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Role of External Fixator Combined with T-Plate Internal Fixation in The Treatment of Comminuted Distal Radial Fractures

Mostafa Hussien Hegazy, Waleed Mohammed Ewees, Ashraf Atef Mahmoud, Mostafa Abdel Fadil Alakbawy*

Department of Orthopedics, Faculty of Medicine, Tanta University

***Corresponding author:** Mostafa Abdel Fadil Alakbawy, **Mobile: (**+20)01007129424, **Email:** alakbawy@gmail.com

ABSTRACT

Background: A technique of external fixator combined with T-plate internal fixation for intra-articular fractures of the distal radius is based on the finding that the separate t-plate fixation do not give complete stability to the fracture. However, if it is combined externally by external fixator, you get a solid synthesis of the fractured radius. This enables early mobilization of the wrist without the use of plaster cast.

Objective: The aim of the study was to evaluate the results of external fixator combined with palmar T-plate internal fixation for the treatment of comminuted distal radial fractures.

Patients and methods: This was a prospective study that was conducted on 20 patients. Patients were treated by the external fixator combined with T-plate internal fixation. All patients were attending to the Emergency Department and Outpatient Clinic of Orthopedic Surgery Department in Tanta University Hospitals.

Results: Patients had excellent range of motion, normal ROM of the arm, shoulder and hand. No significant differences in the radiographic parameters were detected between fracture fixation and fracture healing. Complications were few. At final follow-up evaluations, patients had well to excellent results with respect to range of motion scores. Stable fixation allowed starting active and passive motion of the wrist without compromising postoperative alignment. The poor results in this case were due to late intervention, osteoporosis due to old age and poor general condition of the patient, which resulted in incomplete union.

Conclusion: External fixator combined with T-plate internal fixation is an efficacious treatment option for intra-articular distal radius fractures with excellent long-term results.

Keywords: External fixator combined, T-plate internal fixation, treatment of comminuted distal radial fractures.

INTRODUCTION

Severe comminuted distal radial fractures are defined as unstable fractures that mostly involve the surface of the radiocarpal or distal radioulnar joint. The aim of treatment is resetting articular surfaces, restoring radial length, correcting ulnar deviation and palmar angle, resetting the radiocarpal or distal radioulnar joint, and maintaining the structure after reset. Inappropriate treatments can cause the degeneration of the wrist joint, pain, stiffness, and other symptom as well as obvious changes in the articular surface of the distal radius, ulnar deviation, palmar angle and radial shortening, which severely limit the forearm rotation and wrist function. Distal radial fractures classified as type A or B (according to the AO/ASIF classification) can be treated by plaster external fixation with satisfactory therapeutic results [(1)].

In case of fractures involving the articular surface and unstable comminuted fractures, it is difficult to maintain good results by using common external fixation. This can easily cause distal radial shortening, decrease the palmar and ulnar inclination angles and cause uneven articular surface. These consequently cause secondary pain and joint dysfunction [(2)].

Plate fixation is increasingly being applied in the treatment of comminuted distal radial fractures, and short-term follow-up demonstrates satisfactory results [(3)].

The post-healing functional score after the application of palmar T-shaped locking plates is superior to those with other methods such as non-locking plate fixation [(4)], dorsal plate fixation [(5)] and percutaneous Kirschner wire fixation [(6)].

Although the use of a palmar T-shaped locking plate combined with a dorsal plate [(7)] or the technique of combining volar plating with locked radial column plating or K-wire fixation [(8)] can achieve satisfactory results, they incur greater trauma and more late complications.

In contrast, another study indicated that palmar T-plate fixation is superior to the external fixator with respect to the restoration of radial height and wrist function [(9)].

AIM OF THE WORK

The aim of the study was to evaluate the results of external fixator combined with palmar T-plate internal fixation for the treatment of comminuted distal radial fractures.

PATIENTS AND METHODS

Patients:

This prospective study was performed on 20 patients. Patients were treated by the external fixator combined with T-plate internal fixation. All patients were attending to Emergency Department and Outpatient Clinic of Orthopedic Surgery Department in Tanta University Hospitals. The study was conducted in the period from June 2016 to June 2017. Patients were followed up for about 16 weeks at least. These intra-articular fractures were classified

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according to AO/ASIF classification. The clinical outcomes were calculated according to Cooney's modification of the Green and O'Brien scheme [10].

Inclusion criteria

- Fractures of the distal radius type c.
- Age above 18 years old.

Exclusion criteria

- Age under 18 years old.
- Distal radius fracture type A or B.
- Open fractures.
- General debilitating diseases.

Ethical approval and written informed consent:
An approval of the study was obtained from Al-Azhar University academic and ethical committee. Every patient signed an informed written consent for acceptance of the operation.

According to the AO/ASIF classification, nine cases were **AO type C1** (45.0%), eight cases were **AO type C2** (40.0%) and three cases were **AO type C3** (15.0%) as shown in table (1).

Table (1): AO classification of cases

AO/ASIF classification	No.	%
C 1	9	45.0%
C 2	8	40.0%
C 3	3	15.0%
Total	**20**	**100.0%**

The ages of patients were from 20 to 55 years old. The dominant hand was involved in twelve (60%) patients. Seven males (35.0%) and thirteen females (65.0%) (Tables 2, 3 & 4).

Table (2): Sex distribution of cases:

		No.= 20
Sex	Female	13 (65.0%)
	Male	7 (35.0%)

Table (3): Distribution according to side of fracture

Right (dominant)	Left
12	8
60.0%	40.0%

Table (4): Distribution according to age

40 years old or above	Under 40 years old
9	11
45.0%	55.0%

Table (5): Cases evaluation

Case No	Age	Sex	Work	Mode Of trauma	Interval Before intervention	AO/ASIF
1	30	Male	Plumber	Fall from height	four days	C 1
2	48	female	House wife	Slipped on floor	Two days	C 1
3	20	Male	Mechanic	Fall of hummer on his wrist	One week	C 2
4	47	female	Worker	Fall from bus	Two days	C 2
5	49	female	Secretary	Fall from two meters height	Three days	C 2
6	55	female	House wife	Slipped on floor	Five days	C 3
7	29	Male	Engineer	Road traffic accident	Two days	C 1
8	24	female	Housewife	Motor bike accident	1 day	C 1
9	25	Female	Housewife	Fall from height	0 day	C 1
10	52	Male	Worker	Slipped on the floor	Three days	C 3
11	22	female	Student	Bicycle accident	Two days	C 2
12	51	female	Doctor	Fall down stairs	Five days	C 3
13	36	female	Housewife	Slipped on the floor	One day	C 2
14	29	female	Worker at a factory	Fall from a bus	Two days	C 2
15	42	female	farmer	Motor car accident	Seven days	C 2
16	40	Male	Driver	Motor bike accident	Six days	C 2
17	38	female	Housewife	Fall from bus	Three days	C 1
18	30	female	Teacher	Slipped on the floor	One day	C 1
19	20	Male	Student	Motor car accident	0 days	C 1
20	42	Male	farmer	Hit by a stick	Seven days	C 1

Type C 1: articular simple, metaphyseal simple.**Type C 2:** articular simple, metaphyseal multifragmentary **Type C 3** articular multifragmentary, metaphyseal multifragmentary

Table (6): Distributions according to mode of trauma

Mode Of trauma	No.	%
Fall from height	7	35.0%
Hit by heavy object	2	10.0%
Road traffic accident	6	30.0%
Slipped on floor	5	25.0%
Total	20	100.0%

Table (7): Distributions according to Interval before intervention

Interval before intervention	No.	%
Zero day	2	10.0%
One day	2	10.0%
Two days	5	25.0%
Three days	3	15.0%
Four days	1	5.0%
Five days	2	10.0%
Six days	1	5.0%
One week	4	20.0%
Total	20	100.0%

- **Assessment:**
- Clinical: pain, range of movement, grip strength and activity
- Radiological: x-rays (anteroposterior and lateral views)
- **Material:**
- Hoffmann External Fixation System
- Hand Drill
- T Handle
- T- plate
- Allen / L Key
- C-arm imaging

METHODS

Surgical preparation

- **Preoperative**
- Full history was taken: Name, age and sex.
- Written informed consent was taken from all patients.
- Clinical examination including inspection, palpation, range of movement and neurovascular examination were performed.
- The laboratory investigations revealed that all patients were fit for general anaesthesia.
- **Intraoperative**

Position: All patients were at supine position with a hand table extension.

Anesthesia: All patients get general anesthesia.

Tourniquet: An upper arm tourniquet was applied with cast padding.

SURGICAL TECHNIQUE:

First: The external fixator was applied. Two small (0.5 cm) incisions were made at the dorsum of the second metacarpal bone at the radial side. Blunt dissection was done .Two shanzes for the external fixator were placed in incision as described above, 5 cm away from the fractured end. The wrist joint was fixed to the ulnar deviation of the palmar flexion by the external fixator. The fractured end was treated with preliminary manual reduction under Fluoroscopy (Figure 1).

Figure (1): Intraoperative external fixator

Second: A palmar Henry approach was used in the interval between the flexor carpi radialis tendon and radial artery.

Dissection: distal third (modified Henry approach)

The modified Henry approach utilizes the interval between flexor carpi radialis tendon and the radial artery, whereas the classical Henry approach goes between brachioradialis and the radial artery. The modified approach is medial to the radial artery. The radial artery was retracted laterally and the flexor carpi radialis was retracted in a medial direction. The pronator quadratus muscle was then exposed by retracting medially the muscle belly of the flexor pollicis longus. Exposure of the bone was completed by incision of the lateral and distal edges of pronator quadratus muscle leaving a small lateral cuff on the radius to allow for subsequent repair. This allowed elevation of the muscle belly from the anterior aspect of the distal radius (Figures 2 & 3).

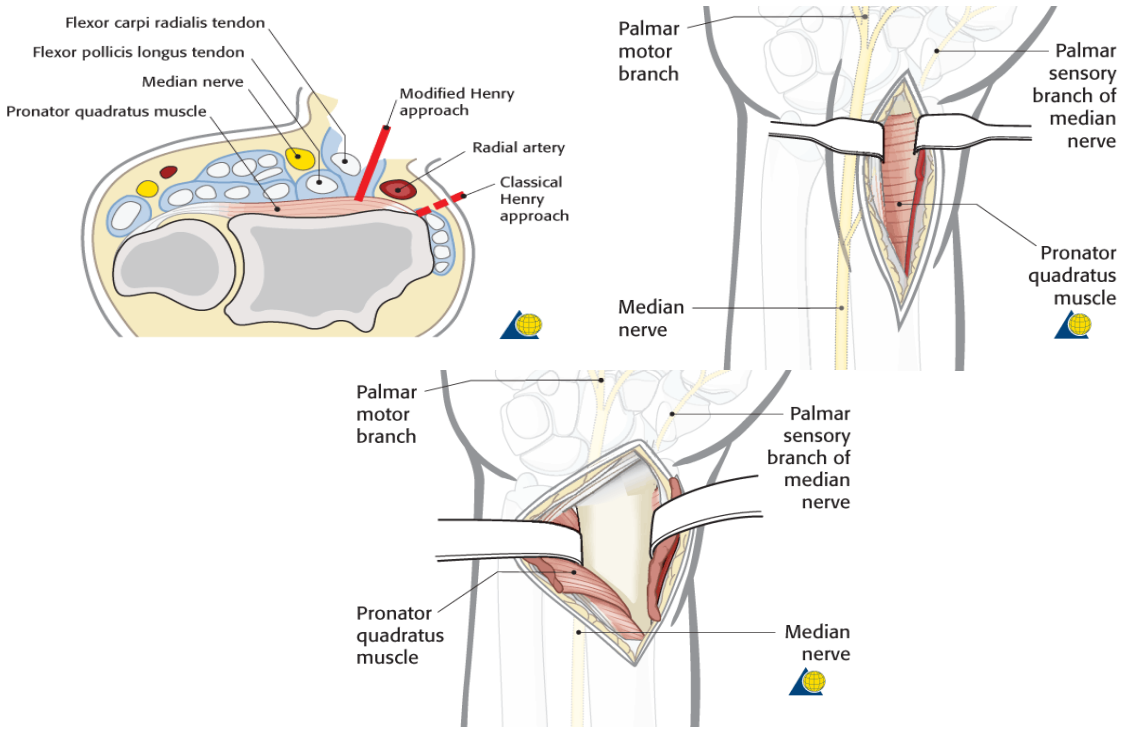


Figure (2): surgical technique illustrations

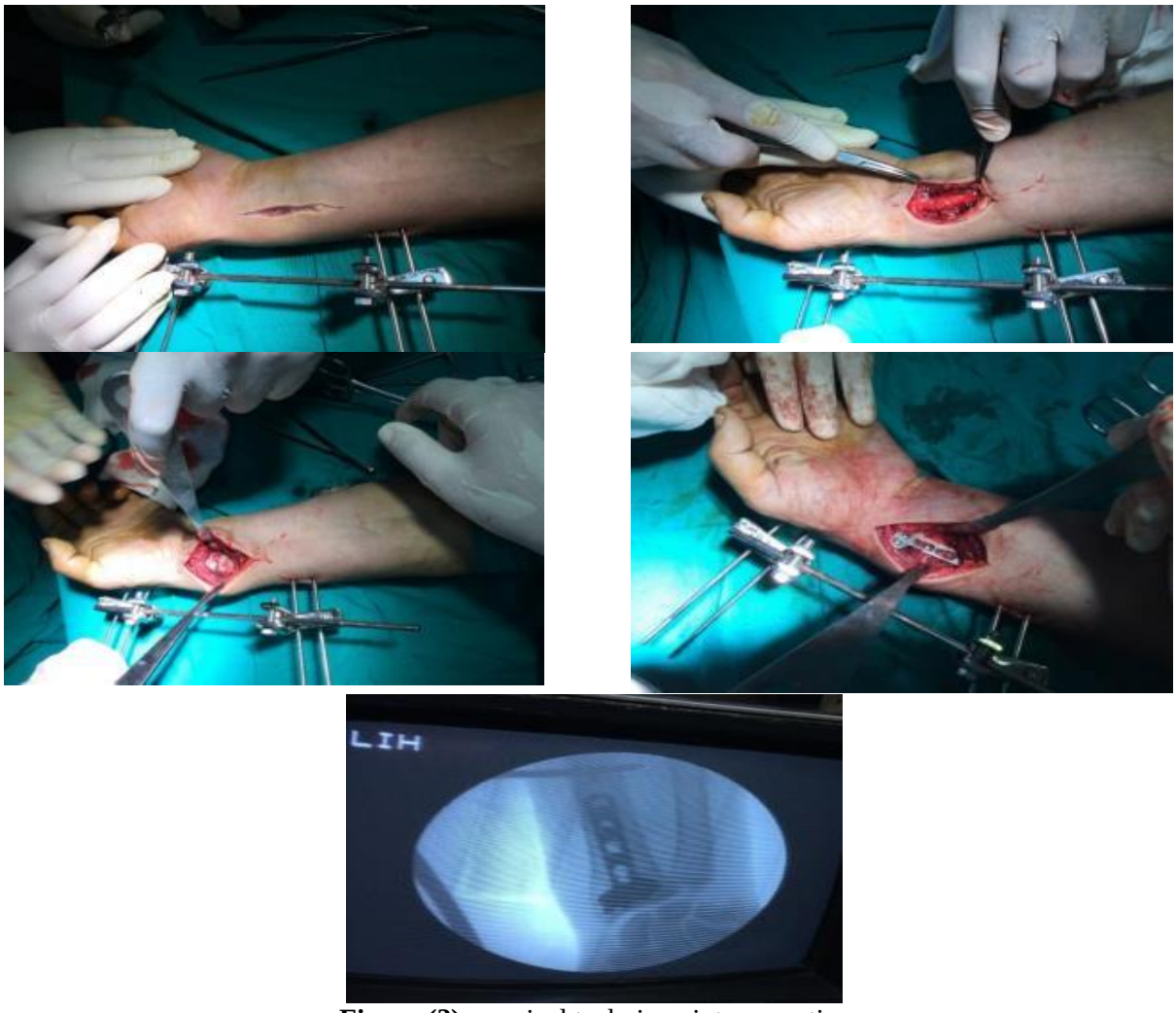


Figure (3): surgical technique intraoperative

Make sure that the plate is seated on the bone without any soft-tissue interposition. First, 2 screws were placed on the proximal part of the T-plate in order to support the distal bone blocks then we placed the distal screws

POST-OPERATIVE CARE

- **Follow-up**

X-rays were done every 2 weeks for 1 month then every 1 month for 6 months postoperatively. When the X-ray confirmed that the fractures were well healed (4-6 weeks postoperatively) the external fixator was removed. The functional exercises of the wrist and forearm were introduced gradually after removal of the external fixator.

- **Postoperative medication**

- Gram positive antibiotics IV
- Anti-inflammatory drugs
- Analgesic drugs

- **Methods of assessment**

Clinical results were evaluated in the follow-up period according to Cooney *et al.* [11] modification of the Green and O'Brien [10] scheme (Table 8).

If the X-ray confirmed that the fractures were well healed 4-6 weeks postoperatively, the external fixator was removed, followed by the gradual introduction of functional exercises of the wrist and forearm. The affected wrist was examined for palmar flexion and dorsiflexion, ulnar and radial deviation, pronation, and supination 6 months postoperatively. The steps of the articular surface, palmar angle, ulnar deviation, and radial height (i.e., the length of radial styloid and ulnar styloid) were measured in the distal part of the affected radius.

Statistical evaluation: Data were shown as mean ± standard deviation or frequency (percentage).

Table (8): Clinical scoring system of Green and O'Brien [10] modified by Cooney *et al.* [11] score

I. Pain (25 points)
- 25 None
- 20 Mild, occasional
- 15 Moderate, tolerable
- 0 Severe or intolerable

II. Range of motion (25 points): flexion + extension, percentage of normal
- 25 100
- 15 75-99
- 10 50-74
- 5 25-49
- 0 0-24

III. Grip strength (25 points), percentage of normal
- 25 100
- 15 75-99
- 10 50-74
- 5 25-49
- 0 0-24

V. Activities (25 points)
- 25 Returned to regular employment
- 20 Restricted employment
- 15 Able to work but unemployed
- 0 Unable to work because of pain

V. Final result
- 90-100 Excellent
- 80-89 Good
- 65-79 Fair
- <65 Poor

RESULTS

We studied 20 patients with age of a Mean ± SD 36.45 ± 11.49 (20 – 55) years. The average period of follow-up was about 6 months. All fractures were stabilized by the external fixator combined with T-plate internal fixation. Radiographs in the post-operative period showed a mean radial height of 11.15 ± 1.31, mean radial inclination of 22.40 ± 2.33 degrees, and mean volar tilt of 10.95 ± 1.83 degrees**.**

-Seven (35.0%) patients achieved post-operative complications: Three (15.0%) cases suffered from tenosynovitis managed by administration of a nonsteroidal anti-inflammatory drugs. Three (15.0%) cases suffered from wound infection managed by daily dressing with intravenous antibiotics. One (5.0%) case suffered from pin loosening managed by shanz removal and replaced by cast. Mean time of radiological union was 8 weeks.

Consolidation of fractures was obtained on average in 40 days, without major complications, in all cases treated except for three cases (15.0%) of infection, three cases with tenosynovitis (15.0%) and one case of pin loosening (5.0%). The Postoperative clinical and radiographic evaluation found no large joint limitation of the operated wrists, or significant loss of radiographic parameters with the intervention. The patients were able to use their operated wrist after an average of one week after surgery. Nine cases (45.0%) were subjected to physiotherapy.

Table (9): follow up results with radiological evaluation

Case no.	Flexion in degrees	Extension in degrees	Pronation in degrees	Supination in degrees	Grip strength	radial height in mm	radial inclination in degrees	volar tilt in degrees
1	(80)	(70)	(80)	(80)	37.7	11	22	9
2	(75)	(70)	(80)	(80)	30.9	10	22	13
3	(50)	(70)	(70)	(80)	15.4	9	19	14
4	(80)	(70)	(70)	(75)	29.1	12	23	9.5
5	(75)	(70)	(80)	(75)	30.2	11	21	12
6	(60)	(50)	(70)	(65)	14.2	8	16	14
7	(80)	(70)	(80)	(80)	34	13	25	8.5
8	(80)	(70)	(80)	(80)	31.5	12	24	13
9	(80)	(70)	(80)	(80)	32.4	11	22	10
10	(75)	(60)	(75)	(80)	25	13	22	9
11	(80)	(70)	(80)	(80)	33.2	12	23	13.5
12	(75)	(60)	(75)	(80)	32.3	11	24	11.5
13	(80)	(70)	(80)	(80)	33.6	12	20	12
14	(80)	(70)	(80)	(80)	33.5	13	22	10.5
15	(80)	(65)	(80)	(80)	38	10	23	9
16	(80)	(70)	(75)	(75)	30.1	11	26	11.5
17	(80)	(70)	(80)	(75)	36.5	12	23	10
18	(80)	(70)	(80)	(80)	35.2	10	21	9
19	(80)	(70)	(80)	(80)	37.2	11	25	10
20	(80)	(70)	(80)	(80)	38.2	11	25	10

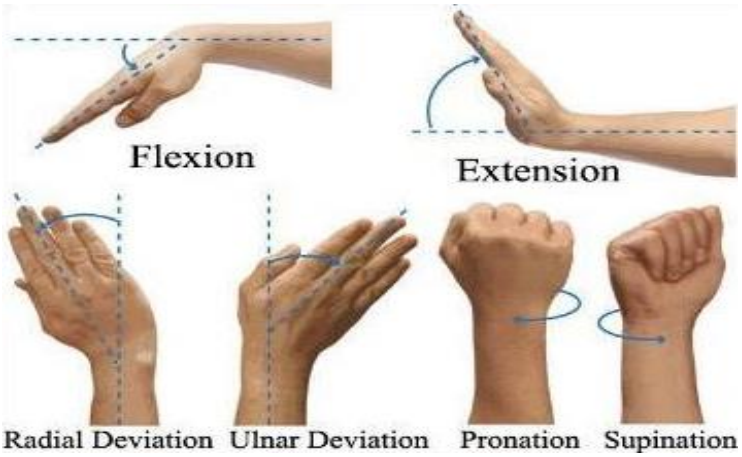


Figure (4): Movements of the wrist joint

Table (10): Complications during follow up

Post-operative complications	No.	%
No complications	13	65.0%
Tenosynovitis	3	15.0%
Pin tract infection	3	15.0%
Pin loosening	1	5.0%
Non union	0	0.0%
Digital stiffness	0	0.0%

Table (11): Results of functional evaluations

Case no.	pain	Range of motion	Grip strength	Activities	Final score
1	20	25	15	25	85
2	20	25	15	25	85
3	20	15	15	25	75
4	20	25	10	15	70
5	25	15	10	20	70
6	15	10	10	20	55
7	20	25	15	25	85
8	20	25	10	25	80
9	25	25	10	25	85
10	15	15	10	15	55
11	20	25	10	15	70
12	20	15	10	20	65
13	20	25	15	15	75
14	15	25	10	15	65
15	20	15	15	15	65
16	20	25	10	15	70
17	25	25	15	15	80
18	20	25	15	25	85
19	20	25	15	25	85
20	20	25	15	25	85

Table (12): Results according to clinical scoring system of Green and O'Brien [10] modified by Cooney *et al.* [11] score

		No.	%
Pain (25 points)	None	3	15.0%
	Mild, occasional	14	70.0%
	Moderate, tolerable	3	15.0%
	Severe or intolerable	0	0.0%
Range of motion (25 points) flexion +extension percentage of normal	0-24	0	0.0%
	24-49	0	0.0%
	50-74	1	5.0%
	75-99	5	25.0%
	100	14	70.0%
Grip strength (25 points) percentage of normal	0-24	0	0.0%
	25-49	0	0.0%
	50-74	10	50.0%
	75-99	10	50.0%
	100	0	0.0%
Activities (25 points)	Unable to work because of pain	0	0.0%
	Able to work but unemployed	8	40.0%
	Restricted employment	3	15.0%
	Returned to regular employment	9	45.0%

90-100 Excellent
80-89 Good
65-79 Fair
<65 Poor

Table (13): Results of functional evaluation

Final score results	No.	%
Poor	2	10.0%
Fair	9	45.0%
Good	9	45.0%
Total	20	100.0%

Table (14): Results of union

Time to union	No.	%
> 2 months	5	25.0%
< 2 months	15	75.0%
Total	20	100.0%

Table (15): Relation between union time, age and functional score

	Age		Final score	
Union time	**> 30**	**≤30**	**> 65**	**≤65**
> 2 months	4	1	0	5
< 2 months	7	8	15	0

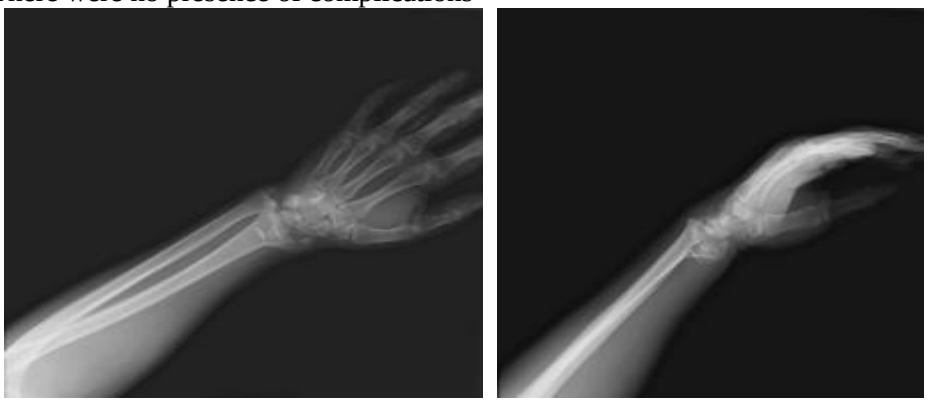
PRESENTATION

CASE 1 (Figure 5 A-B-C-D):

Fifty-one years old female, doctor, presented to Tanta University Hospital with pain, swelling, limitation of movement right wrist due to falling down stairs. Fracture was type C 1 according to **AO/ASIF** classification.

Follow up:

- The patient was followed up for 6 months after period of fixation. The external fixator was removed 1 month post-operative
- Time to union more than 2 months
- The end functional result (Green and O'Brien wrist scoring) = 65 (Fair).
- There were no presence of complications



(Figure 5- A) Pre-operative plain x ray (PA & LAT) with C 3 AO

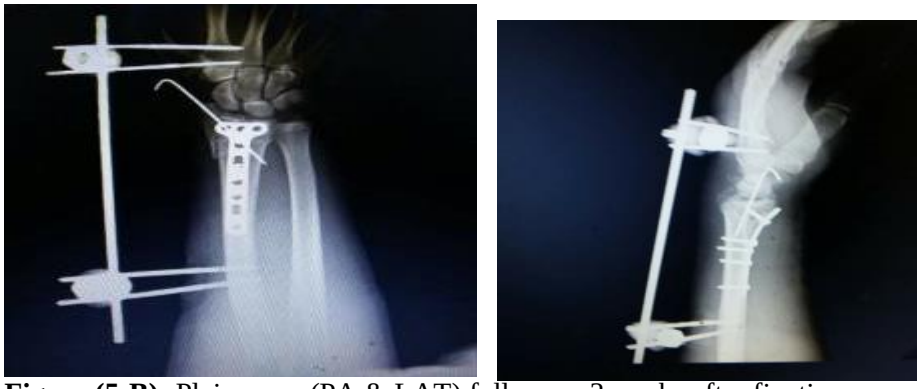


Figure (5-B): Plain x ray (PA & LAT) follow up 3 weeks after fixation

Figure (5-C) Plain x ray (PA & LAT) 6 months after fixation

Figure (5-D): functional results post 6 months

CASE 2 (Figure 6 A-B-C-D):

Twenty years old male, mechanic, presented to Tanta University Hospital with pain, swelling, limitation of movement left wrist due to fall of hummer on his wrist. Fracture was type C 2 according to **AO/ASIF** classification.

Follow up:

- The patient was followed up for 6 months after period of fixation. The external fixator was removed 1 month post-operative
- Time to union less than 2 months
- The end functional result (Green and O'Brien wrist scoring) = 75 (Fair).
- There were no presence of complications

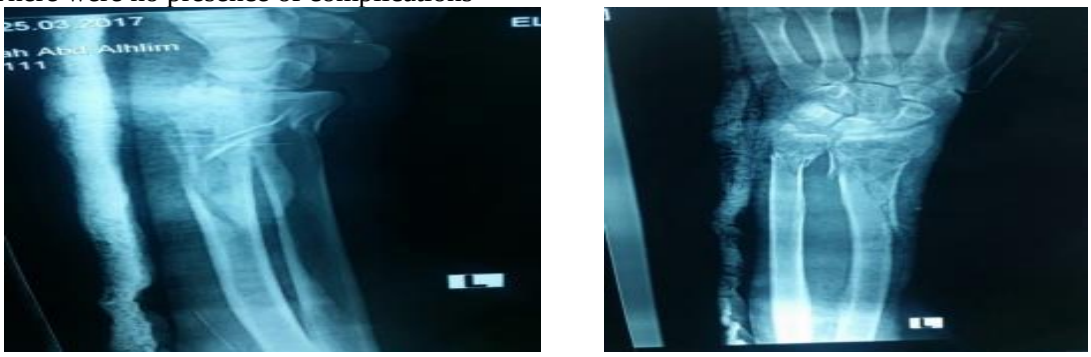


Figure (6-A): Pre-operative plain x ray (PA & LAT) with C 2 AO/ASIF

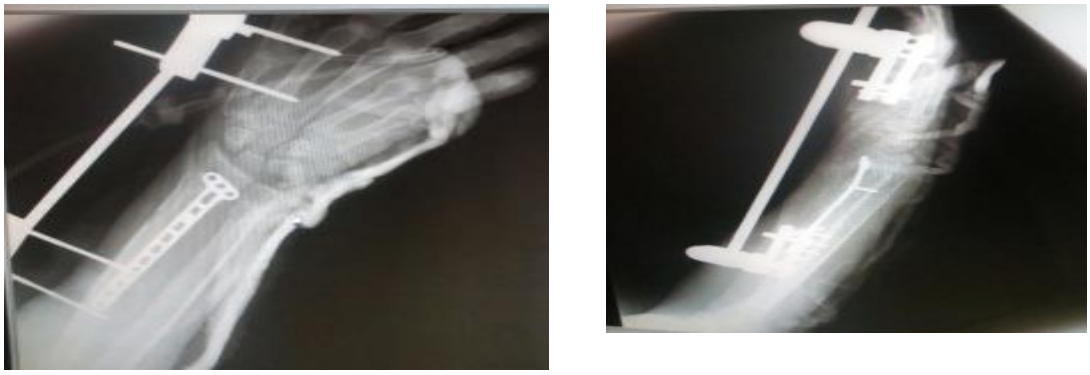


Figure (6-B): Plain x ray (PA & LAT) follow up after fixation**.**

Figure (6-C): Plain x ray (PA & LAT) 6 months after fixation.

Figure (6-D): Functional results post 6 months

CASE 3 (Figure 7 A-B-C-D):

Thirty years old male, plumber, presented to Tanta University Hospital with pain, swelling, limitation of movement of the left wrist due to fall from height. Fracture was type C 1 according to **AO/ASIF** classification.

Follow up:

- The patient was followed up for 6 months after period of fixation. The external fixator was removed 1 month post-operative.
- Time to union less than 2 months.
- The end functional result (Green and O'Brien wrist scoring) = 85 (Good).
- There were no presence of complications.

Figure (7-A): Pre-operative plain x ray (PA & LAT) with type C 1 AO/ASIF

Figure (7-B): Plain x ray (PA & LAT) follow up 2 weeks after fixation

Figure (7-C): Plain x ray (PA & LAT) 6 months after fixation

Figure (7-D): Functional results post 6 months

CASE 4 (Figure 8 A-B-C-D):

Forty eight years old female, house wife, presented to Tanta University Hospital with pain, swelling, limitation of movement left wrist due to Slipped on floor. Fracture was **type** C 1 according to **AO/ASIF** classification.

Follow up:

- The patient was followed up for 6 months after period of fixation. The external fixator was removed 1 month post-operative.
- Time to union less than 2 months.
- The end functional result (Green and O'Brien wrist scoring) = 85 (Good).
- There were no presence of complications.

Figure (8-A): Pre-operative plain x ray (PA & LAT) with type C 1 AO/ASIF

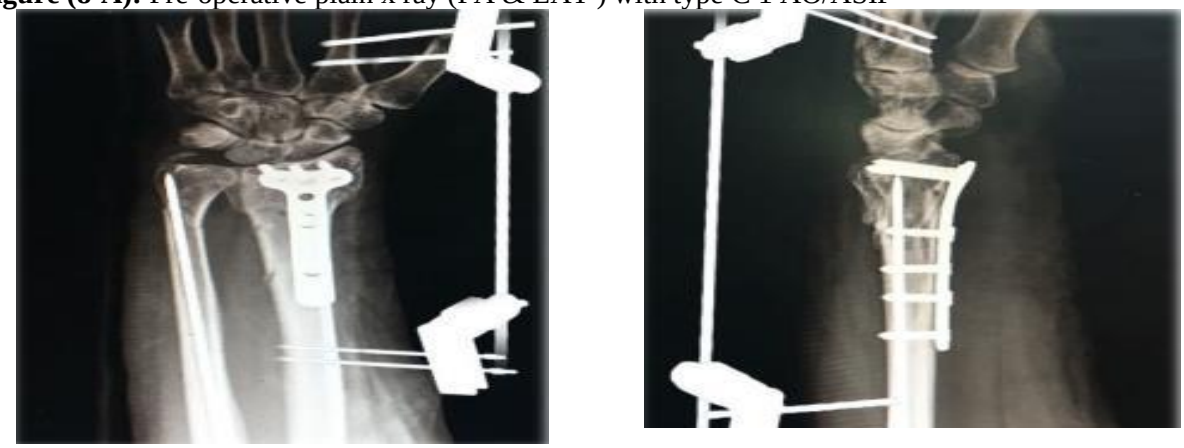


Figure (8-B): Plain x ray (PA & LAT) follow up 2 weeks after fixation

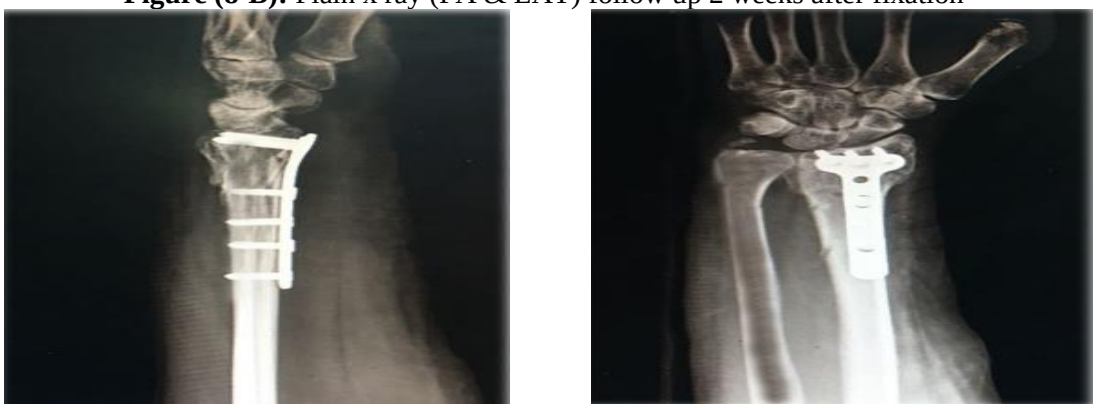


Figure (8-C): Plain x ray (PA & LAT) 6 months after fixation

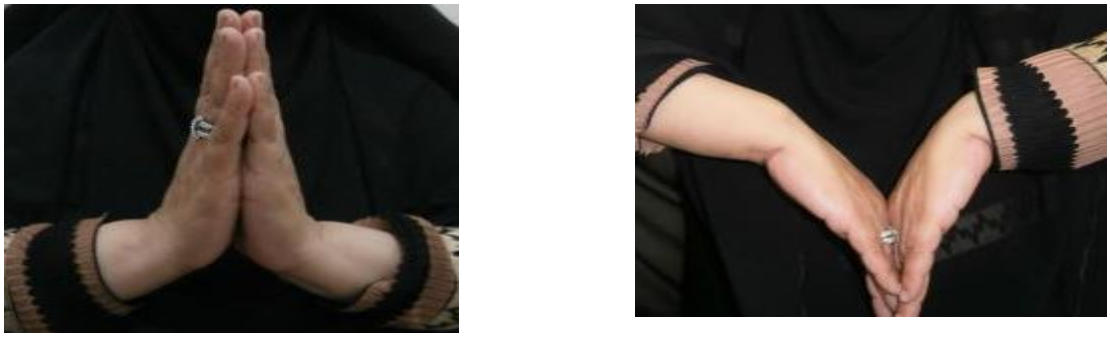


Figure (8-D): Functional results post 6 months

DISCUSSION

For distal radius fractures classified as type A or B according to the AO/ASIF classification, the application of plaster external fixation can achieve satisfactory therapeutic results [(1)]. However, for fractures involving the articular surface and unstable comminuted fractures, it is difficult to maintain a good reset by using common external fixation. This can easily cause distal radius shortening, decrease the palmar and ulnar inclination angles and uneven articular surface. These consequently cause secondary pain and joint dysfunction [(2)]. Plate fixation is increasingly being applied in the treatment of comminuted distal radius fractures, and short-term follow-up demonstrates satisfactory results [(3)]. Moreover, the post-healing functional score after the application of palmar T-shaped locking plates is superior to those with other methods such as non-locking plate fixation [(4)], dorsal plate fixation [(5)], and percutaneous Kirschner wire fixation [(6)]. Nevertheless, although the use of a palmar T-shaped locking plate combined with a dorsal plate [(7)] or the technique of combining volar plating with locked radial column plating or K-wire fixation [(8)] can achieve satisfactory results, they incur greater trauma and more late complications. In contrast, another study indicated that palmar T-plate fixation is superior to the external fixator with respect to the restoration of radial height and wrist function [(9)].

In the study, the early functional consequences and possible complications were infection in the operated location, tenosynovitis and loosening of pins that were documented in 15.0%, 15.0% and 5.0% of the patients, respectively. All these complications were resolved by non-invasive measures. No case of non-union or digital stiffness was encountered during the follow-up period.

Han *et al.* (2015) [(12)] compared the efficacy between external fixator combined with palmar T-plate internal fixation and simple plate internal fixation for the treatment of comminuted distal radius fractures from 2004 to 2011. A total of 61 patients classified as type C according to the AO/ASIF classification underwent surgery for comminuted distal radius fractures. There were 54 and 7 cases of closed and open fractures, respectively. Moreover, 19 patients received an external fixator combined with T-plate internal fixation, and 42 received simple plate internal fixation. The follow-up results showed that the palmar flexion and dorsiflexion of the wrist, radial height, and palmar angle were significantly better in those treated with the external fixator combined with T-plate compared to those treated with the simple plate only ($P < 0.05$). However, there were no significant differences in radial-ulnar deviation, wrist range of motion, or wrist function score between groups ($P > 0.05$). Hence, the effectiveness of external fixator combined with T-plate internal fixation for the treatment of comminuted distal radius fractures was satisfactory. Patients sufficiently recovered wrist, forearm, and hand function. **Hayes *et al.*** [(13)] followed up 358 patients with distal radius fractures after percutaneous pinning for 11 months. Infection, pain and non-union were reported in 27, 4 and 0.6% of the cases, respectively. It should be reminded that there are various methods in reporting pain and this possible may affect the final report.

Farhan *et al.* [(14)] reported that 24 patients underwent combined volar and dorsal locked plating for AO type-C3 distal radial fractures. Bone union, volar tilt, radial inclination, radial height, range of motion, grip strength, and any complications were assessed by a single hand surgeon. After a mean follow-up of 17 (range, 14–25) months, the mean palmar flexion was 49º (range, 30º–80º), dorsiflexion was 52º (range, 30º–80º), supination was 86º (range, 60º–90º), pronation was 77º (range, 30º–90º), radial deviation was 16º (range, 5º–30º), and ulnar deviation was 27º (range, 10º–50º). The mean time to radiological union was 3.9 (range, 2.5–6.0) months. No patient had non-union. At the time of union, the mean volar tilt was 5º (-22º–14º), radial inclination was 18.6º (8º–28º) and radial height was 8.5 mm (5.0 mm–13.6 mm). One patient had collapse of the dorsal fragment resulting in a dorsal tilt of 22º and limited (30º) forearm pronation. The patients also had minor complications of little finger flexor tendon irritation and carpal tunnel syndrome. She underwent implant removal and carpal tunnel release at 8 months. One patient had implant-related extensor digitorum communis irritation. Another patient had non-specific chronic wrist pain, which was resolved at one year.

In another series by **Rosati *et al.*** [(15)] in Italy, 106 patients with distal radius fractures were operated by percutaneous pinning approach. Mild infection was reported in 1.2% of cases and pain was reported in 5.6% of patients, which all resolved by non-invasive treatments. The complications in current series were not serious in majority and all recovered by simple therapies. Based on the same grading scheme, the final outcomes as follows: excellent, good, fair and poor in 53.7, 26.5, 11.3 and 8.5% of cases, respectively.

In conclusion the clinical outcomes at the end of follow-up period according to Cooney's modification of the Green and O'Brien scheme were as good, fair and poor in 45.0, 45.0 and 10.0% of cases, respectively. This study showed that the external fixator combined with T-plate internal fixation provides satisfactory treatment for intra-articular distal radius fracture and is relatively good with minor complications. Present differences might be justified by differences in the studied populations' characteristics (such as gender, age and severity of lesions), level of surgeon's skills and post-operative facilities and follow-up period [(16, 17)].

At final follow-up evaluations, patients had well to excellent results with respect to range of motion scores. Stable fixation allowed starting active and passive motion of the wrist without compromising postoperative alignment. Our results showed that nine cases got good score (45.0%), nine cases were fair score (45.0%) and two cases were poor (10.0%) according to Green and O'Brien score. The poor results in this case was due to late intervention, osteoporosis due to old age and poor general condition of the patient which resulted in incomplete union. However, the sample size and duration of follow up was short so that a bigger sample and longer follow up duration are needed to achieve statistically significant data. External fixator combined with T-plate internal fixation provided good stability to fracture of the distal radius.

CONCLUSION

The T-plate internal fixation, combined with external fixator ensures good stability, strong fixation and reduction of intra-articular distal radius fractures. It is an effective method to maintain reduction and prevent stiffness of wrist and hand.

Theorized benefits, include:

(1) ease of anatomic reduction by ligamentotaxis
(2) early return of hand and upper-limb function,
(3) diminished frequency and duration of formal occupational therapy and
(4) decreased risk of displacement

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