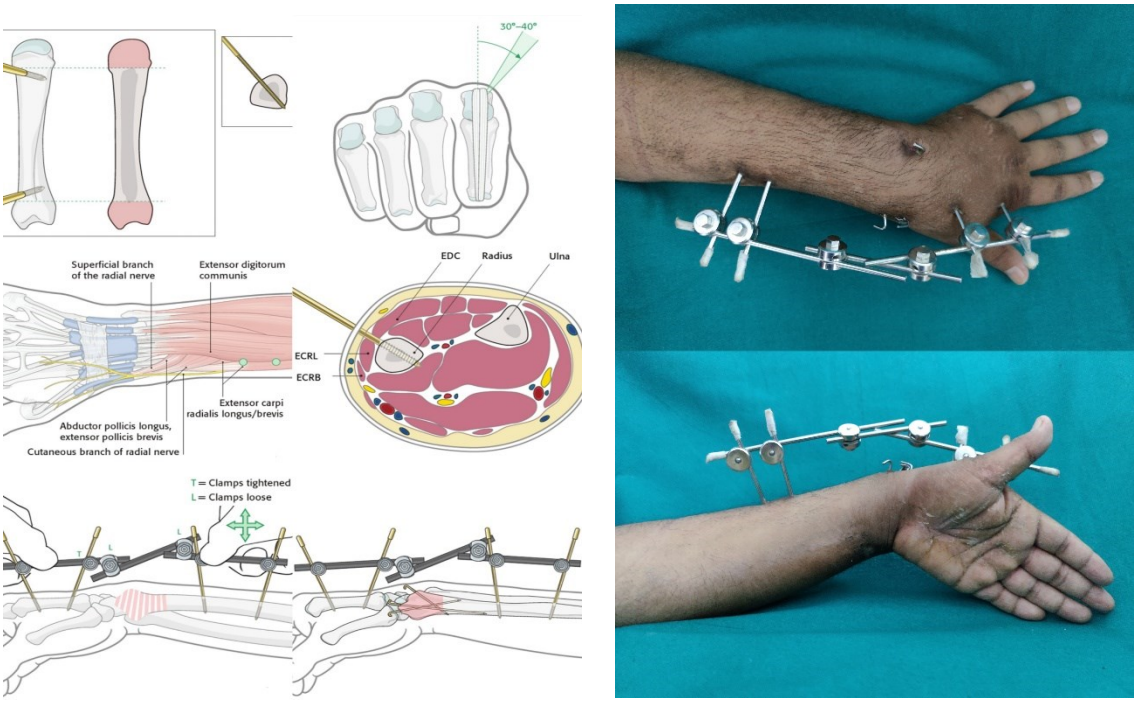

Figure 2: Surgical technique showing pin insertion and post-operative clinical image

Table 1: Modified Demerit Point System of Gartland and Werley.

Category	**Points**
Residual deformity (0-3 Points)	
Prominent ulnar styloid process	1
Residual dorsal tilt.	2
Residual deviation of hand	2-3
Subjective evaluation (0-6 points)	
Excellent: No pain, disability or limitation of motion	0
Good: Occasional pain, some limitation of motion and no disability	2
Fair: Occasional pain, some limitation of motion, weakness in wrist, activities slightly restricted.	4

Poor: Pain limitation of motion, disability, Activities more or less markedly restricted.	6
Objective evaluation (0-5 points)	
Loss of dorsiflexion	5
Loss of ulnardeviation	3
Loss of supination	2
Loss of Palmarflexion	1
Loss of radial deviation	1
Loss of circumduction	1
Pain in distal radioulnar joint	1
Grip strength 60% or less than opposite side	1
Loss of pronation	2
Arthritic changes	
Minimum	1
Minimum with pain	3
Moderate	2
Moderate with pain	4
Severe	3
Severe with pain	5
Nerve complications (Median)	1-3
Poor finger functions due to cast	1-2

Table 2: Grading

Excellent	0-2
Good	3-8
Fair	9- 20

Poor	>21

Radiographic parameters used in assessment are [14,15]: 1) Volar angulation (palmar tilt, radial tilt): measured in lateral radiograph, angle created between distal articular surface of radius and line perpendicular to the long axis of radius. Range: 0-22 (mean 14.5 SD 4.3). 2) Radial angulation (radial inclination): measured in PA view, angle between distal radial articular surface and perpendicular line in the long axis of radius. Range: 16 -28 (average 20). 3) Radial length: measured in PA view, perpendicular distance between surface of ulnar head and horizontal line from tip of radial styloid. Range 8-18mm (average 11-12mm). 4) Radial shift (radial width): measured in PA view, distance between the longitudinal axis through the center of the radius and the most lateral point of the radial styloid process. This is compared with uninjured wrist and is normally within 1mm of each other in length. 5)Articular congruity: acceptable articular step off is ≤2mm. [16,17]

Table 3: Criteria for Anatomic results (Sarmiento) (1980)

Result	Criteria
Excellent	No or insignificant deformity, Dorsal angulation ≤0, Shortening <3mm, Loss of radial deviation <4
Good	Slight deformity, Dorsal angulation 1-10, Shortening 3-6mm, Loss of radial deviation 5-9
Fair	Moderate deformity, Dorsal angulation 11-14, Shortening 7-11mm, Loss of radial deviation 10-14
Poor	Dorsal angulation >15, Shortening ≥12mm, Loss of radial deviation ≥15

RESULT AND OBSERVATION:

AGE DISTRIBUTION

Table 4: Distribution of patients according to age

Age Group (years)	Number of cases	Percentage
18-20	8	11.42%
21-40	19	27.14%
41-60	32	45.72%
60-80	11	15.72%
Total	70	100%

SEX DISTRIBUTION

Table 5: Sex distribution of patients

Sex	No of cases	Percentage
Male	28	40.00 %
Female	42	60.00 %
Total	70	100 %

SIDE OF INVOLVEMENT

Table 6: **Side of involvement**

Side	No of Cases	Percentage
Right	38	54.28%
Left	32	45.72%
Total	70	100%

MODE OF INJURY

Table 7: Distribution of patients based on mode of injury

Mechanism of injury	No of Cases	Percentage
Road Traffic Accident	39	55.71%
Fall from height	18	25.71%
Fall on outstretched Hand	13	18.58%
Total	70	100%

TYPE OF FRACTURE (CLOSED / OPEN)

Table 8: Distribution based on closed / open type of fracture

Type of fracture	No of cases	Percentage
Closed #	56	80.00%
Open #	14	20.00%

Total	70	100

FRYKMAN'S TYPE OF FRACTURES

Table 9: Distribution based on Frykman's type of fracture

Frykman's Type	No of fractures	Percentage
Type I	02	2.86%
Type II	05	7.15%
Type III	02	2.86%
Type IV	04	5.71%
Type V	07	10.00%
Type VI	10	14.28%
Type VII	14	20%
Type VIII	26	37.14%
Total	70	100%

DURATION OF EXTERNAL FIXATION

Table 10: **Duration of external fixation**

Duration in weeks	No of cases	Percentage
5-6	56	80.00%
7-8	14	20.00%
Total	70	100

FOLLOW UP

Table 11: Duration of follow up

Duration in weeks	No of cases	Percentage
21-30	44	62.86.%
31-40	19	27.14%
41-50	7	10.00%
Total	70	100%

FRACTURE UNION

All the fractures in the study united without the need for a second procedure, within 3 months. Thus, the union rate was 100%, with no non-unions in the study. The average time taken for union was 7.65 weeks.

AVERAGE RANGE OF MOVEMENT ACHIEVED AFTER 6 MONTHS:

Table 12: Average range of movement achieved after 6 months:

Movements	Average movement in degree
Dorsiflexion	57.39
Palmar flexion	48.26
Radial deviation	17
Ulnar deviation	23
Supination	72.8
Pronation	69

RADIOLOGICAL ASSESSMENT

Table 13: Average radiological assessment

Radiological Assessment	Average in Degree
Radial Inclination	19
Volar Inclination	6.6
Ulnar Variance	-0.8

COMPLICATIONS

Table 14: Associated complications

Complications	No of cases
Residual pain	8
Dorsal angulation	6
Pin tract infection	3
Pin loosening	0
Restricted wrist movements	4

Finger stiffness	3
Arthritis	0
Distal Radioulnar instability	0
Sudek's Dystrophy	1
Carpal tunnel syndrome	0
Non union	0

DISCUSSION

The aim of this study is to evaluate the results of external fixator for distal end radius particularly for open fractures, intra-articular fractures and unstable fractures. Failure in the management may cause permanent disability [18]. The small AO external fixator provides a simple and reliable means of treating distal end radial fractures especially unstable intraarticular fractures employing the concept of ligamentotaxis that was proposed by Vidal et al. [19]

The efficacy of ligamentotaxis in neutralizing detrimental compression forces, which are likely to cause displacement of unstable fracture with radial shortening, is a significant and increasingly appealing advance in the management of distal radius fracture.[20] Usually the fractures which are non-osteoporotic, maintained conservatively by Colle's cast and fractures which are comminuted & osteoporotic, collapsed by conservative treatment and tendency to malunion. To prevent collapse and malunion, reduction with ligamentotaxis and external fixation used. The same ligaments, retinaculae, tendons and the periosteum that envelop the fracture which are the surgical barrier for open reduction of the fracture fragments, help to achieve reduction of the fracture by ligamentotaxis.

There are numerous demerits of distal end radius plating like: 1)irritation/rupture of dorsal tendons due to past pointing of distal screws, 2)placement of the distal screws into the radiocarpal joint, 3)irritation/rupture of volar tendons due to prominent plates, incomplete reduction or backing out of distal screws, 4)subsidence of fragments and/or dorsal subluxation of the carpus due to failure to engage the dorsal ulnar fragment, 5)subsidence of fragments and volar subluxation of the carpus due to failure to stabilize the volar rim of the lunate facet, 6)failure to support the subchondral bone by placement of the distal screws too proximally, 7)prominent hardware that is clinically palpable volarly due to implant placement too far radially, 8) inability to remove a plate/screws due to bony adherence.

In contradiction to volar plating, external fixation has several advantages like: 1) Superior mechanical efficiency and its capacity for fracture adjustment during healing period, 2) Simple device and easy and safe to use even under anesthesia, 3) Shorter period of surgery, minimal exposure, no need for tourniquet are its distinct advantage over plate fixation. 4) Can be performed in emergency with minimum instrumentation. 5) Provides better functional and anatomical results in comminuted intra-articular and unstable extra-articular wrist injuries also provides early mobilization and reduces edema stiffness of joints thus leading to better and early functional recovery, 6) Effective method of treating unstable extraarticular and complex intraarticular fractures of the distal end radius.

RESULT

At the end of six months, we evaluated our results for each patient in terms of total G & W score and graded them accordingly. Overall, we obtained "excellent" results in 47.15%; "good" in 35.72% cases; "fair" in 14.28% and "poor" in 2.85% cases with a mean G & W score of 6.35. Patients, who obtained excellent results, had no residual deformities or pain. Range of motion was within the normal functional range. They had no arthritic changes or other complications. Radial length, volar tilt and articular step-off were within acceptable limits. They were co-operative to physiotherapy. Patients with good results had minimal residual deformities, pain and slight limitation. Rest of their findings was within acceptable parameters. (Table 15,16)

Table 15: Functional Results of our study

Functional result	No. of Cases	Percentage
Excellent	33	47.15%
Good	25	35.72%
Fair	10	14.28%
Poor	2	2.85%
Total	70	100%

Table 16: Anatomical Results of our study

Anatomical result	No. of Cases	Percentage
Excellent	34	48.57%
Good	25	35.72%
Fair	09	12.86%
Poor	2	2.85%
Total	70	100%

In our case series attributes to 82.87% of excellent to good results and 17.13% of fair to poor results. Thus, it suggests that ligamentotaxis plays a good role in anatomic restoration in unstable fractures as well as intra articular fractures. Results of various case series are following [Table:17] (Case 1)

Table 17: Results of Various Case Series [21-26]

S. No	Name of Series	Modality of treatment	Number of cases	Results	
				E/G	F/P
1.	Dowling and sawyer (1961)	Percutaneous Pinning	51	84%	16%
2.	Cooney *et al.* (1979)	R.A Frame	60	87%	13%
3.	D"Anca *et al.* (1984)	Hoffmann	54	94%	06%
4.	Howard 1989	Hoffmann	50	96%	4%

Pre - op X-ray

Post - op X-ray

12 weeks follow-up xray

5.	Rajeev Shukla (2013)	JESS	72	77.8%	22.2%
6.	Our series (Present study)	A.O	70	82.87%	17.13%

CASE 1

CONCLUSION

A small external fixator is a simple apparatus for application and can produce excellent to good results. The final functional result of treatment of distal radius fractures not only depends on the anatomical restoration of the articular surface but also on the associated soft tissue injuries and articular damage.

By observing and comparing the results of our study with standard studies we would like to conclude that external fixator is an easy, cost effective, reliable, and most suitable treatment in treating intraarticular and unstable extraarticular distal end radial fractures by the principle of ligamentotaxis.

ACKNOWLEDGEMENT: NIL

FUNDING: - NIL

CONFLICT OF INTEREST: NIL

REFERENCES

1. Ark J, Jupiter JB. The rationale for precise management of distal radius fractures. Orthop Clin North Am. 1993 April; 24(2): 205-210.
2. Nagi ON, Dhillon MS, Aggarwal S, Deogaonkar KJ. External fixators for intra-articular distal radius fractures. Indian Journal of Orthopaedics. 2004; 38: 19-22.
3. Jupiter JB. Current concepts review - Fractures of the distal end of the radius. J Bone Joint Surg (Am). 1991; 73-A: 461-469.
4. Nguyen TV, Center JR, Sambrook PN. Risk factors for proximal humerus, forearm, and wrist fractures in elderly men and women: the Dubbo Osteoporosis Epidemiology Study. Am J Epidemiology. 2001; 153(6):587-595.
5. Vidal, Fischbach, Brahin Act Orthop Belgium. 1977; 43:781-789.
6. Colles A. On the fracture of the carpal extremity of the radius. Edinb Med Surg J. 1814, 10:181.
7. Melone CP Jr. Distal radius fractures: Patterns of articular fragmentation. Othop Clin North Am. 1993; 24 (2): 239-253.
8. Sommerkamp 'TG, Seeman M, Silliman J, et al. Dynamic external fixation of unstable fractures of the distal part of the radius. A prospective, randomized comparison with static external fixation J Bone Joint Surg Am. 1994;76A: 1149- 1161.
9. Szabo RM. Extra articular fractures of the distal radius. Orthop Clin North Am. 1993 April; 24 (2): 229-237.
10. Cooney WP, Linscheid RL, Dobyns JH. External Pin Fixation for Unstable Colles' Fractures. J Bone Joint Surg. 1979; 61-A: 840–845.
11. Jenkins NH, Jones DG, Mintow CW et al. External fixation and recovery of function following fractures of the distal radius in young adults. Injury. 1988; 19: 235-238.
12. Gartland J, Werley C. Evaluation of healed Colles' fractures. J Bone Joint Surg. 1951; 33(4):895-907.
13. Sarmiento A, Pratt GW, Berry NC, Sinclair WF. Colle’s Fractures: Functional Bracing in Supination. J Bone Joint Surg. 1975; 57-A: 311-317.

14. Metz VM, Gilula LA. Imaging techniques for Distal radius fractures and related injuries. Orthop Clin North Am. 1993 April; 24(2): 217-228.
15. Van der Liden W, Ericson R. Colle's fractures: how should its displacements be measured and how should it be immobilised?. J Bone Joint Surg. 1981; 63-A: 1285-1288.
16. Fernandez DL, Geissler WB. Treatment of displaced articular factures of the radius. J Hand Surg. 1991; 16-A: 375-384.
17. Trumble TE, Schmitt SR et al. Factors affecting functional outcome of displaced intra articular distal radius fractures. J Hand Surg. 1994; 19-A(2): 325-340.
18. Boparai RPS, Boparai RS, Kapilar, Pandher DS. Role of ligamentotaxis in management of comminuted intra/juxta articular fractures. IJO. 2006; 40(3):185-7.
19. Vidal Buscayret J, Fischbach. Une methode originale dans le traitement des fractures comminutives de du radius Le taxis ligamentaire Acta Orthop. Belgica. 1977; 43:781-789.
20. Robert Bocholz W, James Hackman D. Rockwood and Greens fracture in adult's 5th edition. 1:829-880.
21. Dowling JJ, Sawyer Blackwell. Comminuted Colles fractures evaluation of method of treatment JBJS. 1961; 43-A:657-668.
22. Cooney WP, Agee JM, Hastings HI, Melone CPJ, Rayhack JM. Management of Intraarticular Fractures of the Distal Radius. Contemp Ortho. 1990; 21:71-104.
23. D"Anca AF, Byron TW, Feinstein PA. External fixator management of unstable Colles fractures Orthopedics. 1984; 7:853-9.
24. Markiewitz AD. Five pin external fixator and early range of motion for distal radius fracture, Orth, Clinics of North America, 2000.
25. Aktekin CN, Altay M, Gursoy C. Comparison between external fixation and cast treatment in the management of distal radius fractures in patients aged 65 years and older, J Hand Surg. 2010; 35:86.
26. Rajeev Shukla. A multifactorial study of application of Joshi"s External Stabilizing System in displaced Distal End Radius Fractures. Indian Journal of Basic and Applied M.