Multipurpose External Fixation for Unstable Comminuted Intraarticular Fracture of Distal Radius

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Background: *Most of the Intraarticular distal radius fractures are complex and unstable. They are caused by high-energy injuries. The optimal and appropriate treatment remains a topic of controversy. Many different methods of treatment have been advocated such as closed reduction maintained by cast, K-wire fixation with cast, and opened reduction with internal fixation with plate and screws or external fixation with or without K-wire augmentation.*
Objective: *To study the efficacy of the TU Model External Fixator for the treatment of unstable intraarticular fracture of distal radius. This was assessed by radiographic anatomical alignment and clinical functional outcome.*
Material and Method: *Between January 2009 and March 2011, 147 cases of displaced unstable intra articular fracture of distal radius were treated at Thammasat University Hospital. Among these, 35 cases were treated by closed reduction and fixed by TU Model External Fixator. Their anatomical alignment (Jupitor and Knirk grading) and clinical outcome (Modified Green and O'Brien score) were assessed with at least 18 months of follow-up. The inclusion criteria are age more than 18 year and AO Type A2 to Type C3 unstable comminuted intraarticular fracture. The patients were excluded if they were Type II Gustillo open fracture, cannot follow the treatment protocol for at least two months, and the cases with volar marginal intraarticular fracture (AO type B or volar Barton pattern), or were younger than 18 year.*
Results: *The anatomical outcome were good to excellent in 28 of 30 cases = 93%. The clinical outcome was excellent in 21 cases. The functional result (Green & O'Brien) were good to excellent in 28 of 31 cases = 90%.*
Conclusion: *The study shows the functional and/or anatomical outcome for the treatment of the unstable intraarticular fracture of distal radius by the TU Model external fixator. It demonstrated equally the efficacy of this device when compared to the previous studies by the other researchers. Therefore, the TU Model external fixator could be a new device for the treatment of unstable comminuted fracture of the distal radius.*

Keywords: *External fixator, Intraarticular fracture, Distal end radius, Treatment*

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The present study was based on the AO classification of distal radius fracture (Fig. 1, 2). All 30 cases were AO type A2 to C3 of which have intra articular extension and comminution. Two of them were injured by animal bites and were excluded from the present study. The rest of them were caused by high-energy injuries and were included in the present study. The associated injuries were blunt abdominal injury and head injury. Four of the die punch fracture had DRUJ instability.

Literature Reviews

External fixation is one of several accepted methods used to manage distal radius fracture. The principal of ligamentotaxis has been used to confirm its mechanism for the treatment of unstable intra-articular fracture of distal radius. At present, there are few available devices available. However, they still allowed surgeons adequate versatility to follow their biomechanical principles.

Basic mechanic of an external fixator[1] has been around since 1943. It is the initial fixator designs of transfixing pins through the extremity with a frame on either side, the so-called bilateral frame. In 1960s, improved biomechanical understanding and metallurgy led to the development of sturdier and less complicated Schanz screws for the unilateral frames. In 1951, Ilizalov described a complex ring fixators that encircled the extremity are anchored with transfixion K-wires. The most recently various hybrid fixation pins and proximal Schanz screws are being proposed for use in distal radius fractures.

The components of the external fixator used to treat wrist fractures are a modular system that

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requires assembly at the time of use to create a stable construct and can use for reconstructive procedures such as correction of deformity and limb. Lengthening the fixation frame can be varied in their appearances. However, all of them have the same basic component, an external frame consisting of longitudinal bars that are connected by clamps to pins anchored into the bones. Basically, a fracture is immobilized by inserting the pins to a scaffold that is constructed outside the extremities. The longitudinal bars provide the stable frames. The pins and the bone fixation play an important role in the stability of the construct.

Indications for such use are[2] to manage the severe grade open fractures with extensive soft tissue loss, to resuscitate polytraumatized patients, to reduce internal hemorrhages, and to manage closed fractures that are too comminuted to consider open reductions, internal fixations, and pending transfers to tertiary referral facilities.

Definite external fixation may be left in place for the duration of fracture healing rather than just as a temporary measure pending soft tissue repair.

Recently, the multipurpose external fixator (TU Model) designed by the authors for treatment of intraarticular comminuted fracture of distal radius was purposed[3].

It is composed of parts as listed below (Fig. 1).

The multipurpose external fixator (TU model[3]), (Fig. 1):

1. The external connecting rod is light in weight and can be adjusted in different degrees of wrist flexion or extension, abduction, or adduction. This can reduce the fractures through the principle of ligamentotaxis by distracting the telescoping rods.

2. Anchored by 2.5 to 3 mm half-threaded Schanz pin, two pins proximal and two pins distal to the fracture site.

3. Designed as non-bridging and bridging that can fix non-across or across the wrist joint, to facilitate the motion of the wrist and grip-strength[4].

4. The design can resist at least 500 N for grip strength, 750 N for wrist flexion and avoids compression effect (computed by the metallic property and designed).

5. Designed as a static fixator and can be adjusted into multiple direction to provide an adequacy of maintaining the reduction and immobilization that is the "Multiplana external fixation".

Objective

To study the efficacy of the TU Model External Fixator for the treatment of unstable intraarticular fracture of distal radius, by evaluating anatomical and clinical outcome.

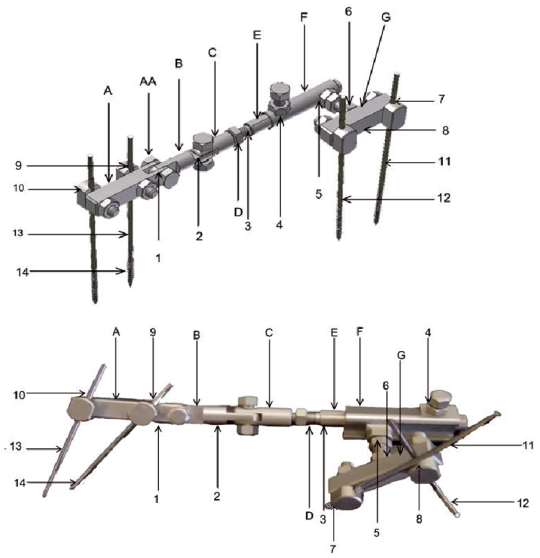
Material and Method

Between January 2009 and March 2011, 147 cases of displaced unstable intra articular fracture of distal radius were treated at Thammasat University Hospital. Among these, 35 cases were treated by closed reduction and fixed by TU Model External Fixator. Their anatomic and clinical outcome was evaluated with at lease18 months of follow-up.

The inclusion criteria are:

1. Age more than 18 years.

2. Intraarticular fracture of distal radius that was classified as Type A2 to type C3 by the AO Classification (Fig. 2).



a. Bridging external fixator

b. Nonbridging external fixator

Fig. 1 Multipurpose external fixator.

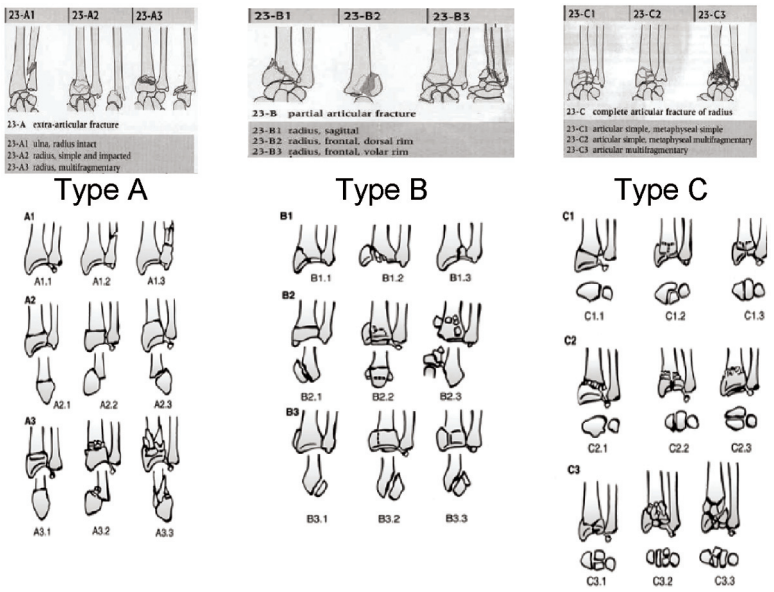


Fig. 2 AO classification of distal radius fracture.

Modified from Rockwood and Green's sixth edition Fracture in adults by Lippincott-Raven.

3. They were close fracture and/or open fracture, but must less than type II Gustillo classification of open fracture.

4. Patient accepts the treatment regimen and can follow-up for more than 18 months.

The exclusion criteria are:

1. Age less than 18 years.

2. More than type II by Gustillo classification of open fracture.

3. Cannot follow at least 18 months of follow-up schedule.

4. Patients with other medical problems that preclude surgery or disturb the fracture healing.

5. Do not accept the treatment protocol.

6. Cases with volar marginal intraarticular fracture (AO type B or volar Barton pattern) (Fig. 3).

The objective evaluation (Table 1-4)

1. Anatomical outcome by Sarmiento et al modified from Lidstrom[5] and the criteria of Knirk and Jupiter[6].

2. Functional or clinical outcome by the clinical scoring system of Green and O'Brien[7] and Gartland and Werley Evaluation of healed Colles' fracture[8].

Results

They were 35 fractures treated by close reduction and external fixation by TU model external

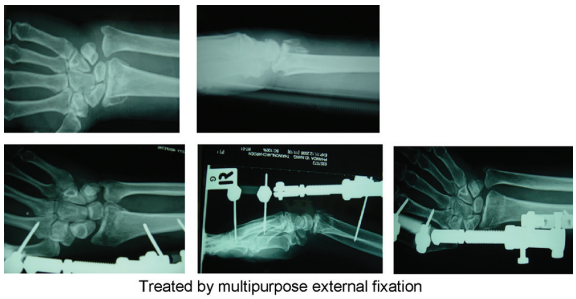


Fig. 3 Type A3 (AO) distal radius fracture.

Table 1. Criteria for anatomic results by Samiento et al modified from Lidstrom[5]

Result	Contents
Excellent	No significant deformity Dorsal angulation <0° Shortening <3 mm Loss of radial deviation <4°
Good	Slight deformity Dorsal angulation 1-10° Shortening 3-6 mm Loss of radial deviation 5-9°
Fair	Moderate deformity Dorsal angulation 11-14° Shortening 7-11 mm Loss of radial deviation 10-14°
	Severe deformity Dorsal angulation >15° Shortening >12 mm Loss of radial deviation >15°

fixator. Among these, 18 cases are female and 17 cases are male (Table 5-7, Fig. 4-6).

Complications after treatment

1. Pin loosening Tendon injury by the pin.
2. DRUJ Instability.
3. Shoulder stiffness in three cases (with age of 45, 79, and 45).
4. Pine tract infection in two case (treated by local dressing).
5. Regional reflex sympathetic dystrophy (RSD).
6. DS in one case (with RSD at the age of 70, a female presented with a mild swelling and pain of the hand and wrist joint).

Other clinical and anatomical outcome were evaluated according to the requirement as shown in Fig. 5.

Anatomical outcome (Jupitor and Knirk grading system)[6]

Good to excellence 28/30 = 93%**

Articular congruity grade and step off (follow Knirk and Jupitor)

Grade 0, 23 cases

Grade 1, 5 cases

Grade 2, 2 cases (2 of die punch fracture and other 2 could not be reduced in AO) type C3

Table 2. Articular grading according to the method of Knirk and Jupiter[6]

Grade	Step off	Finding
0	0-1 mm	None
1	1-2 mm	Slight joint space narrowing
2	2-3 mm	Marked joint space narrowing Osteophyte formation
3	>3 mm	Bone on bone Osteophyte formation Cystic formation

Table 3. Modified clinical scoring system of Green and O'Brien[9]

Category	Finding	Point (score)
Pain	None	25
	Mild occasional	20
	Moderate tolerat	15
	Severe or in tolerate	0
Functional status	Return to regular employment	25
	Restricted employment	20
	Able to work but unemployment	15
	Unable to work because of pain	0
Range of motion	Percent of normal ROM	
	100	25
	75-99	15
	50-74	10
	25-49	5
	0-24	0
Dorsiflexion-Palmar flexion arc (injured hand only)	120° or more	25
	91-119°	25
	61-90°	10
	31-60°	5
	≤30°	0
Grip strength	Percent of normal side	
	100	25
	75-99	15
	50-74	10
	25-49	5
	0-24	0
Final result	Excellent	90-100
	Good	80-89
	Fair	65-79
	Poor	<65

Table 4. Gartland and Werley point system used to evaluate end result of healed Colles' fracture[7,10]

Result	Point
Residual deformity	
Prominent ulnar styloid	1
Residual dorsal tilt	2
Radial deviation of hand	2-3
Point range	0-3
Subjective evaluation	
Excellent: No pain, disability or limitation of motion	0
Good: Occasional pain, slight limitation of motion, no disability	2
Fair: Occasional pain, slight limitation of motion, feeling of weakness in wrist, no particular disability if careful, activity slightly restricted	4
Poor: pain, limitation of motion, disability, and activities more or less markedly restricted	6
Point range	0-6
Objective evaluation	
Loss of dorsiflexion (<45°)	5
Loss of ulnar deviation (<15°)	3
Loss of supination (<50°)	2
Loss of pronation (<50°)	2
Loss of palmar flexion (<30°)	1
Loss of radial deviation (<15°)	1
Loss of circumduction	1
Pain in distal radioulnar joint	1
Grip strength: 60% or less than the opposite side	1
Point range	0-5
Complications	
Arthritic change	
Minimal	1
Minimal with pain	3
Moderate	2
Moderate with pain	4
Severe	3
Severe with pain	5
Nerve complications (median)	1-3
Poor finger function due to cast	1-2
Point range	0-5
End result point range	
Excellent	0-2
Good	3-8
Poor	9-20
Fair	≥21

Table 5. Cause of injuries

Cause of injuries	Cases
MC accident	17
Auto car injuries	4
Domestic fall	8
Fall from the height	7
Hit by heavy material	1
Animal bite	2

Table 6. Associated problem

Associated problem	Cases
Open fracture	2
Acute Gouty arthritis of the wrist	1
DM	1
Head injury	1
Blunt abdominal injury	1

Grade 3, none

Clinical outcome (modified clinical scoring system of Green and O'Brien)[9]

Excellent, 21 cases

Good, 6 cases

Fair, 3 cases

Poor, 1 case (70 years old female with RSD and malunion fracture)

Functional result (Green & O'Brien) 28/30

Good to excellent 28/31= 90%**

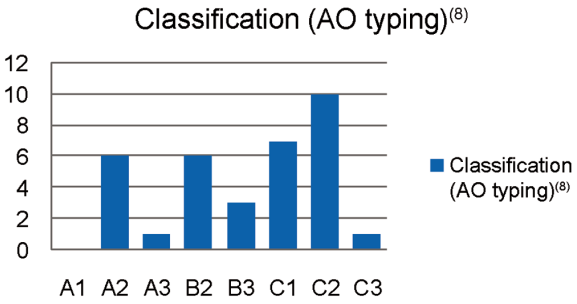


Fig. 4 Cases by (AO classification)[8].

Table 7. Cases by (AO classification)[8]

A1		B1		C1	7
A2	6	B2	6	C2	10
A3	1	B3	3	C3	1

** according to the method of Knirk and Jupiter[6]

Results

Excellent, 25 cases (one case augmentation with K-wire)

Good, 3 cases

Fair, 1 case (24 year with die punch fracture and other cases of 70 year of age with malunion)

Good to excellent, 28/29 cases = 0.965 = 96.5%

Discussion

Intraarticular distal radius fractures are complex and unstable. They are normally caused by high-energy injuries. The optimal and appropriate treatment remains a topic of controversy. Many different methods of treatment have been advocated

3	4	5	6	7	8	9	10	12	13	14	15	16	17	18	19	20	21	22	site	หมายเหตุ
69	F	Fall	20/5/2008	A2	45	10	0	10		80	70	50	45	180	180		100	50		1 name
30	M	H Fall	7/1/2008	A2	45	8	0	10		80	90	50	45	180	180	druj sublux	80	38		2 HN
40	F	Anmal hit	1/4/2008	A2	45	8		15		70	90	45	45	180	180		80	60		3 Age
17	F	Mc	22/11/2007	A2	45	8	0	10		80	60	45	45	180	180	Head inj Blunt abd		Lost F	Lt	4 Gender
46	M	Mc	29/5/2009	A2	45	10	0	10		90	90	45	45	180	180		80	16	Lt	5 Cause
70	F	fall	31/3/2009	A2	10	0	5	10		90	90	45	45	45	30	RDS mal u 3 m	80	12	RT	6 Date
56	F	Fall	9/9/2007	A3	45	10	0	10		30	50	45	45	45	130	Should stiff	30	8	Rt	7 Classification
				Ave	40	7.71	0.83	10.71		74.29	77.14	46.4	45	141.4	151.4		75			
				SD	13.23	3.55	2.04	1.89		20.7	17.04	2.44	0	65.87	56.69		23.5			8 Radial
50	M	Car	4/407	B2	45	10	0	10		90	80	45	50	180	180	loss fu	70	6		tuiting
35	M	Animal bit	15/5/2007	B2	40	8	0	8	open reduction							Loss FU	cellulitis'		Rt	9 Radeai
90	F	Fall H	18/9/2007	B2	45	10	0	10		80	70	45	45	180	180	cast fail	80	6	Rt	heigth
58	F	Mc fall	11/9/2007	B2	45	10	0	10		90	90	45	45	180	180	HT	90	44	Lt	10 Art
60	F	Home fall	12/6/2008	B2	45	10	0	10		90	90	45	45	180	160	druj inj	90	27	Rt	stepping
26	M	Mc	15/4/2006	B2	30	10	0	30		90	90	45	45	180	160	closed reduction	80	16	malunion 3 mons Lt	12 Volar
40	m	Mc	24/4/2006	B3	45	10	0	8		90	80	45	60	180	180	n	80	24		angulation
72	F	Fall H	9/4/2008	B3	45	10	0	10		90	90	45	45	180	180	should imp	100	54		13 Dorsal angle
25	M	Mc	3/507	B3	30	8	0	10		50	40	45	50	180	180	druj sublux	80	4	Rt multi f	14 Volar flexion
				Ave	41.11	9.56	0	11.78		83.75	78.75	45	48.1	180	175		83.8			15 Dorsiflexion
				SD	6.509	0.88	0	6.888		14.08	17.27	0	5.3	0	9.258		29.2			16 Ulnar
40	M	Fall Three	6/6/2007	C1	45	10	0	10		40	30	45	50	180	180	open f#	80	46	L	deviation
35	F	Mc	19/12/2006	C1	45	10	0	10		70	50	45	45	180	180	open f#	80	19	Rt	17 Radial
24	F	Mc	10/12/2007	C1	24	10	3	10		80	70	45	50	180	150	dsdie piunch	80	6	Lt	deviation
17	F	car	16/1107	C1	45	10	0	10		80	90	30	50	180	180		80	11	Lt	18 Pronation
48	M	Mc	1/5/2007	C1	45	10	9	10	70	90	70	45	45	180	150		80	2	Lt	19 Suprenation
35	M	Mc	26-ต.ค.	C1	20	10	2	20		90	70	45	45	180	180	gouty art	100	58	Rt	20 Complicatio
70	F	Fall	18/3/2009	C1	10	0	5	-15		90	40	45	60	180	180	shoulder stiffness		25		n
30	M	Mc	28/2/1950	C2	45	8	0	10		90	80	45	45	180	180	K wire	90	30		21 Grip
27	M	Car fall	7/2//07	C2	45	9	0	9		90	70	45	50	180	180		90	12		strength
55	F	Fall	9/10/2007	C2	45	10	0	10		80	70	40	60	180	180		80	16		22 FU time
70	F	Home fall	11/8/2008	C2	30	5	2	40		30	30	45	45	150	120	Lost reduction	60	7	Lt	
59	F	Fall H	28/12/2009	C2	30	6.5	0	12		90	90	30	45	180	180		100	37	Rt	
16	F	Mc	18/9/2007	C2	20	12	0	10		50	70	45	30	180	160	W infection	80	13	Lt	
78	M	Three F	21/1/2007	C2	15	10	2	-15		70	80	60	45	180	180	DRUJ inj	80		RT	
43	M	Hit by meta	2/5/2009	C2	45	10	8	10		90	90	45	45	180	180		80	2	Lt	
47	M	fall	29/5035	C2	20	10	0	-15	60	70	80	50	50	180	160		30	RT	Lt	
20	M	Fall three	4/12/2007	C3	20		10	10		80	70	45	50	180	180	Lock pl	90	20		
				Ave	32.29	8.78	2.41	8	65	75.29	67.65	44.1	47.6	178.2	170.6		80			
				SD	13.16	2.86	3.47	13.26	7	18.75	19.21	6.67	6.64	7.276	17.13		16.3			
				Ave	35.13	8.39	1.36	9.413	65	73.97	69.73	42.5	44.7	162.4	159.8		76.8	23.1		
				SD	13.06	2.95	2.7	9.689	38	21.97	21.72	11.2	11.6	45.71	42.25		23.5	18.2		
					A1	A2	A3	B1	B2	B3	C1	C2	C3							
					0	6	1	0	6	3	7	9	1							

Fig. 5 Biographic results.

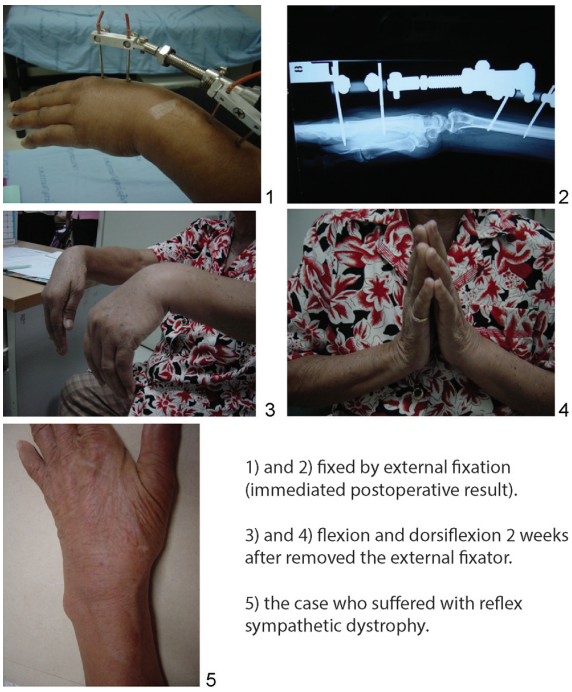


Fig. 6 Case treated and result of treatment.

such as closed reduction and maintained by cast, K-wire fixation with cast, opened reduction and plate fixation, or external fixation with or without K-wire augmentation.

Recently, many advances in both surgical technique and hardware design, such as low profile dorsal plates by Carter et al[11] have been studied. Ring et al[12] reported good clinical outcome for dorsal plate fixation by low profile plate. However, they cautioned that, in extensive comminuted fracture, the fixation should be supplemented with an external fixator to prevent or protect fracture redisplacement. Grewal et al presented good and equal outcome when comparing the dorsal pi plate and the external fixation. They showed no statistically significant clinical outcome of Range of Motion (ROM) between the two methods. Nevertheless, they observed that grip strength was greater in the external fixator group.

For the external fixator, complexity of designs has varied since 1943. The initial design was bilateral frames with transfixing pins passed through the extremity with a frame on either side[1]. By the late 1960s, improved biomechanical understanding and metallurgy led to the development of a sturdier but less complicated frame applied on one side of the limb using threaded Schanz screws as a unilateral frame. In 1951, Ilizarov introduced a new concept in limb lengthening with three-dimensional deformity correction by a complex ring external fixator that encircled the extremity and anchored with a thin transfixion K-wire. Wide spread use of the system began in 1990. Most recently, various hybrid fixators consisting of combination of distal transfixion pins and proximal Schanz screws are being proposed for the use in distal radius fracture[2].

The fundamental goal of external fixation is to obtain and to maintain an acceptable reduction until the fracture has gained sufficient stability. It can be applied before or after reduction is achieved. Some method is to insert the anchoring Schanz pins and to use the fixator to achieve indirect reduction. The ability to reduce the fracture after the fixator was applied is varied with the fixator's clamps, not the frame design. This is because the fixator's clamps do not have sufficient degree of freedom in all axis. In the bridging construct, no mobilization of wrist is possible until the removal of the fixator. Jone[13] suggested that it would be possible to move the wrist during bridging external fixation by placing a flexible tube between the connecting rods. Clyburn designed a fixator frame with a ball joint for the same purpose[14]. Several commercial external fixation devices for the treatment of distal radius fracture do not replicate normal wrist kinematics, which involves rotational and sliding movements. Movement with these fixators in place causes risks in forcing the carpal bones into an abnormal pattern of movement. A clinical study has demonstrated poorer results with loss of reduction and increased complications with the use of ball joint type external fixator compared with static fixation[15]. De palma demonstrated that the soft tissue envelope around the radiocarpal and distal radioulnar joint was preserved in artificial created comminuted fractures of the distal end of radius[16]. Straight traction of the hand with the wrist in full supination was capable of anatomic repositioning of the fragment, except for the volar tilt. The popularization of articular fracture reduction by distraction is credited to Vidal et al[17]. Radial length and inclination are easily restored because of the pull on the radial styloid by the attachments of the strong volar ligament. Several clinical studies showed that palmar tilt is often restored inadequately. Excessive application of the longitudinal distraction force with the wrist in palmar flexion causes tension in the extrinsic long extensor muscle and produces a clinically evident clawing of the fingers. Agee has refined further the concepts of ligamentotaxis as applied to the distal radius. They termed conventional

ligamentotaxis as a force applied in one plane thus, uniplanar ligamentotaxis. It does not achieve restoration of the palmar tilt. Longitudinal traction can be combined with radioulnar and dorsopalmar translation. However, it provides multiplannar ligmentotaxis that is capable of restoration of normal anatomy of the distal radius.

For the above reasons, the multipurpose external fixation system has to be improved and developed to a mechanism that incorporates the longitudinal supporting frame to allow supplemental translation after application of distraction. With the application of the fixator, the hand is translated in a palmar direction, producing a palmar vector at the midcarpal joint. The volar displacement of the capitate creates a rotatory force on the lunate. The distal radius fragment follows the lunate and tilts palmar ward, restoring the normal palmar inclination. For the volar marginal intraarticular fracture (AO type B or volar Barton fracture), ligamnetotaxis alone is not capable of reduction. This requires an additional volar buttress plate. Severe impacted fragments may not be reduced with traction and requires percutaneous manipulation and supplementation using K-wire[18].

After reduction of the distal radius fracture, the wrist will be immobilized in the position of extreme wrist flexion and ulnar deviation by either cast or external fixation. This position has been reported to cause potentially uncorrectable wrist stiffness by capsular contracture, digital stiffness, and inhibiting flexion by long extensor tightness and increased risk of median nerve compression resulting in carpal tunnel syndrome[19]. Even wrist in neutral position, overdistraction in fixator can result in similar untoward effects, including wrist and digital stiffness, median nerve neuropathy, and possibly even delay union or nonunion. Over distraction has been implicated as a possible risk factor in production of complex regional pain syndrome although this problem may represent another expression of distraction neuropathy[19]. Extreme wrist flexion and ulnar deviation or over distraction may be temporarily helpful in the operating room to achieve fracture reduction, but the fixator should never immobilized the wrist in these positions to a long time.

It has been indicated that the fixator frame should be readjusted to the neutral position, which can maintain the reduction of the fracture. Therefore, the character of the external fixator must be able to adjust in many directions with more degree of freedom on directions and can reduce the distraction force without causing redisplacement of the fracture's fragment. The external fixator must be synchronous with the center of rotation of the wrist[1]. Therefore, the ideal external fixation must have telescoping adjusting frame for the correction of distraction force. In addition, it should be able to adjust in any direction such as radial deviation or ulnar deviation and can flex volarly or dorsally in a low profile modular frame with radiolucency construct as the TU Model external fixation devices for wrist fracture[3].

A center with substantial experience in the treatment of distal radius fracture with external fixation reported overall complication rates of 14% or less, with superficial pin track infection in 4% to 10% of cases. It should have substance of deep infection, loss of fixation, and fracture through pin sites that occurred in approximately 1% of cases, where the possibility of nerve and tendon injury is virtually eliminated by the open technique of pin placement[20].

According to the study by Bradway JK et al[21] and Chan BK et al[22], 32 cases of intraarticular fracture of the distal radius were treated through an external fixation alone. Twenty-four cases were treated through external fixation. The rest were treated through K-wire augmentation. The external devices were removed after 6.9 week of fixation. They were rehabilitated by occupational therapists. Their final assessment results were evaluated and found 65% were good to excellent and 35% had fair outcome by the Modified Gartland and Werley's criteria[7]. While the present study found that 83% were ranging from good to excellent and 17% had fair results, the present study of open reduction and internal fixation by Bradway JB et al[21] found more than 65% good to excellent and 35% had fair result. For the anatomical assessments study by Chan BK et al[22], they found that 85% had a step off less than 2 mm. While the present study found that 93% ranged in good to excellent according to Green and O' Brien criteria for functional outcome and the authors found 87.1% of excellent of articular congruity following the scoring system of Jupitor and Knirk grading system as compared to 56% for the study by Bradway JK et al[21]. Therefore, these results showed that TU Model external fixator is effective for the treatment of unstable intraarticular fracture of the distal radius.

Regarding the complications of treatment in the present study, tendon injuries occurred by accidental penetration of the pin to the tendon. For the DRUJ instability, the external device did not cause ligament injuries in this area, so the pathology may be

caused by the previous injuries. It needs a careful preoperative assessment to set an appropriate plan for treatment of such a case. Some cases may require K-wire augmentation[23]. Pine tract infection in the present study was a superficial wound infection and may be caused by soft tissue trauma during the pinning process. Therefore, the surgeon should apply the Schanz pin gently and carefully to avoid traumatized injuries to the soft tissues. RSD occurred in only one case who was an elderly patient. According to the study by Mc Auliffe JA[24], prolonged distraction had been implicated as a possible risk factor in production of complex regional pain syndrome or RSD[20]. The authors can resolve this problem by the distraction adjustment after the external device is applied to the distal radius. For the TU model device, it was designed to be a telescoping adjustable external frame. Therefore, the surgeon should frequently evaluate and readjust the distraction and its alignment without any loosening of the frame and pin. For the case with shoulder stiffness, it occurred in an old female who was suffering from RSD, it was a problem of old age patient who did not move their shoulder for a period of time. The shoulder capsule and surrounding tissues may have some degree of soft tissue injury, which can cause shoulder stiffness. To prevent this problem, the old patients who suffer from distal radiusfracture and treated by any options of treatment should move their shoulder joints early with range of motion exercise.

Conclusion

The present study shows the functional and/or anatomical outcome for the treatment of the unstable intraarticular fracture of distal radius by the TU model external fixator. The results equally demonstrated efficacy of this device when compared to the previous studies by the other researchers. Therefore, the TU Model external fixator could be a new device for the treatment of unstable comminuted fracture of the distal radius.

Potential conflicts of interest

None.

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การประเมินผลการรักษาภาวะการแตกหักแบบเข้าข้อของกระดูกข้อมือส่วนปลายของกระดูก radius (unstable comminuted intraarticular fracture of distal radius) โดยใช้ชุดโลหะยึดตรึงกระดูกจากภายนอก แบบเอนกประสงค์

ยงยุทธ ศิริปการ, ธงชัย สุนทราภา, บัญชา ชื่นชูจิตต์

ภูมิหลัง: *การแตกหักของกระดูกที่เป็นแบบ unstable comminuted intra articula fracture ส่วนมากเกิดจากการบาดเจ็บที่รุนแรง วิธีการรักษามีหลายรูปแบบและยังไม่มีวิธีที่ถือเป็นมาตรฐาน เช่น closed reduction and cast, K-wire fixation with cast, internal fixation with plate and screws หรือ external fixation and K-wire or cast augmentation*

วัตถุประสงค์: *ศึกษาเปรียบเทียบสมรรถนะของเครื่องมือ external fixation ที่ออกแบบโดยมหาวิทยาลัยธรรมศาสตร์ ในการรักษาผู้ป่วยภาวะปลายกระดูก radius หักแบบแตกเข้าข้อ โดยประเมินจาก radiographic anatomical alignment และ clinical functional outcome*

วัสดุและวิธีการ: *รวบรวมการรักษาผู้ป่วยที่เป็น unstable comminuted intraarticular fracture ของ distal radius ที่ถูกจัดเป็นกลุ่มตาม AO classification type A2 ถึง Type C2 และ C3 อายุตั้งแต่ 18 ปีขึ้นไป จำนวน 35 ราย จากผู้ป่วยแบบเดียวกันทั้งสิ้น 147 ราย ที่มารับการรักษาที่โรงพยาบาลธรรมศาสตร์เฉลิมพระเกียรติ ในปี พ.ศ. 2552 ถึง 2554 ยกเว้นในรายที่เป็น open fracture type II ตาม Gustillo อายุน้อยว่า 18 ปี และผู้ที่ไม่สามารถมาติดตามประเมินการรักษาอย่างน้อย 2 ปีต่อเนื่อง*

ผลการศึกษา: *พบว่า anatomical outcome ได้ผลดีถึงดีเยี่ยม 93% (28/30) ผลทาง clinical หรือ functional outcome ได้ผลดีถึงดีเยี่ยม 90% (28/31)*

สรุป: *External fixator แบบเอนกประสงค์ของมหาวิทยาลัยธรรมศาสตร์ สามารถนำไปใช้รักษาภาวะปลายกระดูก radius แตกหักแบบแตกเข้าข้อได้อย่างมีประสิทธิภาพไม่ต่างจากการรักษาโดยวิธีอื่น*
