Full length article

Transverse pinning versus intramedullary pinning in fifth metacarpal's neck fractures: A randomized controlled study with patient-reported outcome

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ABSTRACT

Introduction: The 5th metacarpal fractures accounts for 38% of all hand fractures given that the neck is the weakest point in metacarpals, so neck fracture is the most common metacarpal fracture. Surgical fixation is also advocated for such fractures to prevent mal-rotation of the little finger which will lead to fingers overlap in a clenched fist. Various methods are available for fixation of such fractures, like intramedullary & transverse pinning. There are very few reports in the literature comparing both techniques.

Authors wanted to compare outcomes and complications of transverse pinning versus intramedullary pinning in fifth metacarpal's neck fractures.

Methods: A single-center, parallel group, prospective, randomized study was conducted at an academic Level 1 Trauma Center from October 2014 to December 2016.

A total of 80 patients with 5th metacarpal's neck fractures were randomized to pinning using either transverse pinning (group A) or intramedullary pinning (group B). Patients were assessed clinically on range of motion, patient-reported outcome using the Quick-DASH (Disabilities of the Arm, Shoulder, and Hand) questionnaire & radiographically.

Two blinded observers assessed outcomes.

Results: At final follow up for each patient (12 months) the statistically significant differences were observed in operative time, the transverse pinning group showed shorter operative time, as well as complication rate as complications were observed only in intramedullary pinning group. No differences were found in range of motion or the Quick-DASH score.

Conclusion: Both techniques are equally safe and effective treatment option for 5th metacarpal's neck fractures. The only difference was shorter operative time & less incidence of complications in transverse pinning group.

Level of evidence: Level II, Therapeutic study.

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1. Introduction

The 5th metacarpal fractures accounts for 38% of all hand fractures given that the neck is the weakest point in metacarpals, so neck fracture is the most common metacarpal fracture.¹ Most metacarpal bones fractures occur in active young men.² Although such fractures can be managed non-operatively; cases with palmar angulation of $>30^\circ$ and shortening of >5 mm would greatly affect hand function³ thus they merit surgical fixation. Surgical fixation is also advocated for such fractures to prevent mal-rotation of the little

finger which will lead to fingers overlap in a clenched fist.⁴ Various methods are available for fixation of such fractures, Foucher et al.⁵ advocated the use of intramedullary wires while Berkman and Miles⁶ described the use of transverse pinning method where wires are passed transversely between the 5th and the 4th metacarpal. There are very few reports in the literature comparing both techniques regarding outcomes & complication rate.^{7,8}

The aim of this study was to compare outcomes and complications of transverse pinning versus intramedullary pinning in fifth metacarpal's neck fractures.

2. Method

A single-center, parallel group, prospective, randomized study was conducted at an academic Level 1 Trauma Center. The

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inclusion and exclusion criteria are enumerated in Table 1. The study was conducted from October 2014 to December 2016.

A total of 80 patients met the inclusion criteria (patients who suffered closed sub-capital 5th metacarpal fracture with angulation more than 30° & where 20–40 years old at time of injury) & and did not have any of the exclusion criteria (open, comminuted or pathological fractures & patients with any concomitant hand fractures) were included in the study. Patients were randomized (using the closed envelop method) into two groups (40 patients in each group), one group treated surgically using transverse pinning (group A) & the other group using intramedullary pinning (group B). Only 60 patients (58 males and 2 females) completed the study. All fractures were fixed on the same day of injury, except 4 patients were fixed 5 days after the injury. The mean age for group A (transverse pinning) was 32.2 ± 6.1 years, while that for group B (intra-medullary pinning) is 31.8 ± 6.3 years. There was no statistical difference between both groups in term of age ($p = 0.97$). The mode of trauma in the current study was direct blow in 42 (70%) patients, direct trauma in 14 (23.33%) patients & Fall to ground in 2 (3.33%) patients.

All surgeries were performed by the 1st author. Surgeries were performed under general anesthesia in 6 patients & under regional anesthesia (wrist block) in 54 patients. Patients were in supine position with hand to be operated over side arm support, a tourniquet was used only in group B (intramedullary pinning) patients. All operations were performed under fluoroscopic guidance.

All fractures were closed reduced & held in position using the technique described by Jahss.⁹

For transverse pinning, a total of 4 wires were used (2 on each side of the fracture). Wires were inserted from the ulnar side of the 5th metacarpal & driven toward the 4th metacarpal. The finger is then flexed & extended to check for any mal-rotation, & if alignment was satisfactory the wires were cut short & left protruding from the skin for easy later removal (Fig. 1).

For intramedullary pinning, a small incision was made at the dorso-ulnar aspect of the metacarpal base, a small drill was used to reach the medullary cavity the pre-bent K-wires were hammered gently, till the fracture level, then they are rotated so that the bent tips are pointing dorsally and diverging in slightly different directions (dorso-radial and dorso-ulnar) then wires are pushed to extend as far as the subchondral bone of the metacarpal head. This allows for a 3-point fixation which increases the stability of the construct and prevents the wires from backing out proximally. The K-wires are then bent at the level of the entry portal, cut & buried beneath the skin (Fig. 2)

Postoperatively, a splint was used only for 1 week, physiotherapy was started after splint removal. Transverse wires were removed at time of clinical union, intramedullary wires were not removed.

The patients were followed up at 2 & 6 weeks, 3 & 12 months. Radiographic follow up included obtaining anteroposterior (AP) view and a lateral oblique hand X-ray, this obtained till radiographic union was achieved (this was defined as evidence of callus). Clinical union was defined an absence of tenderness at the fracture site.

Clinical follow up included functional assessment using the following scoring systems:

1. Total active range of motion (**TAM**)¹⁰; This is achieved by adding the active flexion range (after subtracting the extension deficit) at metacarpophalangeal (MCP), proximal interphalangeal (PIP) and distal interphalangeal (DIP) joints. The population average values for flexion ranges in these joints were used as reference (0–85° for the MP joint, 0–110° for the PIP joint, 0–65° for the DIP joint, thus TAM would be the sum as 260°). Patients are then given a grade based on percent-regained motion compared to normal, thus patients who gained back 85–100% of range are graded as excellent; 70–84% is graded good; 50–69% is graded fair; and <50% is graded as poor outcome.
2. The American Society for Surgery of the Hand (ASSH) Total Active Flexion (**TAF**)¹¹; This is achieved by adding the sum of active flexion at MCP, PIP, DIP joints. Results >221° are graded as excellent, 121°–220° are graded as good, <120° are graded as poor.
3. **Quick-DASH** score^{12,13} (short version of the Disabilities of the Arm, Shoulder, and Hand questionnaire); It contains 11 items each graded from 1 to 5. At least 10 of the 11 items must be completed for a score to be calculated. The assigned values for all completed responses are simply summed and averaged, producing a score out of five. This value is then transformed to a score out of 100. This transformation is done to make the score easier to compare to other measures scaled on a 0–100 scale with zero as the best result (Fig. 3).

Two blinded observers assessed the outcomes.

Operative time & complications (e.g. loss of reduction, mal-union, nonunion, wires migration, infection) were recorded for every patient.

The statistical difference was calculated using the Student's *t*-test for continuous variables which followed a normal distribution and Mann-Whitney *U*-test for those not following a normal distribution. A *P*-value of less than 0.05 was considered statistically significant. Wilcoxon rank sum test was used for the Quick-DASH and Fisher exact test was used for complications.

3. Results

The mean operative time for group A (transverse pinning) was 10 ± 2 min, while that for group B (intramedullary pinning) was 32 ± 4 min; The difference was found significant (*P*-value = 0.025).

All patients achieved union, time to clinical union was 6.2 weeks (range from 6 to 8 weeks) in group A (transverse pinning), while that for group B (intramedullary pinning) was 6.13 (range from 6 to 8 weeks). The difference was found insignificant (*P*-value = 0.78).

At final follow up for each patient (12 months) the following clinical outcome results where noted:

1. Regarding TAM score (Table 1), group A (transverse pinning) 24 patients scored excellent & 6 scored good; while in group B

Table 1
Results of TAM & TAF scores.

Technique	TAM	Number	Percentage	TAF	Number	Percentage
Transverse Pinning	Excellent	24	80%	Excellent	28	93.33%
	Good	6	20%	Good	2	6.67%
Intra-medullary Pinning	Excellent	22	73.33%	Excellent	24	80%
	Good	8	26.67%	Good	6	20%

Fig. 1. X-rays for an example of transverse pinning; **A:** Pre-operative, **B:** Post-operative, **C:** Final follow up.

Fig. 2. X-rays for an example of Intramedullary pinning; **A:** Pre-operative, **B:** Post-operative, **C:** Final follow up.

(intramedullary pinning) 22 patients scored excellent & 8 scored good. The difference was found insignificant (P -value = 1).

2. Regarding TAF score (Table 1), group A (transverse pinning) 28 patients scored excellent & 2 scored good; while in group B (intramedullary pinning) 24 patients scored excellent & 6 scored good. The difference was found insignificant (P -value = 0.59).
3. Regarding Quick-DASH score, in group A (transverse pinning) the median was 3 points (0–28). In group B (intramedullary pinning), the median was 5 points (0–62). The difference was found insignificant (P -value = 0.51).

Complications were observed only in group B (intramedullary pinning) where 1 patient had wire backing out after lifting heavy object, 2 showed superficial wound infection that resolved with daily dressing & short course of oral antibiotics, 2 patients had symptoms suggestive of injury to the dorsal branch of ulnar nerve. Complications showed statistical significance in favor of group A (transverse pinning) (P -value = 0.04).

All patients returned to their pre-injury employments.

4. Discussion

Fifth metacarpal neck fractures result in volar angulation of the metacarpal head, such an angulation has been shown by many biomechanical studies to reduce hand function,^{14,15} thus, operative fixation of such fractures has been popularized recently. Many methods are available for fixation of such fractures, among these methods are transverse pinning or intramedullary pinning which both have the advantage of avoiding the complications that may

result from open reduction and internal fixation (such as soft tissue scarring that results in joints & extensor tendon adhesion).¹⁶

With transverse pinning, the 2 main concerns are: soft tissue tethering (especially the sagittal bands of the extensor mechanism) and pin tract infections.¹⁷ With intramedullary pinning, the 2 main concerns are: perforation of the metacarpal head and wires migration. Such a complication can be prevented by pre-the bending wires so that a three-point contact is created with 2 dorsal contact points at the proximal and distal ends of the metacarpal and one palmar contact point at the metacarpal's shaft. This configuration is in the opposite direction to the natural dorsal convexity of the metacarpal.¹⁹

Potenza et al.¹⁸ managed 35 patients with fracture neck of the fifth metacarpal with transverse pinning but only 28 could return for follow up. He reported an average follow up of 25 months, only 2 patients had loss of about 10° of extension at the MCP joint without significant impairment of hand function, all other patients had full extension. All their patients had at least 90° flexion of the fifth MCP joint and full range of motion of the IP joints. They recommended transverse pinning in all 5th metacarpal neck fractures in which surgery is indicated, especially when severe swelling of the hand is present.

Guy Foucher⁵) was the first one to describe the intra-medullary pinning “bouquet” technique for fractures of the metacarpal's neck. He later conducted a separate review of 66 consecutive patients with 68 metacarpal neck fractures with an average follow up period of 4.5 years. Postoperative complications were infrequent and included 1 case of reflex sympathetic dystrophy (with no residual impairment) and 1 case of dorsal ulnar sensory neuritis. Only 6 patients presented with an MCP joint extension lag (average 10°) and 6 patients had an

The Disabilities of the Arm, Shoulder and Hand Score(QuickDash)

Clinician's name (or ref) _____

Patient's name (or ref) _____

INSTRUCTIONS: This questionnaire asks about your symptoms as well as your ability to perform certain activities. Please answer *every question*, based on your condition in the **last week**. If you did not have the opportunity to perform an activity in the past week, please make your *best estimate* on which response would be the most accurate. It doesn't matter which hand or arm you use to perform the activity; please answer based on your ability regardless of how you perform the task.

Please rate your ability to do the following activities in the last week.

1. Open a tight or new jar	☐ No difficulty	☐ Mild difficulty	☐ Moderate difficulty	☐ Severe difficulty	☐ Unable
2. Do heavy household chores (eg wash walls, wash floors)	☐ No difficulty	☐ Mild difficulty	☐ Moderate difficulty	☐ Severe difficulty	☐ Unable
3. Carry a shopping bag or briefcase	☐ No difficulty	☐ Mild difficulty	☐ Moderate difficulty	☐ Severe difficulty	☐ Unable
4. Wash your back	☐ No difficulty	☐ Mild difficulty	☐ Moderate difficulty	☐ Severe difficulty	☐ Unable
5. Use a knife to cut food	☐ No difficulty	☐ Mild difficulty	☐ Moderate difficulty	☐ Severe difficulty	☐ Unable
6. Recreational activities in which you take some force or impact through your arm, shoulder or hand (eg golf, hammering, tennis, etc)	☐ No difficulty	☐ Mild difficulty	☐ Moderate difficulty	☐ Severe difficulty	☐ Unable

During the past week, to what extent has your arm, shoulder or hand problem interfered with your normal social activities with family, friends, neighbours or groups?

7. ☐ Not at all ☐ Slightly ☐ Moderately ☐ Quite a bit ☐ Extremely

During the past week, were you limited in your work or other regular daily activities as a result of your arm, shoulder or hand problem?

8. ☐ Not limited at all ☐ Slightly limited ☐ Moderately limited ☐ Very limited ☐ Unable

Please rate the severity of the following symptoms in the last week

9. Arm, shoulder or hand pain	☐ None	☐ Mild	☐ Moderate	☐ Severe	☐ Extreme
10. Tingling (pins and needles) in your arm, shoulder or hand	☐ None	☐ Mild	☐ Moderate	☐ Severe	☐ Extreme

During the past week, how much difficulty have you had sleeping because of the pain in your arm, shoulder or hand?

11. ☐ No difficulty ☐ Mild difficulty ☐ Moderate difficulty ☐ Severe difficulty ☐ So much difficulty I can't sleep

Thank you very much for completing all the questions in this questionnaire.

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The Disabilities of the Arm, Shoulder and Hand (quickdash) Score

(NB. A DASH score may not be calculated if there are greater than 1 missing items.)

There are two further small sections to this score. They are both optional. Just click below to select

WORK MODULE

SPORTS/PERFORMING ARTS MODULE

Reference for Score: Hudak PL, Amadio PC, Bombardier C. Development of an upper extremity outcome measure: the DASH (disabilities of the arm, shoulder and hand) [corrected]. The Upper Extremity Collaborative Group (UECG)

Am J Ind Med. 1996 Jun;29(6):602-8. Erratum in: Am J Ind Med 1996 Sep;30(3):372.

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Fig. 3. Quick DASH score.

MCP joint flexion lag (average 15°). He concluded that the “bouquet” technique is simple & provides enough stability for early mobilization and gives excellent functional results.

In the study performed by Winter et al.⁷, 36 patients with fracture of the neck of the fifth metacarpal were included; 18 patients underwent transverse pinning & 18 patients underwent intramedullary pinning. The mean age for their patients was 31.4

(range 18–65) years which is close to our study & their mean follow-up was 2.7 (range 2–3) months which is less than our study. They showed that the intramedullary group had better outcome as regard to TAM & TAF as compared to the transverse pinning group, their results are different from ours.

In the study performed by Wong et al.¹⁹, 59 patients were included to compare transverse pinning and intramedullary pinning

Table 2

Comparison of our results to the results of similar 2 studies.

	Our study	M. Winter et al. [7]	T. C. WONG et al. [19]
No. of patients	60 patients	36 patients	59 patients
Mean age	32 years	31.4 years	22.5 years
Mean follow up period	12 months	3 months	1 year
Technique	<u>Transverse</u> : 2 wires distal and 2 wires proximal to the fracture site. <u>Intra-medullary</u> : 2 wires ante-grade.	<u>Transverse</u> : 1 wire distal and 1 wire proximal to the fracture site. <u>Intra-medullary</u> : three wires used ante-grade.	<u>Transverse</u> : 2 wires distal+/- 1 wire proximal to the fracture site. <u>Intra-medullary</u> : 2 wires ante-grade.
Union	6–8 weeks	6 weeks	10 weeks
Range of motion	No statistical significance.	TAM showed a significant difference between the two groups, with a better result in the intramedullary pinning group ($p = 0.02$).	No statistical significance.
Complications	Complications showed statistical significance in the favor of transverse pinning.	No statistical significance.	No statistical significance.
Conclusion	Transverse pinning may be better due to less incidence of complications and less operative time.	Intra-medullary pinning has shown better results than transverse pinning, although more demanding.	Both methods are comparable.

in treating closed fractures of the metacarpal neck of the little finger; 29 patients were treated by transverse pinning and 30 patients were treated with intramedullary pinning. They showed no statistically significant differences between both groups as regarding total active motion, time to union, their results are similar to ours.

Table 2 shows a comparison between our study these 2 similar studies that compared both fixation methods.

The limitations to our study includes, the small numbers of patients (20 out of the original 80 patients included in this study were lost to follow-up). We tried to minimize selection bias by making the selection process to be performed by a computer-generated random numbering system. Multi-center studies & long term follow-up is recommended.

In conclusion, both techniques are equally safe and effective treatment option for fifth metacarpal's neck fractures. The only difference was shorter operative time & less incidence of complications in group A (transverse pinning), an advantage that some surgeons may find it appealing in that technique.

Disclosure

No form of financial support was received during this study. None of the authors is associated with any commercial entities at time of manuscript submission.

Funding

No funding was received for this study.

Conflict of interest

Authors declare that they have no conflict of interest

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent

Informed consent was obtained from all individual participants included in the study.

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