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Research Article

Management of Unstable Metacarpal Fractures with Traversing Kirschner Wiring

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Abstract

Trauma to the hand is exceedingly common, not infrequently resulting in metacarpal and phalangeal fractures and dislocations. Fractures of the metacarpals and phalanges comprise approximately 10% of all fractures.

Although failure to gain union in such fractures is unusual, the prevention of angular or rotational deformity, tendon adhesion and the consequent joint stiffness continues to challenge even the most experienced surgeon.

Aim: The aim of this study is to evaluate the functional and radiological outcome of transfixing a metacarpal shaft fracture into the adjacent intact metacarpal using Kirschner wires.

Patients and Methods: A sum of 23 fractures presented in 21 cases were treated using the transfixing Kirschner wires method. The age of these patients ranged from 18 to 62 years old.

Results: There were 13 patients (61.90%) who ended up with excellent results (Figure 3), 6 patients (28.57%) with fair results, and 2 patients (9.52%) with poor results.

Conclusion: Transfixing a fractured shaft metacarpal into an adjacent intact one using percutaneous transfixing Kirschner wires is a well-founded method of fixation in all simple metacarpal shaft fractures whenever surgery is indicated.

Keywords: *Metacarpal Fractures; Kirschner Wires; Trauma*

Introduction

Trauma to the hand is exceedingly common, not infrequently resulting in metacarpal and phalangeal fractures and dislocations. Fractures of the metacarpals and phalanges comprise approximately 10% of all fractures. Metacarpal fractures account for 30 - 40% of all hand fractures; fractures of the first and fifth metacarpals are the most frequent. Fractures of the fifth metacarpal neck (boxer's fracture) alone account for 10% of all fractures of the hand. Lifetime incidence of metacarpal fractures surprisingly [1].

While most of metacarpal fractures can be treated non-operatively, it may be beneficial to perform closed reduction in a setting where percutaneous pinning would be performed if the reduction could not be maintained without the introduction of some sort of internal stabilization [2].

Although failure to gain union in such fractures is unusual, the prevention of angular or rotational deformity, tendon adhesion and the consequent joint stiffness continues to challenge even the most experienced surgeon [3].

Aim

The aim of this study is to evaluate the functional and radiological outcome of transfixing a metacarpal shaft fracture into the adjacent intact metacarpal using Kirschner wires.

Patients and Methods

A sum of 23 fractures presented in 21 cases were treated using the transfixing Kirschner wires method. All cases were managed within the first 48 hours of their injury.

All patients were followed up for a minimum period of 24 months.

The age of these patients ranged from 18 to 62 years old. There were 19 males (90.47%) and 2 females (9.52%). Eleven patients were cigarette smokers (52.38%).

The non-dominant hand was involved in 12 patients (42.85%), while the dominant hand was involved in 9 patients (57.14%). Direct trauma either by impaction or by crushing in 16 patients (76.19%), indirect trauma in the form of a twisting injury was responsible for fractures in 5 patients (23.80%).

In this study, all metacarpal fractures dealt with were closed fractures.

There were 9 transverse (39.13%), 7 spiral (30.43%), 5 oblique (21.73%) and 2 comminuted (8.69%) fractures managed in this study.

The fourth metacarpal was the most frequently fractured in 9 patients (39.13%), the fifth in 7 patients (30.34%), the third in 4 patients (17.39%) and the second in 3 patients (13.04%).

Two patients had double fractures; spiral fractures in both the third and the fourth metacarpal in one patient, a spiral fracture in the third and a transverse fracture in the fourth metacarpal in the other.

Surgical Technique

After establishment of the anesthesia whether general or regional, primary reduction was attempted in the dorsally angulated fractures using the Jhass maneuver [4].

Failure to achieve a satisfactory reduction or its maintenance till the introduction of the transfixing Kirschner wires were overcome by introducing a disto-proximal antegrade non-threaded 1.2 to 1.4 mm intramedullary Kirschner wire under fluoroscopy to restore the alignment and the length of the fractured metacarpal.

The primarily introduced reducing intramedullary wire was needed in 8 fractures (34.78%); 5 transverse fractures (21.73%) and 3 oblique fractures (13.04%).

A Kirschner wire with a diameter ranging from 1.4 mm to 1.8 mm was typically introduced percutaneously perpendicular to the peripheral border of the metacarpal.

Starting with one of the distal wires introduced as close as possible to the fracture followed by another wire introduced as proximally away from the fracture as possible that is to be parallel -if feasible- to the first one (Figure 1).

Lastly, one more distal wire was introduced as farthest from the fracture as possible yet avoiding transgression on the sagittal bands of the collateral ligaments of the carpometacarpal joints that was achieved by applying the wire just proximal to the collateral recess.

Wires were essentially introduced either through the fractured border (second and fifth) metacarpal transfixing it to the intact central (third and fourth) metacarpal in 8 fractures (34.78%) or through the intact border metacarpal to transfix the fractured central metacarpal in 10 fractures (43.47%).

In order to avoid the medio-lateral translation to the achieved preliminary reduction on introducing the wires -especially in oblique and transverse fractures; in 5 cases (21.73%), all with only a single fracture, one or more wires were necessarily introduced first through the central (fractured in one case and intact in another case) metacarpal to the border (fractured in two cases and intact in one case) metacarpal (Figure 2), then pulled throughout the border metacarpal till it passes under the skin but not out of the central metacarpal.

Figure 1: *The most distal wire was placed through the fractured "border" metacarpal to the intact "central" one just proximal to the collateral recess of both bones and has also avoided tethering the sagittal bands.*

A ***B*** ***C***

Figure 2: *A. Anteroposterior view showing an oblique fracture in the lower third of the fifth metacarpal shaft. B. The distal wires were to be introduced first through the central intact metacarpal into the fractured border metacarpal. C. The resultant reduction on the image intensifier.*

All wires were left protruding from the skin after being bent. All fractures' fixation were protected by the means of a below elbow slab with wrist in slight dorsiflexion leaving the metacarpophalangeal joints freely mobile in the early postoperative period.

Postoperative Measures

Early motion was encouraged to be started within the first 24 hours of the procedure in 17 patients (80.95%), that was not necessarily the case in 2 patients (9.52%) with massive edema where motion started 4 days later as soon as it was tolerated and two other patients (9.52%) with comminuted fractures where the motion were cautiously allowed three weeks postoperatively.

Postoperative x-rays were done for all patients before discharge. All patients were discharged in the next day.

The protective slab was removed three weeks postoperatively for all patients but those with comminuted fracture where the slab was removed 6 weeks postoperatively.

Results

Almost every author used his own definition of appreciation of digital function. In order to make use of the common denominator of different studies in which the Total Active Movement (TAM) of 180° was the dividing line between 'poor' function on one side and 'fair/ excellent' function on the other, A TAM score of 180° and the presence of any measurable degrees of deformities were chosen as simple division between the 'satisfactory' and the 'unsatisfactory' results, for reasons of simplicity and uniformity.

According to the system adopted by the American Society for Surgery of the Hand (ASSH) Total Active Movements score (5), there were 13 patients (61.90%) who ended up with excellent results (Figure 3), 6 patients (28.57%) with fair results, and 2 patients (9.52%) with poor results (Table 1).

Figure 3: *Excellent range of motion of fingers flexion and extension was fully restored eight weeks postoperatively.*

			Total active movements (TAM)			
			Excellent	**Fair**	**Poor**	**Total**
Deformity (either angular or rotational deformities)	Without Deformity	Number	11	6	0	17
		Percentage	52.38%	28.57%	0	80.85%
	With Deformity	Number	2	0	2	4
		Percentage	9.52%	0	9.52%	19.04%
	Total	Number	13	6	2	21
		Percentage	61.90%	28.57%	9.52%	100%

Table 1: *Correlation between the deformities and total active movement.*

At the end of the follow up period, 4 patients (19.04%) sustained deformities; 2 patients (9.52%) both with comminuted fractures from second and third age groups with radiologically measured 30° and 45° degrees of dorsal angulation respectively, both with poor results and 2 patients (9.52%) one with a transverse fracture and the other is with a spiral fracture of the second group of age with rotational deformities of the affected digit overlapping more than 50% of the adjacent nail plate on fingers flexion, both with excellent results (Table 1).

Accordingly, satisfactory results (excellent and fair TAM score without any measurable deformities) were encountered in 17 patients (80.85%) while unsatisfactory results (poor TAM score or gross deformities) were met in 4 patients (19.04%) (Table 2).

	Overall end results	
	Number of the patients	**Percentage**
Satisfactory	17	80.85%
Unsatisfactory	4	19.04%
Total	21	100%

Table 2*: Distribution of cases according to the end results.*

Union was seen in all 21 patients (100%); within 6 to < 8 weeks in 10 patients (47.61%) (Figure 4), 8 to < 10 weeks in 8 patients (38.09%) and 10 to < 12 weeks in 2 patients (9.52%). Delayed union (i.e. union within more than 16 weeks) was encountered in only one patient (4.76%) with a comminuted fracture. (Table 3).

Figure 4: *A 19 years old female patient presented to the emergency department with a closed spiral fracture of the lower third of the fourth metacarpal shaft of her left hand due to a twisting injury to the fourth finger.*

A) Anteroposterior and oblique radiographs showing a spiral fracture in the lower third of the fourth metacarpal of the left hand

B) Intraoperative anteroposterior and oblique views off the image intensifier screen showing the application of the three transfixing wires after an adequate fracture reduction was achieved.

C) Anteroposterior and oblique radiographs showing sound union between the fracture fragments six weeks postoperative.

	Radiological union	
Weeks	**Number of patients**	**Percentage**
6 - < 8	10	47.61%
8- < 10	8	38.09%
10 - 12	2	9.52%
> 12	1	4.76%
Total	21	100%

Table 3: *Weeks till radiological union is detected.*

Complications

Out of 21 patients presented with 23 metacarpal fractures treated with transfixing wires; eight patients (38.09%) manifested with complications during the follow up period.

Complications varied from minor ones as infection and loosening of wires with no consequences on the treatment outcome in 4 patients (19.04%) to major complications as deformity (Figure 5,6) and stiffness affecting the final end results in 4 patients (19.04%).

Figure 5: *A. The middle finger overlaps the rotated ring finger(arrow) on flexion of the fingers of the left hand. B. Same patient was able to fully flex the rotated finger showing no stiffness of the affected left hand.*

Figure 6: *A. A dorsal hump (arrow) denoting a dorsal angulation of the left fourth metacarpal. B. The hump (arrow) becomes more prominent on fingers flexion.*

Discussion

Many isolated metacarpal fractures can be treated conservatively provided that they are stable enough to allow mobilization of the fingers to begin within a few days of the injury. If they are angulated, rotated or shortened, especially if they are multiple; they will require fixation of some sort. Bottom-line; whenever a metacarpal fracture requires manipulation, it is deemed to be fixed. Fixation allows earlier mobilization of hands presenting with multiple or complex injuries while securing the achieved reduction [6].

Satisfactory results in the largest sector of patients in this study could be attributable to a multifactorial influence starting with the affection of 13 (61.90%) patients aging between 20 - <40 years old; who were medically fit, with an adequate bone quality, sufficing healing capabilities and motivation towards rehabilitation.

The predominance of simple fractures either transverse, spiral or oblique in 19 (90.47%) patients, which was easier to handle during reduction and fixation. Simple fractures competently stabilized by the transverse wires were amenable to an early start of fingers motion.

On the other side of the spectrum, poor results encountered in this study could be traced back to either the comminution of the presenting fracture in 2 patients (9.52%) ending with unsound union and angulation, or the imprecise initial reduction in 2 patients (9.52%) that ended up in malrotation.

Smoking as well must have attributed to those poor results being a common factor in all patients who have ended in poor results. The definite determining factor of anticipating whether a single patient would either benefit from these method of fixation or not is undisputedly the ability of achieving a good range of active motion in the first few days postoperatively, a fair assumption could be safely made about the outcome of the patient depending mainly of this factor.

Compliance of the patient to exercise, nutrition and refraining from manual work till it was absolutely harmless to the course of treatment were as well important factors in the overall results. Early engagement of manual duties must have definitely burdened an existing imperfect reduction or questionable fixation, which is believed was the case for the patients who have ended with dorsal angulation of the metacarpal fractures and final poor results.

One of the points that was addressed in this study and was not merely combined with the transverse pinning in the same installation in literature was the usage of an intramedullary wire in 8 patients (38.09%) when an adequate preliminary reduction was difficult either to achieve or to maintain till the introduction of the transfixing wires. Such usage was found to statistically affect the final end results significantly.

Another attribute to this study that emerged through such learning curve was the introduction of the wires from the central towards the border metacarpals and/or vice versa in order to not only avoid the reduction displacement but also to impose it by pushing fragment back into place and out to its length.

The limitations of this study are that it is a non-randomized prospective study which included a relatively small number of patients, without a control series of patients treated with a different method. There was an unequal demographic distribution of patients with a relatively short 6 to 9 months follow-up.

Conclusion

This study justified the conclusion that transfixing a fractured shaft metacarpal into an adjacent intact one using percutaneous transfixing Kirschner wires is a well-founded method of fixation in all simple metacarpal shaft fractures -whenever surgery is indicated- offering a fairly stable construct allowing an immediate postoperative rehabilitation program to take place and thus restoring function to the demanding hand yet avoiding a whole spectrum of complications environ offered by other methods of fixation.

Comminuted shaft fractures are the least amenable to this method of fixation, owing to delimiting the gap for ideal wires introduction.

Using a preliminary intramedullary wire is invaluable in both achieving and maintaining reduction throughout this procedure.

It could be deemed as a technically undemanding procedure, once the rotation of the digits is ascertained before and after the fixation.

The role of rehabilitation with early mobilization afterwards cannot be underestimated.

Conflicts of Interest

No conflicts of interest.

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