ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

A Study On Dynamic Vs Static External Fixation Of Distal End Of Radius Fractures.

M Manikandan[1]*, R Hubert Praveen Abner[2], and S Vignesh[3].

[1]Assistant Professor, Department Of Orthopedics, Government Nagapattinam Medical College& Hospital, Nagapattinam, Tamil Nadu, India.
[2]Assistant Professor, Department Of Emergency Medicine. Government Thiruvarur Medical College & Hospital, Thiruvarur, Tamil Nadu, India.
[3]Junior Resident, Department Of Orthopedics Government Nagapattinam Medical College & Hospital, Nagapattinam, Tamil Nadu, India.

ABSTRACT

Distal radius fractures may be managed non-operatively or operatively with both methods resulting in good reliable results when appropriately used.The operative methods for displaced unstable fractures include closed reduction with percutaneous pinning, open reduction with internal fixation, external fixation, combinations of percutaneous pinning with internal and external fixation, arthroscopically assisted reduction and bone grafting and cementing techniques. External fixation of distal radius fractures may be static or dynamic. Static fixation involves a wrist-bridging (WB) external fixator with no possibility of wrist mobilisation during the treatment period. Dynamic fixation allows wrist mobilisation whilst the fixator is in place. This may be achieved with a WB fixator with a mobile hinge joint or by a non-bridging (NB) fixator with pins being inserted into the distal end of the radius. To analyse and compare functional and anatomical outcomes of management of displaced, unstable and comminuted fractures of the Distal Radius and early wrist mobilization in adult patients with dynamic multiplanar external fixation (Penning-type fixator) against those of patients managed with static monoplanar fixation. This study was conducted in the year 2021 august Department of orthopedics, Government Nagapattinam Medical College& Hospital, Nagapattinam, Tamil Nadu, India. About 23 patients with intraarticular distal radius fractures were selected and treated with dynamic external fixator with or without supplementary techniques. 3 patients had lost follow up and so 20 patients were analysed in the study. Average follow up is 12.84 months. The results were analysed as functional outcome using Green and O'Brien score (modified by Cooney et al) and anatomical outcome using Lidstrom score. After proper analysis and doing statistical comparison, we got p- value of 0.159 for anatomical outcome which is statistically insignificant and 0.046 for functional outcome which is statistically significant. (Significance of p value determined as <0.05). With regard to individual parameters in the scores, we got significantly better results in the values of range of motion in dynamic group and less reduction in radial length in static group. 3 patients had superficial infection and1 patient had secondary arthritis in dynamic group and 2 patients had superficial infection ,2 patients had secondary arthritis and 1 patient had deep infection in static group. We concluded that there are no major differences in the anatomical outcome of both the techniques in terms of volar tilt, radial length and radial inclination in treating comminuted distal radius fractures. Even though there is no statistical difference in the anatomical outcome, dynamic external fixation plays a better role than static external fixation in functional parameters like range of motion, early return to work due to early wrist mobilisation.

Keywords: Distal radius fractures, dynamic external fixator, static external fixator, multiplanar ligamentotaxis, uniplanar ligamentotaxis.

https://doi.org/10.33887/rjpbcs/2023.14.1.28

Corresponding author

ISSN: 0975-8585

INTRODUCTION

In day-to-day practice of most orthopaedic surgeons, fractures of distal part of radius are one of the most commonly occurring fractures and encountering problems in selecting treatment option, accounting about 16% of all fractures in orthopaedic casualty and it has bimodal age distribution [1].

Distal radius fractures are mostly insufficiency fractures in osteoporotic bone of elderly and following high velocity injuries in young patients. Since their description by **Colles** in 1814, distal radial fractures remain a therapeutic challenge. Collapse, loss of palmar tilt, radial shortening, and articular incongruity is frequent after closed treatment of unstable and comminuted intra- articular fractures of the distal radius, and these often results in permanent deformity, pain, and loss of function [2]. The closed reduction and immobilization of displaced fractures in a cast may lead to early displacement, hence skeletal fixation to maintain the reduction has been recommended [3]. The incorporation of transfixing Kirschner wires (K-wires) within the plaster or use of external fixation is recommended for severely comminuted fractures.Many external fixation devices are described to achieve reduction and fixation of the fragments without loss of position and acceptable functional results.The ligamentotaxis is the basic principle used by external fixation [4]. Prolonged rigid immobilization of the wrist in an external fixator leads to decreased blood supply to bone and soft tissues and causes periarticular fibrosis. This leads to osteoporosis, poor motion, and compromised functional outcome. Often, intense physiotherapy is required to rehabilitate these patients [5]. The early mobilization of the wrist leads to normalization of blood supply, hastened functional recovery, earlier resolution of wrist swelling, and decreased joint stiffness. Functional bracing and crepe bandages have been used successfully in the treatment of stable distal radius fractures. However, many fractures have severe comminution, leading to significantinstability [6.]

MATERIALS AND METHODS

This study was conducted in the year 2021 august Department of orthopedics, Government Nagapattinam Medical College& Hospital, Nagapattinam, Tamil Nadu, India. Ethical committee approval was obtained. Patients with unstable intraarticular distal radius fractures were treated with the application of double ball joint external fixator with or without K-wire augmentation and compared with similar cases treated with static external fixator.

Inclusion Criteria

Patients in the age group >18 years, Patients with comminuted distal radius fractures following road traffic accident or fall on outstretched hand or assault, Closed fractures, Reported within 7 days of injury.

Exclusion Criteria

Open fractures, Pathological fractures, associated ipsilateral upper limb fractures or carpal bone fractures, associated neurovascular injuries, Preexisting inflammatory and degenerative arthritis of the injured wrist, ipsilateral elbow or shoulder. About 23 patients with comminuted distal radius fractures were treated, amongwhich 3 patients had lost follow up and only 20 patients are included in the study. All of them were skeletally matured, came with pain, swelling, deformity and inability to use the wrist joint following injury. True posteroanterior and true lateral radiographs were taken. Distal radius fractures were classified according to Frykmann's classification and AO classification and managed initially in the casualty with closed reduction and Dorsoradial short arm POP under hematoma block.Then patients were evaluated with chest X ray, ECG, complete hemogram, RFT, Random blood sugar, Blood grouping & typing required for anaesthetic fitnessfor surgery. Most of the patients were posted for surgery within 1-7 days in elective operation theatre. Distal neurovascularity, adjacent joint movements, skin condition and other co-morbid conditions and associated injuries were already assessed.

ISSN: 0975-8585

OBSERVATION AND ANALYSIS

Table 1: Age Distribution

	Group	N	Mean	Std. dev.	p value by't' test
Age	Dynamic EF	20	37.30	9.84	0.752
	Static EF	20	36.20	11.88	

Table 1: The mean Age among Dynamic was 37.3 (± 9.84) and the mean Age among Static EF was 36.2 (± 11.88) which are almost equal and the difference was not statistically significant ($p > 0.05$). Considering the Group of the subjects with Sex distribution, 60% of the Dynamic Group had males which is lower compared to Static EF Group of whom 80% had males and the difference was not statistically significant ($p > 0.05$).

Table 2: Side Distribution

Group	Side		Total	p value
	Left	Right		
Dynamic EF	12 (60%)	8 (40%)	20 (100%)	0.114
Static EF	7 (35%)	13 (65%)	20 (100%)	
Total	19 (47.5%)	21 (52.5%)	40 (100%)	

Table 2: Considering the Group of the subjects with Side distribution, 60% of the Dynamic External fixator Group had left Side which is higher compared to Static EF Group of whom 35% had Left Side and the difference was not statistically significant ($p > 0.05$).

Table 3: Dominant Vs Non-Dominant Limb

Group	Dominant Hand		Total	Fisher exact pvalue
	Left	Right		
Dynamic EF	2 (10%)	18 (90%)	20 (100%)	0.24
Static EF	4 (20%)	16 (80%)	20 (100%)	
Total	6 (15%)	34 (85%)	40 (100%)	

Table 3: Considering the Group of the subjects with Dominant Hand distribution, 90% of the Dynamic EF Group had Right Dominant Hand which is higher compared to Static EF Group of whom 20% had Right Dominant Hand and the difference was not statistically significant ($p > 0.05$).

Table 4: Mode Of Injury

Group	Mode of Injury		Total	p value
	RTA	Self Fall		
Dynamic EF	12 (60%)	8 (40%)	20 (100%)	1
Static EF	12 (60%)	8 (40%)	20 (100%)	
Total	24 (60%)	16 (40%)	40 (100%)	

Considering the Group of the subjects with Mode of Injury distribution, both Dynamic EF Group and Static EF Group had similar prevalence of RTA and self- fall Mode of Injury and the difference was not statistically significant ($p > 0.05$).

ISSN: 0975-8585

Table 5: Comorbid Conditions

Comorbid Condition	Group		Total	Fisher exactp value
	Dynamic EF	Static EF		
Diabetes Mellitus	3 (15%)	3 (15%)	6 (15%)	0.12
Hypertension	1 (5%)	1 (5%)	2 (5%)	
Seizures	0 (0%)	1 (5%)	1 (2.5%)	
Nil	16 (80%)	15 (75%)	31 (77.5%)	
Total	20 (100%)	20 (100%)	40 (100%)	

Considering the Comorbid Condition of the subjects with Group distribution, in both groups, 15% had Diabetes Mellitus and 5% had hypertension. The difference in Group between different Comorbid Condition was not statistically significant (p> 0.05).

Table 6: Associated Fractures

Associated Fracture	Group		Total	Fisherexact p value
	Dynamic EF	Static EF		
CALCANEUM	0 (0%)	1 (5%)	1 (2.5%)	1
CLAVICLE	0 (0%)	1 (5%)	1 (2.5%)	
FEMUR	1 (5%)	0 (0%)	1 (2.5%)	
IT	1 (5%)	1 (5%)	2 (5%)	
NIL	18 (90%)	17 (85%)	35 (87.5%)	
Total		20 (100%)	20 (100%)	40 (100%)

The difference in Group between different Associated Fracture was not statistically significant (p > 0.05).

Table 7: Frykmann Classification

Frykmann Classification	Group		Total	Fisher exact p value
	Dynamic EF	Static EF		
III	4 (20%)	2 (10%)	6 (15%)	0.001
IV	0 (0%)	6 (30%)	6 (15%)	
V	0 (0%)	2 (10%)	2 (5%)	
VI	0 (0%)	1 (5%)	1 (2.5%)	
VII	12 (60%)	3 (15%)	15 (37.5%)	
VIII	4 (20%)	6 (30%)	10 (25%)	

The difference in Group between different Frykmann Classification was statistically significant (p < 0.05)

Table 8: Supplementary Techniques

Group	Supplementary Techniques		Total	Fisher exact pvalue
	K wiring	Nil		
Dynamic EF	5 (25%)	15 (75%)	20 (100%)	0.275
Static EF	4 (20%)	16 (80%)	20 (100%)	
Total	9 (22.5%)	31 (77.5%)	40 (100%)	

Considering the Group of the subjects with Supplementary Techniques distribution, 25% of the Dynamic EF Group had K wiring which is higher compared to Static EF Group of whom 20% had K wiring and the difference was not statistically significant (p > 0.05).

ISSN: 0975-8585

Table 9: External Fixator Removal

After External Fixation Removal	Group		Total	Fisher exactp value
	Dynamic EF	Static EF		
5.0	0 (0%)	2 (10%)	2 (5%)	0.137
6.0	14 (70%)	10 (50%)	24 (60%)	
7.0	6 (30%)	6 (30%)	12 (30%)	
8.0	0 (0%)	1 (5%)	1 (2.5%)	
9.0	0 (0%)	1 (5%)	1 (2.5%)	
Total	20 (100%)	20 (100%)	40 (100%)	

The difference in Group between different External Fixation Removal was not statistically significant ($p > 0.05$).

Table 10: Pain

Pain Grade	Group		Total	Fisher exact pvalue
	Dynamic EF	Static EF		
Mild	8 (40%)	6 (30%)	14 (35%)	0.079
Moderate	3 (15%)	3 (15%)	6 (15%)	
Severe	0 (0%)	1 (5%)	1 (2.5%)	
No	9 (45%)	10 (50%)	19 (47.5%)	
Total	20 (100%)	20 (100%)	40 (100%)	

Considering the Pain Grade of the subjects with Group distribution, No Pain was higher in Dynamic EF Group with 45% followed by mild Pain with 40% whereas Static EF group had 50% of no Pain followed by Mild Pain with 30%. The difference in Group between different Pain Grade was not statistically significant ($p > 0.05$).

Table 11: Functional Outcome (Green And O''Brien)

FunctionalOutcome	Group		Total	Fisher exactp value
	Dynamic EF	Static EF		
Excellent	8 (40%)	4 (20%)	12 (30%)	0.046
Good	6 (30%)	7 (35%)	13 (32.5%)	
Fair	5 (25%)	6 (30%)	11 (27.5%)	
Poor	1 (5%)	3 (15%)	4 (10%)	
Total	20 (100%)	20 (100%)	40 (100%)	

Considering the Functional Outcome of the subjects with Group distribution, Excellent Functional Outcome was higher in Dynamic EF Group with 40% followedby Good Functional Outcome with 30% and least in Poor Functional Outcome with5% whereas in Static EF group Good Functional Outcome was higher with 35% followed by fair Functional Outcome with 30%. The difference in Group between different Functional Outcome was statistically significant ($p < 0.05$).

Table 12: Radial Length

Radial Length	Group		p value by 't' test
	Dynamic EF	Static EF	
Pre-op	1.55 (± 3.83)	3.35 (± 2.37)	0.083
Post-op	7.9 (± 1.89)	9.15 (± 1.53)	0.027
Final Follow up	7 (± 2.18)	8.6 (± 1.96)	0.019
Normal Side	11 (± 0.79)	11.25 (± 0.91)	0.361

The mean Radial Length Pre-op among Dynamic EF was 1.55 (± 3.83) which is lower than mean Radial Length Pre-op among Static EF which was 3.35 (± 2.37) and the difference was not statistically significant. The mean Radial Length Post-op among Dynamic EF was 7.9 (± 1.89) which is lower than mean Radial Length Post-op among Static EF which was 9.15 (± 1.53) and the differencewas statistically significant. The mean Radial Length Final Follow up among Dynamic EF was 7 (± 2.18) which is lower than mean Radial Length Final Follow up among Static EF which was 8.6 (± 1.96) and the difference was statistically significant. The mean Radial Length Normal Side among Dynamic EF was 11 (± 0.79) which is lower than mean Radial Length Normal Side among Static EF whichwas 11.25 (± 0.91) and the difference was not statistically significant.

Table 13: Volar Tilt

Volar Tilt	Group		p value by 't'test
	Dynamic EF	Static EF	
Pre-op	-12.5 (± 6.42)	-10.6 (± 8.95)	0.445
Post-op	8.35 (± 4.56)	9.65 (± 1.69)	0.243
Final Follow up	7.4 (± 4.21)	8.85 (± 2.58)	0.197
Normal Side	10.95 (± 1.05)	11.2 (± 0.83)	0.410

The mean Volar Tilt Pre-op among Dynamic EF was -12.5 (±6.42) which is lower than mean Volar Tilt Pre-op among Static EF which was -10.6(± 8.95) and the difference was not statistically significant. The mean Volar Tilt Post-op among Dynamic EF was 8.35 (± 4.56) which is lower than mean Volar Tilt Post-op among Static EF which was 9.65 (± 1.69) and the difference was not statistically significant. The mean Volar Tilt Final Follow up among Dynamic EF was 7.4 (± 4.21) which is lower than mean Volar Tilt Final Follow up among Static EF which was 8.85 (± 2.58) and the difference was not statistically significant. The mean VolarTilt Normal Side among Dynamic EF was 10.95 (± 1.05) which is lower than mean Volar Tilt Normal Side among Static EF which was 11.2 (± 0.83) and the differencewas not statistically significant

Table 14: Radial Inclination

Radial Inclination	Group		p value by 't' test
	Dynamic EF	Static EF	
Pre-op	7.8 (± 5.07)	6.8 (± 4.35)	0.507
Post-op	17.1 (± 4.51)	18.65 (± 3.27)	0.221
Final Follow up	16.25 (± 3.8)	18.15 (± 3.31)	0.100
Normal Side	21.95 (± 0.89)	22.2 (± 1.06)	0.423

The mean Radial Inclination Pre-op among Dynamic EF was 7.8 (± 5.07) which is higher than mean Radial Inclination Pre-op among Static EF which was 6.8 (± 4.35) and the difference was not statistically significant. The mean Radial Inclination Post-op among Dynamic EF was 17.1 (± 4.51) which is lower than mean Radial Inclination Post-op among Static EF which was 18.65 (± 3.27) and the difference was not statistically significant. The mean Radial Inclination Final Follow up among Dynamic EF was 16.25 (± 3.8) which is lower than mean Radial Inclination Final Follow up among Static EF which was 18.15 (± 3.31) and the difference was not statistically significant. The mean Radial Inclination Normal Side among Dynamic EFwas 21.95 (± 0.89) which is lower than mean Radial Inclination Normal Side among Static EF which was 22.2 (± 1.06) and the difference was not statistically significant.

Table 15: Residual Deformity

	Group		Total	Fisher exactp value
	Dynamic EF	Static EF		
Nil	9 (45%)	9 (45%)	18 (45%)	0.161
Slight	7 (35%)	7 (35%)	14 (35%)	
Moderate	4 (20%)	4 (20%)	8 (20%)	
Total	20 (100%)	20 (100%)	40 (100%)	

Considering the Deformity of the subjects with Group distribution, DynamicEF Group and Static EF group had almost equal distribution of deformities and the difference in Group distribution between

different Deformity was not statistically significant (p > 0.05).

Table 16: Anatomical Outcome (Lindstrom Criteria)

Lindstrom Grading	Group		Total	Fisher exactp value
	Dynamic EF	Static EF		
Excellent	9 (45%)	8 (40%)	17 (42.5%)	0.159
Good	7 (35%)	8 (40%)	15 (37.5%)	
Fair	4 (20%)	4 (20%)	8 (20%)	
Total	20 (100%)	20 (100%)	40 (100%)	

Considering the Lindstrom Grading of the subjects with Group distribution, Dynamic EF Group had higher proportion of excellent Lindstrom grading with 45% whereas Static EF group had 40% of excellent Lindstrom grading. The difference in Group distribution between different Lindstrom Grading was not statistically significant (p > 0.05).

Table 17: Complications

Complications	Group		Total	Fisher exactp value
	Dynamic EF	Static EF		
Nil	16 (80%)	15 (75%)	31 (77.5%)	0.139
Secondary Arthritis	1 (5%)	2 (10%)	3 (7.5%)	
Superficial Infection	3 (15%)	2 (10%)	5 (12.5%)	
Deep Infection	0 (0%)	1 (5%)	1 (2.5%)	
Total	20 (100%)	20 (100%)	40 (100%)	

Considering the Complications of the subjects with Group distribution, Dynamic EF Group had higher proportion of Superficial Infection with 15% whereas Static EF group had higher proportion of Superficial Infection and Arthritis as 10%. The difference in Group between different Complications was not statistically significant (p > 0.05).

DISCUSSION

In our comparative study we have compared the functional and anatomical outcome of dynamic external fixator with or without supplementary techniques and static external fixator in the treatment of comminuted intraarticular fractures of the distal radius [7]. Dynamic external fixation was first introduced by Clyburn in 1987. He proposed to reduce the final disability associated with an unstable fracture of the distal radius by facilitating early motion of the wrist. Similar results were obtained by Penning and coworkers using their design of a dynamic fixator [8]. Pilcher LS et al. in their small study showed that dynamization of the wrist at 3 weeks may lead to improved function. Our study revealed significant advantage in terms of anatomical restoration and early functional outcome of early dynamization using the dynamic fixator for displaced unstable comminuted intra articular fractures of the distal radius [9]. Destot E et al in his randomized study compared the outcomes of penning external fixator with JESS type fixator. In Vikas Kulshrestha study regarding anatomical outcome measured using Lindstorm score, the average volar tilt of the distal radius at 6 months follow up was 4.3^0 in penning group as against.1.7 in the JESS fixator group. In our study by using the same Lindstorm score, average volar tilt of the distal radius at 6 months follow up is 7.4^0 in dynamic group as against 8.85^0 in static group [10]. The average loss of radial height was 3.1 mm in thepenning group as against 4mm in the JESS fixator group in their study, but in our study, it is 4mm in dynamic group and 2.65mm in static group which is different from regarding functional outcome using Gartland Werley ,70% had excellent results and 30% had good results in penning group as against 25% excellent results and 65% good results and 10% fair results in static group [11]. In our study functional evaluation was done by using Green and O'Brien scoreand and analysed that 70% had excellent and good results ,25% had fair results and 5% had poor results in dynamic group as against 55% excellent and good results, 30% fair results and 15% poor results in static group which is almost similar in bothstudies [12-24].

ISSN: 0975-8585

CONCLUSION

We conclude that there are no major differences in the anatomical outcome ofboth the techniques in terms of volar tilt, radial length and radial inclination in treating comminuted distal radius fractures. Even though there is no statistical difference in the anatomical outcome, dynamic external fixation plays a better role than static external fixation in functional parameters like range of motion, early return to work.

REFERENCES

[1] Colles A. On the fracture of the Carpal extremity of the radius. Edinburgh MedSurg 1814; 10:182-186

[2] Goyrand G: Memoirs sur les fractures de l'extremite inferieure de radius, quisimulent les luxations du poignet. Gazette de Medicine 1832; 3:664.

[3] Nelaton A: Elements de pathologie chirurgicale. Paris, Germer Bailliere, 1844.

[4] Smith RW: A treatise on fractures in the vicinity of joints and on certain forms ofaccidental and congenital dislocations. Dublin, Hodges & Smith, 1847.

[5] Beck C: Colles 'fracture and the Roentgen-rays. Med News 1898; 72:230.

[6] Cotton FJ: A study of the x-ray plates of one hundred and forty cases of fracture ofthe lower end of the radius. Boston Med Surg J 1900; 143:305.

[7] Morton R.Lancet 1907; 1:731.

[8] Lambotte A. Sur l'OsteÂosynthese. La Belgique MeÂdicale 1908,231

[9] Pilcher LS: Fractures of the lower extremity or base of the radius. Ann Surg 1917;65:1.

[10] Destot E: Injuries of the Wrist, a Radiological Study. New York, Paul B. Hoeber,1926

[11] Gartland JJ, Werley CW: Evaluation of healed Colles 'fractures. J Bone Joint Surg Am 1951; 33:895-907.

[12] Lidstrom A: Fractures of the distal end of the radius: a clinical and statistical study of end results. Acta OrthopScand 1959; 30:1-118.

[13] Ellis J: Smith's and Barton's fractures: a method of treatment. J Bone Joint Surg Br 1965; 47:724-727.

[14] Frykman G: Fractures of the distal radius, including sequelae—shoulder- and 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- 153.

[15] Rang M: The Story of Orthopaedics. Philadelphia, WB Saunders, 1966

[16] Jones KG. A modification of the use of extraskeletal immobilization for comminutedfractures of the distal radius. Clin Orthop Relat Res 1977; 83-6.

[17] Peltier LF. Fractures of the distal end of the radius. An historical account. ClinOrthop Relat Res. 1984 Jul-Aug;(187):18-22.

[18] Melone Jr CP: Articular fractures of the distal radius. Orthop Clin North Am 1984;

[19] 15:217-236.

[20] Bonnel F, Allieu Y: The radioulnocarpal and midcarpal joints: Anatomical organization and biomechanical basis. Ann Chir Main 1984; 3:287-296

[21] Solgaard S, Peterson VS. Epidemiology of distal radius fractures. Acta OrthopScand,1985;56:391-393.

[22] Altissimi M, FL,Fiacca C,Mancini GB; Long term results of conservative treatment of fractures of the distal radius. Clinical Orthopedics & Related Research, 1986; 206:202-210.

[23] Clyburn TA. Dynamic external fixation for comminuted intra-articular fractures of the distal end of the radius. Journal of Bone and Joint Surgery 1987; 69:248.

[24] Mcqueen M, Caspers J; Colle 's fracture. Does the anatomical result affect the final function? J. Bone Joint Surg Br; 1988;70: 649-651.