

Original Research Article

Result of management of closed distal radial fracture by Ayjaz Azim foundation mini external fixator

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ABSTRACT

Background: Distal radius fractures are one of the most common orthopedic conditions and intra-articular types (AO/ASIF type C) are difficult to treat. While various treatment options exist, external fixation remains valuable, particularly in the developing world. The present study evaluated the efficacy of the Ayjaz Azim foundation (AAF) mini external fixator for the treatment of closed, complete articular distal radius fractures.

Methods: This study evaluated outcomes in 32 patients with closed intra-articular distal radial fractures by purposive sampling. Patients between 18 and 60 years, within two weeks of injury, received standardized surgery. Structured questionnaires were used to collect data, and outcomes at 12 weeks after surgery were assessed using Sarmiento's radiological criteria and the Green and O'Brien functional scoring system. Statistical analysis was performed with SPSS v26, and significance was at $p < 0.05$.

Results: The study population (41.63 ± 12.39 years) had a predominance of males (78.1%), and the most common injury mechanism was motor vehicle accidents (68.75%). Surgery was performed in 90.6% of patients within 24 hours of trauma. Radiologically, 62.5% had excellent results, 31.3% good, and 6.3% fair. The mean loss of volar tilt was $5.03^\circ \pm 3.84^\circ$, radial shortening $2.47 \text{ mm} \pm 2.27 \text{ mm}$, and radial inclination $4.03^\circ \pm 3.27^\circ$. Functionally, 62.5% had excellent results, 21.9% good, 12.5% fair, and 3.1% poor. Pin tract infection occurred in 16% of the cases and post-removal stiffness in 62.5% of patients. Radiological and functional results had a good correlation ($r = 0.876$, $p < 0.001$).

Conclusions: AAF mini external fixator is a useful tool for the treatment of AO/ASIF type C distal radius fractures, with 94% patients showing satisfactory results. The technique is reliable for anatomical reconstruction and functional rehabilitation with acceptable complication rates and is a well-suited treatment method worthy of consideration, particularly in regions with limited resources.

Keywords: AAF, Distal radial fracture, Mini external fixator

INTRODUCTION

Distal radius fractures represent approximately 17% of all fractures presented to emergency departments, and they are one of the most common orthopedic injuries encountered in practice.¹ They occur in all ages but have a bimodal distribution peaked in young adults due to high-energy trauma and elderly individuals with osteoporotic bone.² Among the various types, intra-articular distal

radius fractures (AO/ASIF type C) are the most difficult to manage due to their inherent complexity and potential for complications like malunion, post-traumatic arthritis, and functional impairment.³ Their optimal management remains controversial despite plentiful study. The management ranges from non-surgical techniques (closed reduction and cast immobilization) to a variety of surgical techniques including percutaneous pinning, external fixation, internal fixation using volar locking plates, and

fragment-specific fixation.⁴ Each of the techniques has its own advantages and limitations, with the choice in many cases being influenced by fracture pattern, patient factors, surgeon preference, and available resources.⁵ External fixation has been a helpful technique in the management of complex distal radius fractures, particularly in developing nations. The method enables fixation in a stable manner regarding soft tissue integrity and blood supply to the fragments of the fracture.⁶ The AAF mini external fixator is a recent innovation in the area, and the smaller and more universal nature of the device makes it an enhancement compared to other external fixators.⁷ The biomechanical principles behind external fixation include ligamentotaxis, where the reduction of displaced fragments is obtained by tension in intact ligaments and the joint capsule with longitudinal traction.⁸ This is particularly helpful in the management of intra-articular fractures where anatomic reduction of the articular surface plays a critical role in preventing post-traumatic arthritis.⁹ The external fixator also provides stability with early controlled motion of adjacent joints, which can prevent stiffness and aid functional recovery.¹⁰ There has been a previous success with the external fixation of distal radius fractures. Wei et al described satisfactory radiological and functional outcomes in 87% of patients treated by external fixation for comminuted distal radius fractures.¹¹ Excellent to good results in 92% of cases were also reported by Kamano et al using a mini external fixator system.¹² However, complications like pin tract infection, pin loosening, and complex regional pain syndrome have been reported with variable incidence in studies.¹³ The AAF mini external fixator combines principles of traditional external fixation with innovative design features potentially permitting enhanced versatility and patient comfort.¹⁴ However, widespread evaluation of its efficacy for the treatment of complex intra-articular distal radius fractures has been limited, particularly in South Asian populations. This study is designed to evaluate the radiological and functional outcomes of AO/ASIF type C distal radius fractures managed with the AAF mini external fixator at the national institute of traumatology and orthopaedic rehabilitation (NITOR), Dhaka. By methodical observation of perioperative variables, complications, and post-operative outcomes, this investigation aims to contribute to the evidence base informing management decisions for these challenging fractures.¹⁵ In addition, the study examines relationships between subtypes of fracture, radiological outcome, and functional outcome to identify potential predictors of treatment success, thereby informing patient selection and refinement of surgical technique.

METHODS

The study, conducted from July 2016 to June 2018 at the NITOR, Dhaka, examined outcomes following closed intra-articular distal radial (AO/ASIF type C) fractures. A purposive, non-randomized sample of 32 patients aged between 18 and 60 years was recruited, even though an initially calculated sample size of 27 had been determined

based on a 93.4% prior success rate. Inclusion criteria were patients of any sex or side presenting within two weeks of trauma; excluded were patients with prior fractures, open/pathological fractures, or outside the aforementioned age. Data collection was arranged with a pretested questionnaire and involved demographic, perioperative, treatment, complication, and follow-up details. Informed written consent was taken from all patients prior to systematic surgical management. Follow-up at 12 weeks after operation measured outcomes. Radiological outcomes were assessed based on Sarmiento's criteria (inclination, radial length, and tilt), while functional outcomes were measured with the use of the Green and O'Brien scoring system, considering pain, motion, grip strength, and activity. Statistical comparison was facilitated with the use of SPSS v26, and continuous data was presented as mean and standard deviation, and the categorical one as percentages at 95% confidence interval. A p -below 0.05 was considered statistically significant, ensuring precision and dependability in interpreting findings.

Implant-AAF mini external fixator

The external fixator which has been used in this clinical study is a unilateral double bar frame configuration placed on the dorsal aspect of the distal forearm and hand. It is fixed to the distal radial shaft and to the 2nd metacarpal by means of two pairs of threaded pins (Schanz screw) of various sizes depending on the size and quality of bone.

The basic element of the device comprises: Two self-tapping Schanz screws for 2nd metacarpal (diameter 2.5 mm), two self-tapping Schanz screws for distal radius (diameter 3.5 mm), two connecting threaded bars of diameter-4 mm, four adjustable clamps and drill sleeves.

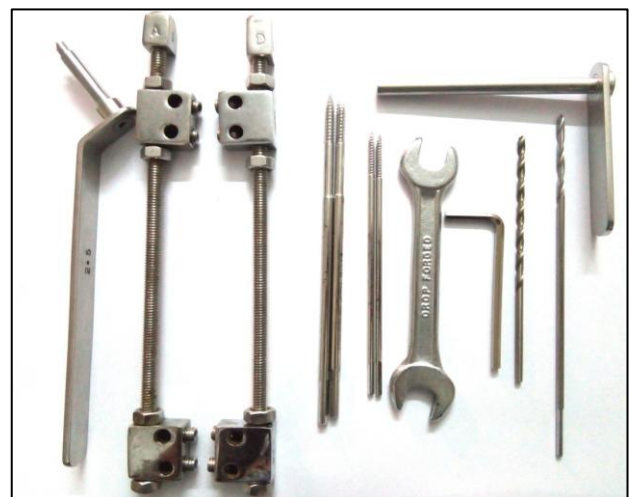


Figure 1: Basic elements of the external fixator.¹⁶

AAF

Associate professor Ayjaz Ahmed Khan and associate professor M. Shohidul Azim was the founder of this

foundation. Around the year of late nineties, these two orthopedic surgeons designed two fixators, one is a spanning fixator for the wrist for the treatment of distal radius fracture and another for the treatment of open tibial fractures under the inspiration of professor R. J. Garst. Then they asked Munna, the Leath machine operator to make those and named this newly created external fixator as AAF external fixator. They used to print AAF on those fixators. Since then, doctors of NITOR and other orthopedic surgeons are using these fixators. Many improvisations were done on these fixators.

RESULTS

Table 1 summarizes the demographic and injury characteristics of the study participants. The age group with the highest prevalence was 31-40 years (37.5%), and males predominated (78.1%). Businessmen constituted the largest occupational group. Injuries were most commonly caused by pedestrian motor vehicle accidents (56.25%), with the right wrist being predominantly affected (75%). Extension wrist position at the time of injury was more common (72%), and type C.2 fractures were most frequent (50%).

Table 2 outlines surgical timing and fracture classifications. Most surgeries were performed within 1 day (90.6%) of injury, with a mean delay of 1.13 ± 0.71 days. External fixator was used for an average of 6.63 ± 0.94 weeks. C.2 type fractures remained most common (50%), followed by equal distribution of C.1 and C.3 (25% each).

Table 3 details early and late complications. During fixation, 81% had no complications; 16% had pin tract infections. After removal, 50% developed wrist stiffness, and 12.5% had finger stiffness. Most patients (71.9%) required 4 weeks of physiotherapy. These findings indicate a favorable but not complication-free post-op course.

Table 4 presents key radiological parameters at final follow-up. Volar tilt loss was minimal in most cases, with a mean of $5.03^\circ \pm 3.84^\circ$. Radial shortening was <3 mm in 68.8% of patients, and radial inclination loss was $<5^\circ$ in 65.6%, indicating effective anatomical restoration in the majority.

Figure 2 shows the duration of therapy with limited physiotherapy following treatment with the AAF mini external fixator. The doughnut chart shows that 71.9% of the patients had 4 weeks of therapy only, whereas 28.1% had 6 weeks.

Figure 3 illustrates the frequency of complications after the removal of the external fixator, with 50% being wrist joint stiffness, 12.5% finger stiffness, and 37.5% not having any complication.

Table 5 consolidates radiological and clinical findings. Excellent radiological outcomes were noted in 62.5%, and

65.6% of patients reported no pain. Mild deformity was observed in 31.3%, while moderate deformity occurred in only 6.3%. These findings validate the effectiveness of surgical treatment in restoring form and comfort.

Table 6 evaluates functional recovery parameters. Nearly all patients (96.9%) regained at least 75% of wrist motion, and 65.6% achieved full grip strength. Most returned to their regular jobs (84.4%). Functional outcomes were excellent or good in 84.4%, highlighting high treatment success.

Table 7 explores relationships among outcome variables. A strong positive correlation ($r=0.876$, $p<0.001$) was found between radiological and functional outcomes, and a moderate correlation ($r=0.588$, $p<0.001$) between fracture subtype and functional outcome. These suggest that anatomical restoration and fracture complexity significantly influence recovery.

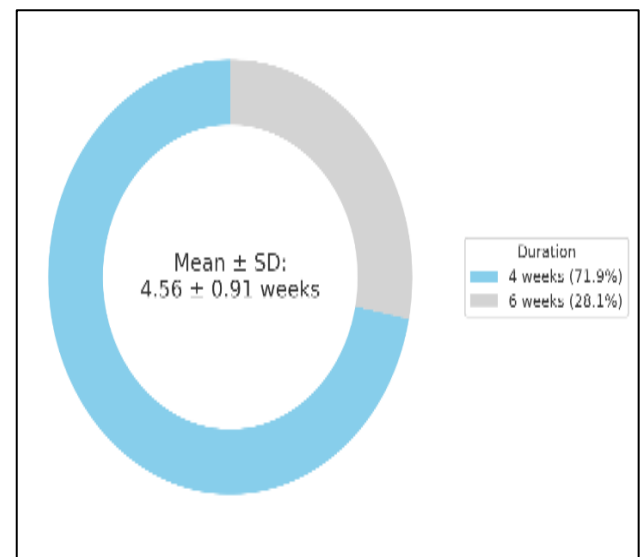


Figure 2: Duration of limited physiotherapy (n=32).

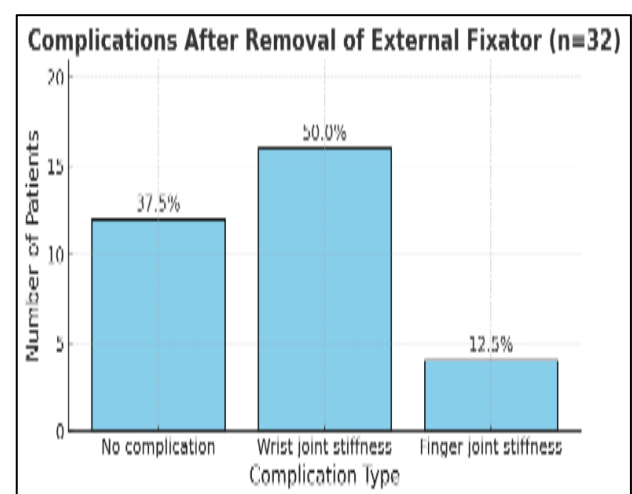


Figure 3: Complications after removal of ex-fix, (n=32).

Table 1: Demographic and injury characteristics of the study population, (n=32).

Variables	Category	N	Percentage (%)
Age group (in years)	18-30	6	18.8
	31-40	12	37.5
	41-50	6	18.8
	51-60	8	25
Sex	Male	25	78.1
	Female	7	21.9
Occupation	Farmer	6	18.8
	Businessman	9	28.1
	Service holder	5	15.6
	Student	4	12.5
	Housewife	7	21.9
	Other	1	3.1
Wrist position at injury	Extension	23	72
	Flexion	9	28
Cause of injury	MVA (Pedestrian)	18	56.25
	MVA (Rider or occupant)	4	12.5
	Fall from height	7	21.9
	Fall on slippery ground	3	9.4
Affected side	Right	24	75
	Left	8	25
Fracture type	C.1	8	25
	C.2	16	50
	C.3	8	25

Table 2: Operative timing, fixator duration, and fracture classification, (n=32).

Variables	Category	N	Percentage (%)	Mean±SD
Time interval (Days)	0-1	29	90.6	1.13±0.71
	2-3	2	6.3	
	4-7	1	3.1	
Duration of fixator (Weeks)	6	22	68.8	6.63±0.94
	8	10	31.2	
AO/ASIF fracture type	C.1	8	25	-
	C.2	16	50	
	C.3	8	25	

Table 3: Complications and rehabilitation outcomes following external fixation, (n=32).

Variables	Category	N	Percentage (%)
Complications with fixator	No complication	26	81
	Pin tract infection	5	16
	Pin loosening	1	3
Physiotherapy duration	4 weeks	23	71.9
	6 weeks	9	28.1
Post-fixator complications	No complication	12	37.5
	Wrist stiffness	16	50
	Finger stiffness	4	12.5

Table 4: Radiological outcomes: volar tilt, radial shortening, and inclination, (n=32).

Outcome variables	Category	N	Percentage (%)	Mean±SD	Range
Deformity	No deformity	20	62.5	-	-
	Slight	10	31.3	-	-
	Moderate	2	6.3	-	-

Continued.

Outcome variables	Category	N	Percentage (%)	Mean±SD	Range
Loss of volar tilt	0°	3	9.4	5.03±3.84	0°-15°
	1°-10°	27	84.4		
	11°-14°	1	3.1		
	≥ 15°	1	3.1		
Radial shortening	<3 mm	22	68.8	2.47±2.27	0-8
	3-6 mm	6	18.8		
	7-11 mm	4	12.5		
Radial inclination loss	<5°	21	65.6	4.03±3.27	0°-13°
	5°-9°	8	25		
	10°-14°	3	9.4		

Table 5: Final radiological, clinical, and pain outcomes, (n=32).

Outcome variables	Category	N	Percentage (%)
Radiological outcome	Excellent	20	62.52
	Good	10	31.3
	Fair	2	6.3
	Poor	0	0
Pain score	No pain (25)	21	65.6
	Mild pain (20)	10	31.3
	Moderate pain (15)	1	3.1
	Severe pain (0)	0	0
Deformity	No deformity	20	62.5
	Mild deformity	10	31.3
	Moderate deformity	2	6.3
	Severe deformity	0	0

Table 6: Functional recovery: motion, strength, and return to activity, (n=32).

Outcome category	Specific outcome	N	Percentage (%)
Range of motion	99-75%	31	96.9
	74-50%	1	3.1
Grip strength	100%	21	65.6
	99-75%	10	31.3
	74-50%	1	3.1
Work activity	Returned to employment	27	84.4
	Restricted employment	5	15.6
	Unable to work	0	0
Functional outcome	Excellent	20	62.5
	Good	7	21.9
	Fair	4	12.5
	Poor	1	3.1

Table 7: Correlation between fracture pattern, radiological and functional outcomes, (n=32).

Variables	Pearson correlation	Sig. (2-tailed)	N
Final radiological outcome vs final functional outcome	0.876	0.000	32
AO/ASIF fracture subtype vs final functional outcome	0.588	0.000	32

*Correlation is significant at the 0.01 level (2-tailed)

DISCUSSION

Treatment of intra-articular distal radius fracture remains challenging in spite of advancements in orthopedic devices and hardware. The present study reveals that the AAF mini external fixator has acceptable outcomes in the treatment of AO/ASIF type C distal radius fracture as 94% of patients had excellent to good functional results. Such a

high rate of success is in accordance with the 88% satisfactory outcomes reported by Gradl et al with external fixation for similar fractures.¹⁹ The population profile of our study showed male predominance (78.1%) and the highest incidence in the economically active age group of 31-40 years (37.5%), as per trends reported by Meena et al.²⁰ The predominance of high-energy trauma, particularly motor vehicle accidents (68.75%), as the primary cause of

injury is suggestive of urbanization and increased motorization in developing countries, as per Wei et al.²¹ Radiological outcomes in our series were satisfactory, with 93.8% showing excellent to good alignment. The mean loss of volar tilt ($5.03^\circ \pm 3.84^\circ$), radial shortening ($2.47 \text{ mm} \pm 2.27 \text{ mm}$), and radial inclination ($4.03^\circ \pm 3.27^\circ$) are similar to those of Kapoor et al who documented mean losses of 7.2° , 3.1 mm, and 5.2° respectively by conventional external fixation.²² This suggests that the mini external fixator is capable of holding the reduction during healing. The significant correlation ($r=0.876$, $p<0.001$) between functional and radiological outcomes in our study supports evidence by Kopylov et al which showed that recovery of normal anatomy is a key predictor of functional recovery.²³ The same applies to the moderate correlation between fracture subtype and functional outcome ($r=0.588$, $p<0.001$), which is consistent with Mackenney's observation that prognostication is affected by initial fracture complexity.²⁴ In terms of complications, our 16% pin tract infection rate is within the published rates of 5-21%. Post-fixator stiffness of 62.5% was higher than in some series but was successfully managed with physiotherapy, allowing 84.4% of patients to resume normal jobs. This is consistent with the findings of Krukhaug et al who highlighted the role of rehabilitation in maximizing outcomes after external fixation.²⁵ Early intervention was prioritized most highly in our protocol, where 90.6% of our patients underwent surgery within 24 hours of trauma. This is corroborated by Weil et al who had improved outcomes with early surgical fixation of the distal radius fracture.²⁶ Similarly, our timing in fixator removal (mean 6.63 weeks) is the balance between sufficient healing without stiffness, according to Slutsky et al recommendations.²⁷ Our series' 94% satisfaction (CI: 89.8-98.2%) is superior to that of other fixation methods for volar complex distal radius fractures. Karantana et al were satisfied in 89% with volar plating with percutaneous pinning.²⁸ It suggests that external fixation remains a valuable modality, particularly in resource-constrained settings, and where sophisticated plating systems are less available or less affordable. The mini external fixator gave following advantages: ease of application, minimal dissection of soft tissue, and preservation of periosteal blood supply. Above qualities most likely were the cause of low complication rate and satisfactory results obtained. Procedure also allowed early movement of uninvolved joints to a limited degree, possibly reducing severity of stiffness compared with absolute immobilization methods. In conclusion, our findings indicate that AAF mini external fixator is an effective treatment option for AO/ASIF type C distal radius fractures with high rates of anatomical restoration and functional recovery. The technique is a valuable alternative treatment option, particularly in areas where resource accessibility may limit access to more advanced fixation systems.

Limitations

The study's limitation lies in its non-randomized design and the fact that it does not have a control group with

which a comparison to other fixation methods can be made. The number of subjects, statistically adequate, is however quite small and may limit the generalizability of the findings to all fracture types. Finally, a 12-week follow-up might be inadequate for the detection of long-term consequences such as post-traumatic arthritis.

CONCLUSION

AAF mini external fixator has a very good result in the treatment of AO/ASIF type C distal radius fracture, with 94% of the patients having excellent to good results. The strong correlation between the radiological and functional results highlights the importance of anatomical restoration. The technique is a reliable form of treatment with acceptable patterns of complications, making it particularly valuable in resource-limited settings where more advanced fixation devices are less accessible.

Recommendations

Future studies in the form of randomized controlled trials comparing the AAF mini external fixator with other fixation techniques such as volar locking plates and fragment-specific fixation are required. Follow-up period (minimum 1-2 years) would give a better insight into long-term functional outcomes and complication rates. Multicenter studies involving larger sample sizes and heterogeneous patient groups would enable more statistical power and generalizability, and would possibly identify the patient subgroups most likely to benefit from this technique.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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