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SURGICAL MANAGEMENT OF INTRA-ARTICULAR FRACTURE DISTAL RADIUS BY MULTI AXIAL LOCKED PLATE

By

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ABSTRACT

Background: Early wrist motion and adequate reduction and fixation of fracture fragments including radial styloid process achieved with volar multi axial locked plate have the advantage of minimizing the risk of joint stiffness and radio carpal joint incongruity present in other treatment modalities of distal radius fractures. The aim of this work was evaluation of surgical management of intra-articular fractures of distal end of radius with volar multi axial locked plate.

Objective: To compare the radiological and clinical outcomes with volar multi-axial locked plate and other treatment modalities of multi-fragmentary and intra-articular distal radius fractures

Patients and methods: This was a prospective study on 20 patients with intra-articular distal radius fractures operated with open reduction and internal fixation with volar multi axial locked plates from February 2018 to March 2020 via trans flexor carpi radialis tendon sheath (modified Henry approach) in 12 patients with radial column involvement, and ulnar (extensile carpal tunnel release approach) in 8 patients with ulnar column involvement. Follow up was carried out for six months.

Results: The mean DASH score at 3rd month was 20.5 ± 6.9, while the mean DASH score at 6th month was 7.25 ± 4.1. The mean 3 months Modified MAYO Wrist Score was 81 ± 9.8 (median = 85), while the mean 6 months MMWS was 85.8 ± 12.5 (median = 90) which indicated a good ability of the patient to perform daily activities with minimal difficulty. At six months follow up 12 patients had excellent results, 6 patients had good results, one patient had fair result, and one patient had poor result.

Conclusion: Multi axial locked plate has the advantage of purchasing small fracture fragments including radial styloid process, and also allowing for early range of motion exercises which prevent the occurrence of radio carpal joint arthritis or stiffness.

Keywords: Distal Radius Fracture, Multi Axial Locked plate, Locked plate.

INTRODUCTION

Distal radius fractures are of the most common orthopedic injuries they account about 16% of fractures encountered in orthopedic practice, 40% are considered unstable and require fixation *(Gregory et al., 2014)*. The peak incidence of distal radius fractures in females occur in peri-menopausal age (40-60) years, whereas in

males were between the age (30-50) years *(Kevin et al., 2013).* Multi-axial locked plate has the advantage of purchasing small fracture fragments including radial styloid process, so allowing early motion exercises preventing the occurrence of radio carpal joint stiffness despite osteopenia or commination *(Park et al.,2010)* and *(Jagodzinski et al.,2018).*

Although some authors suggest that there are minor limitations in the range of wrist motion and limited grip strength as seen with non-operative care which do not seem to limit functional recovery at one year *(Egol et al., 2010),* distal radius fractures with indications of open reduction and internal fixation include those with radial styloid shortening, loss of volar tilt and radial inclination. Multi fragmentary fractures with intra articular step off more than 2 mm and in patients for whom function is a priority anatomic reduction and stable fixation are prerequisites for good results *(Obert et al., 2013).*

Proper reduction and fixation of small fracture fragments including radial styloid process are mandatory for proper results regarding proper function and motion of the wrist joint and protecting against radio carpal joint arthritis and stiffness *(Stanbury et al., 2012).*

Multi-axial locked plate has the advantage over external fixation in comminuted fracture treatment by its proper joint line reduction and stable fixation of small fracture fragments *(Gill et al., 2019).*

Fixation of distal radius fractures with multi axial plate minimize hardware complications encountered with fixed angle plate *(Mehrzad and Kim 2016)* and its anterior sloping protect against flexor tendon irritation.

The aim of this work was to evaluate the surgical management of intra-articular fractures of distal end of radius with volar multi axial locked plate.

PATIENTS AND METHODS

From February 2018 to March 2020 a prospective case series study was performed on 20 patents in Al-Hussein University Hospital. Twenty patients with Intra-articular distal radius fractures were admitted and treated with volar multi axial locked plates.

Inclusion criteria included:

Unstable fractures, Adult cases only after physeal closure, Intra articular fractures, Multi-fragmentary fractures, Intra articular step off >2mm, Presence of radial shortening.

Exclusion criteria included:

Stable fractures, Child cases before physeal closure, extra articular fractures Simple volar or dorsal tilted metaphyseal fractures which become stable after closed reduction.

Pre-operative assessment:

Patients presented with pain and swelling in distal forearm and wrist with inability to use the affected limb were assessed for systemic associated injury in the accident and for associated medical illness. Neuro vascular examination was carried out for detection of associated acute carpal tunnel syndrome or radial pulse impairment. During pre-operative assessment, x rays were taken in antero posterior, lateral and oblique views for detection of fracture pattern, direction of

displacement and number of broken fragments, and also x rays of contralateral side for comparing lengths **(figure 1)**.

Figure (1): Antero posterior and lateral X ray of intra articular distal radius fracture (one of our study cases).

For intra articular fractures, CT was taken for detection of lunate fossa and distal radio ulnar joint incongruity, and also for proper detection of fracture displacement and number of broken fragments including radial styloid and lunate fossa fractures.

Surgical procedure cases were operated with modified Henry approach (trans flexor carpi radialis) in fractures involving the radial column **(figure 2)** and ulnar approach for fractures involving the ulnar column.

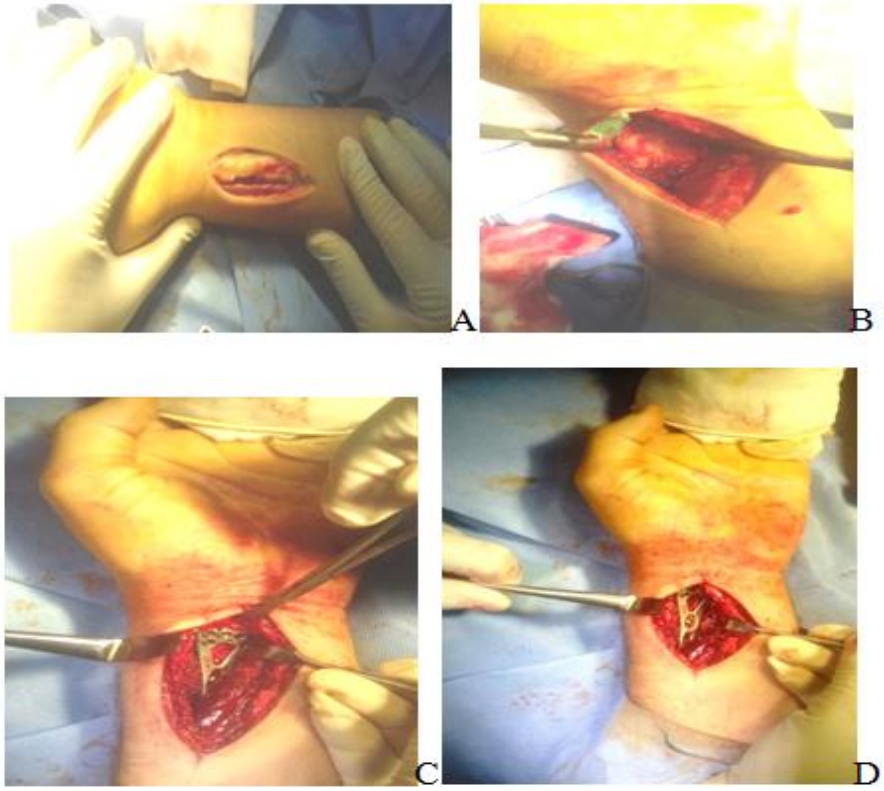

Figure (2): Intra operative plate insertion via modified Henry approach A: Trans flexor carpi radialis tendon incision. B: Fracture exposure. C and D Multi-axial plate insertion

Modified Henry approach was done through the sheath of flexor carpi radialis tendon. Incising the floor of flexor carpi radialis tendon allowing access to the deep volar compartment *(Conti et al., 2016)* Pronator quadratus was incised distally and radially, so distal radius fracture was identified. Trans flexor carpi radialis tendon approach has the advantage of not requiring direct radial artery dissection and isolation but the palmar cutaneous branch of the median nerve is potentially at risk and protected by avoiding any dissection ulnar to flexor carpi radialis tendon. **Ulnar approach** A volar extensile approach incorporates carpal tunnel release in cases with acute carpal tunnel syndrome and affords direct visualization and fracture reduction of the distal ulnar corner of the distal radius, maximum volar visualization of the distal radio ulnar joint and expanded exposure of radio carpal and mid carpal joints *(Asif M 2010).*

Direct manual reduction was done and fixation of broken fragments in poly directional manner including radial styloid process and lunate fossa fractures purchasing small fracture fragments to allow for early motion exercises and reduction of broken joint line preventing the occurrence of radio carpal or distal radio ulnar joint arthritis.

Post-operative care follow up was done at weekly interval for seven weeks then at monthly interval for six months below elbow slab was inserted for two to four weeks and range of motion exercises were carried out after two to three weeks.

Patients were assessed radio logically and clinically by DASH (Disability of Arm Shoulder and Hand) score which is a 30 item self- report questionnaire designed to assess patient health status at the last weak in performing daily activities (21 items) the severity of each of the symptoms of pain, tingling, weakness and stiffness (five items) and the impact of the problem on social functioning, work, sleep and self-image (four items) *(Maria et al 2007),* and by Modified Mayo Wrist Score which assess patient pain ,return to work, grip strength as compared to the opposite side and range of motion as compared to the opposite side.

CASE PRESENTATION

27 years old male patient presented to emergency department suffering from pain and swelling in distal forearm and wrist after road traffic accident, X- ray was taken and revealed AOC2 intra-articular three part fracture of distal end of radius **(figure 3)**.

Figure (3): Pre-operative X ray of AOC2 distal radius fracture. (A) Lateral view showing dorsal displacement of the fracture (B) antero posterior view showing significant shortening

Figure (4): Post-operative X ray after poly axial plate fixation (A) Antero posterior view showing proper fracture fixation (B) Lateral view showing proper fracture and joint line alignment.

Figure (5): Six weeks follow up x ray

Patient was assessed using range of motion which was fully achieved after two months **(figure 6)**, DASH score which was 10(minimal disability) at two months follow up and modified mayo wrist score which was 90 (excellent).

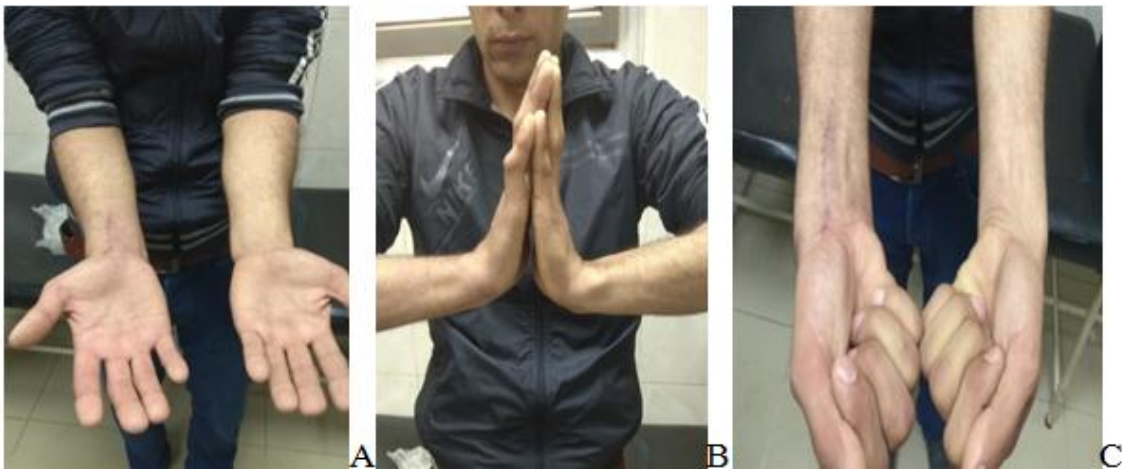

Figure (6): Follow up range of motion (A) supination full range of motion (B) full extension(c) full ulnar deviation

Patient was able to return to employment and performing daily duties in easy manner with minimal difficulty.

RESULTS

1. Operative data:

Demographic data (age and gender):

The mean age of all studied patients was 48.05 ± 11.7 years with minimum age of 27 years and maximum age of 65 years. There were 11 males (55%) & 9 females (45%) in the studied patients. There were 5 patients (25%) AO B1, 5 patients (25%) AO B2, 4 patients (20%) AO B3, 4 patients (20%) AO C1 & 2 patients (10%) AO C2. The mean operative time in all studied patients was 107 ± 9.2 min with minimum time of 90 min and maximum time of 120 minutes **(Table 1)**.

Table (1): Description of fracture type and operative time in studied patient

Parameters		**Studied patients (N = 20)**	
Fracture type	**AO B1**	5	25%
	AO B2	5	25%
	AO B3	4	20%
	AO C1	4	20%
	AO C2	2	10%
Operative time (min)	**90 min**	1	5%
	100 min	9	45%
	110 min	5	25%
	120 min	5	25%
Operative time (min)	**Mean operative time ± SD**	107 ± 9.2	
	Min – Max	90 – 120	

Method of fixation: All cases in the study were treated and fixed with volar multi axial locked plate.

2. Post-operative evaluation:

All cases operated and follow up continued from three to six months. All cases operated through volar modified Henry approach and ulnar approach.

Evaluation of the cases was done by different methods including time to union, time to return to full activity, post-operative range of motion of the wrist joint and DASH scoring system.

1. Radiological evaluation: all cases in the study regained length, volar tilt and ulnar inclination also in all cases articular step off disappeared.
2. Starting of range of motion activities after two to three weeks post operatively.
3. DASH score for evaluation of patient ability or difficulty in performing different activities.
4. Modified MAYO wrist score.

There were 14 patients (70%) started motion after 2 weeks & 6 patients (30%) started motion after 3 weeks.

There were 6 patients (30%) had 6 weeks to clinical union, 12 patients (60%) had 7 weeks to clinical union & 2 patients (10%) had 8 weeks to clinical union.

There was statistical significant difference **(p-value < 0.001)** between follow up months as regard DASH score the mean DASH score at 3rd month was 20.5 ± 6.9 while the mean DASH score at 6th month was 7.25 ± 4.1.The mean 3 months MMWS was 81 ± 9.8 (median = 85) while the mean 6 months MMWS was 85.8 ± 12.5 (median = 90) **(Table 2)**.

Table (2): Comparison between follow up months as regard DASH score and modified MAYO wrist score

Parameters \ Duration		3rd month (N = 20)		6th month (N = 20)		P-value
DASH score	**Mean**	20.5		7.25		**< 0.001**
	±SD	6.9		4.1		
Modified MAYO wrist score	**Mean ±SD**	81 ± 9.8		85.8 ± 12.5		>0.05
	Median	85		90		
Modified MAYO wrist score	**Poor**	1	5%	1	5%	>0.05
	Fair	2	10%	1	5%	
	Good	12	60%	6	30%	
	Excellent	5	25%	12	60%	

At final follow up 12 patients had excellent results, 6 patients had good results, one patient had fair result and only one patient had poor result who neglected post-operative follow up **(Table 3)**.

Table (3): 3 months and six months results of study cases

End result \ Duration	3 months result	3 months result	6 months results	6 months results
Poor	1	5%	1	5%
Fair	2	10%	1	5%
Good	12	60%	6	30%
Excellent	5	25%	12	60%

DISCUSSION

Distal radius fractures are one of the most common orthopedic injuries about 40% of them are unstable and require open reduction and internal fixation with plate and screws *(Gregory et al., 2014)*. Falling on the outstretched hand transfer load directly (about 80%) to the distal radius causing its break either in volar or dorsal directions this may occur either in two, three, or four part fracture pattern. These injuries have two peaks older patients with fragility fracture of mild trauma and younger patients with strong bone which require more force as fall from height or road traffic accidents *(Kevin et al., 2013)*. Multi axial locked plates have the advantage of purchasing small fracture fragments including radial styloid process and lunate fossa fractures also its stable fixation allows early return to motion preventing the occurrence of radio carpal joint stiffness *(Geyer et al., 2011)*. Complicated fractures account for about 20 percent of distal radial fractures which may be due to the fracture itself or as complication to plan of treatment, Management of these complications must be individualized according to patient and sort of problem manner. Reflex sympathetic dystrophy, finger stiffness, Defective motion, Median or ulnar nerve compression may occur early or late in this fracture pattern.

In our study 20 patients were tested in a prospective case series study. Time to clinical union which becomes manifest clinically after disappearance of pain and limitation of movement.

Evaluation of the result was done using DASH and Modified MAYO wrist score. Excellent results reported in cases which begun motion and physiotherapy early. Superficial infection was reported in two cases and healed with regular dressing and antibiotics. Painful implant which required plate removal was reported in one case three months postoperatively after fracture full union.

Geyer et al., (2011) stated that multi axial locked plate shows good radiological and functional results even shortly after the operation in a prospective study on patients treated with ORIF. The emphasis was on early postoperative results.

Jagodzinski et al., (2018) in a retrospective study examining the clinical, functional and radiological outcomes of distal radius fracture fixation with the multi axial volar distal radius plate. They measured wrist range of movement and grip strength, and reviewed radiographs to assess restoration of anatomy, fracture union and complications. All fractures united within six weeks. Mean ranges of movement and grip strength were only mildly restricted compared to the normal wrist. The mean DASH score was 18.2.

Egol et al., (2010) suggested that minor limitations in the range of wrist motion and diminished grip strength, as seen with non-operative care, do not seem to limit functional recovery at one year.

Authors recommended volar poly axial locking plates for management of unstable distal radius fractures due to its lower complication rate as regard prominence and flexor tendon irritation. Anatomical reduction and stable fixation achieved by poly axial plate reduces the occurrence of implant failure and allow early range of motion exercises which prevent the occurrence of joint stiffness. Fixation of small fracture fragments achieved by poly

axial direction of screws gives the advantage of the poly axial plate over conventional plate *(Park et al., 2010*, *Stanbury et al., 2012* and *Obert et al., 2013).*

CONCLUSION

Multi axial locked plate has the advantage of purchasing small fracture fragments like radial styloid process and the stable fixation allowing early motion preventing the occurrence of radio carpal joint stiffness encountered in other treatment modalities also anterior sloping of the plate prevents the occurrence of irritation of flexor tendons.

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المناجزة الجراحية للكسور الممتدة للمفصل أسفل عظمة الكعبرة بواسطة شريحة ذاتية الغلق متعددة المحاور

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خلفية البحث: تعد الشريحة ذاتية الغلق متعددة المحاور من أفضل الطرق الجراحية المعروفة لمعالجة كسور أسفل عظمة الكعبرة، وذلك لقدرتها على تثبيت الكسور المفتتة وتجميع الأجزاء الصغيرة من الكسر، وذلك يعطى المريض القدرة على حركة المفصل سريعا مما يحميه من حدوث تيبس بمفصل الرسغ كذلك قدرتها على رد التفتت فى السطح المفصلى أسفل عظمة الكعبرة مما يمنع حدوث خشونة بالمفصل.

الهدف من البحث: فحص نتيجة إصلاح كسور أسفل عظمة الكعبرة بواسطة شريحة أمامية ذاتية الغلق متعددة المحاور (طريقة الكسر، طريقة العلاج، المضاعفات، التشخيص، الطريقة الجراحية).

المرضى و طرق البحث: تمت الدراسة على 20 مريض فى الفترة من شهر فبراير 2018 حتى شهر مارس 2020 بمستشفيات جامعة الازهر حيث كانوا يعانون من كسور أسفل عظمة الكعبرة حيت تم اصلاح هذه الكسور بواسطة شريحة ذاتية الغلق متعددة المحاور و تمت متابعة كل مريض إكلينيكيا و بواسطة الأشعة لمدة ستة أشهر.

النتائج: تمت هذه الدراسة عمليا بجراحة 20 مريض منهم احدى عشر ذكر وتسعة اناث إختلفت أعمارهم من سن 27 حتى 65 عاما مدة الجراحة إختلفت من 90 حتى 120 دقيقة منهم 13 كسر فى الناحية اليمنى وسبعة كسور فى الناحية اليسرى كما تمت متابعة المرضى لمدة

ستة اشهر بواسطة الأشعة والفحص الإكلينيكى. تمت بدء حركة مفصل الرسغ بعد إسبوعين لثلاثة أسابيع لضمان عدم حدوث تيبس بالمفصل. كانت نتيجة الجراحة ممتازة فى 12 مريض وجيدة فى ستة مرضى وكانت ضعيفة فى مريض واحد و سيئة فى مريض.

الإستنتاج: تحافظ الشريحة ذاتية الغلق متعددة المحاور على تثبيت الكسر ومنع القطع الصغيرة من الإنزلاق مع حركة المفصل، بالإضافة الى ان تعدد محاور تلك الشريحة يساعد على تجميع القطع المختلفة للكسر بإتجاهات مختلفة كما تساعد الشريحة ذاتية الغلق المريض على سرعة حركة المفصل فى خلال اسبوع أو إسبوعين على الأكثرمما يقلل إحتمالية حدوث تيبس بالمفصل.