

Comparative Study of Volar and Dorsal Approaches for Surgical Treatment of Isolated Radial Fractures

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Abstract

Background

The ulna and radius are developed for mobility rather than stability. It is mandatory to achieve anatomical reduction in forearm fractures in order to regain the full range of supination and pronation. Regarding radius two approaches had been described in the literature, the dorsal (Thompson approach) and the volar (Henry approach). The aim of this study is to compare between those 2 approaches regarding duration, outcomes and complications.

Patients and methods

In the study, thirty patients with **isolated radial fractures** had been divided into two groups; 15 patients were treated via Thompson approach and 15 via Henry approach. The patients were followed up for at least 6 months postoperative and the results were evaluated according to DASH score and Anderson's criteria

Results

The mean operative time for patients treated via Thompson approach was 46.67 ± 11.13 minutes, while it was 63.67 ± 22.24 minutes via Henry approach with highly significant difference. The mean of radiological union in the Thompson group was 10.93 ± 3.79 weeks, while it was 12.5 ± 6.91 weeks in the Henry group with no significant difference. In the Thompson group the mean DASH score was 22.89 ± 16.43 , while in the Henry group it was 20.75 ± 12.67 with no significant difference. There were no significant differences between the 2 approaches regarding range of motion or cosmetic appearance. Both approaches showed few complication.

Conclusion

The operative time is highly significant shorter when the Thompson approach is used than the Henry approach.

Keyword

Thompson, Henry, Isolated radial fractures.

Introduction

The radius and the ulna are different from other long bones of the body. These bones are developed for mobility rather than stability. The unequivocal mobility that exists in human upper limbs is due to the unique anatomy of the elbow, forearm, wrist, and hand. The presence of proximal and distal radioulnar joints allows pronation and supination, and such movements are important in the usual activities of daily living. [1]

In case of fracture ulna or radius or both of them it's really important to restore not only the straightness of the ulna, but also the radial bow and the normal interosseous space. A non-anatomical reduction with rotational error is responsible for decreased forearm rotation and limited range of motion of the two joints. [2]

Because of the poor results after closed reduction and casting, open reduction and internal fixation (ORIF) using plates is considered the standard and preferred

method for treatment of displaced forearm fractures in adults. [3]

According to the radius, two general approaches have been advocated for the diaphysis: the anterior approach as described by Henry and the dorsal approach as described by Thompson. [4]

The anterior, or Henry, approach is extensile, while the dorsal or Thompson approach is advantageous in that it is essentially subcutaneous for the distal half of its course. The proximal half is approached as well, with only the common extensors covering the bone. [4] This study discussed the comparison between both approaches.

Patients and Methods

This study included 30 patients with isolated radial fractures, treated by ORIF in the department of

Orthopaedic Surgery, Menofia University hospital and El-Amria hospital from May 2016 to May 2017. Patients were divided randomly using the sealed envelope system [5] into two groups with minimum follow up 6 months: group A, treated using Thompson approach and group B, treated using Henry approach.

The study included adult patients (18 years old and over) with isolated, closed radial shaft fractures.

Patients with fractures both bones forearm, concomitant injuries in the same forearm, neurovascular problems, open fractures or contraindications of plate fixation were excluded from the study.

History, clinical examination, radiological evaluation and laboratory investigations were done.

General anesthesia was used for all the patients and a prophylactic single dose of broad spectrum antibiotic was given.

Regarding the Henry approach, the patient was placed in the supine position with the arm abducted on an arm board and the forearm supinated.

The line of incision extended from just lateral to biceps tendon to the radial styloid. (Fig .1)

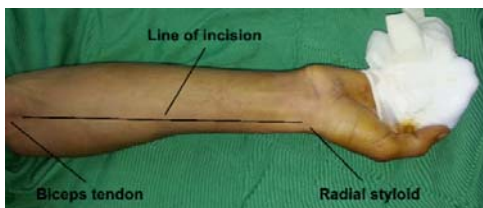


Figure1: the landmarks of the incision.

The deep fascia of the forearm was incised in line with the skin incision (Fig. 2)

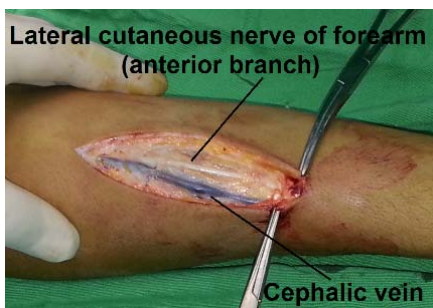


Figure 2: Superficial surgical dissection.

The interval between the flexor carpi radialis and brachioradialis (Fig.3) was deepened and the radial artery was identified. The superficial radial nerve was identified beneath the brachioradialis and was retracted laterally with it.

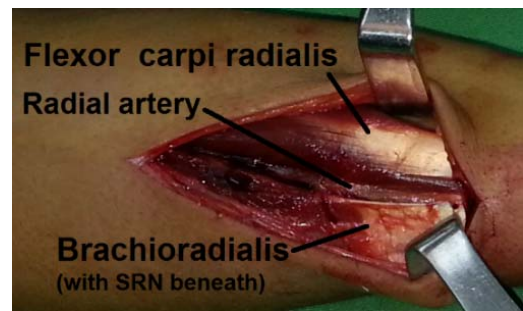


Figure 3: Internervous plane.

In patients with fracture level just above or at the level of the insertion of the pronator teres (Fig. 4), the forearm was pronated and its insertion was detached from the bone to obtain good exposure. The supinator and flexor digitorum superficialis were elevated.

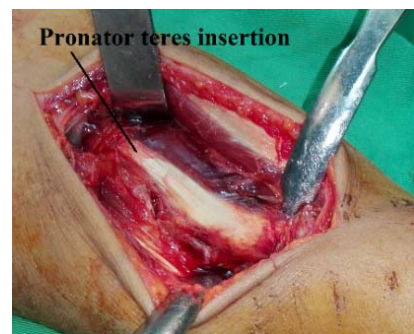


Figure 4: Pronator teres insertion.

In patients with fracture below the level of the insertion of pronator teres, detachment of its tendon was not necessary. The flexor pollicis longus muscle was gently elevated from the volar surface of the bone (Fig.5) and the plate was applied.

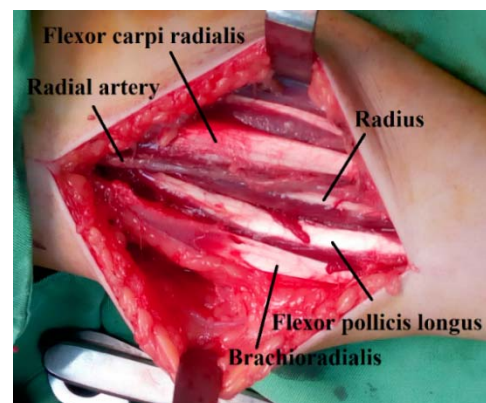


Figure 5: Deep surgical dissection.

Regarding the Thompson approach, the patient was placed in the supine position with the arm abducted on an arm board and the forearm pronated.

The line of incision extended from a point anterior to the lateral humeral epicondyle to a point just distal to the ulnar side of the Lister's tubercle. (Fig. 6)

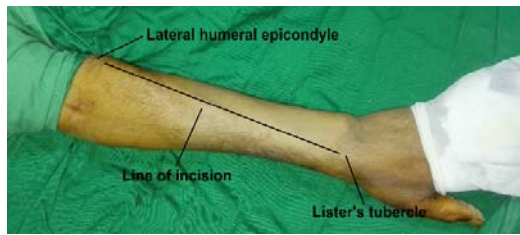


Figure 6: The landmarks of the incision.

In patients with upper third radial fractures, the internervous plane between the extensor carpi radialis brevis laterally and the extensor digitorum communis medially was identified. (Fig.7)

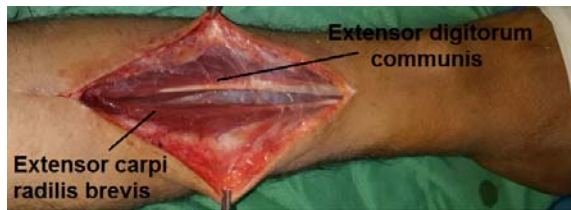


Figure 7: Superficial surgical dissection (fracture upper radius).

In patients with middle third and lower third radial fractures, the abductor pollicis longus and extensor pollicis brevis were separated from the underlying bone and retracted either proximally or distally depending on the required exposure. (Fig. 8)

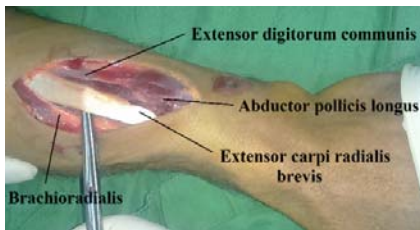


Figure 8: Superficial surgical dissection (fracture middle third radius).

In patients with upper third radial fractures, the supinator muscle was exposed (Fig. 9) and the posterior interosseous nerve was identified. (Fig.10) The forearm then was supinated to bring the anterior surface of the radius into view and the supinator was stripped off subperiosteally.

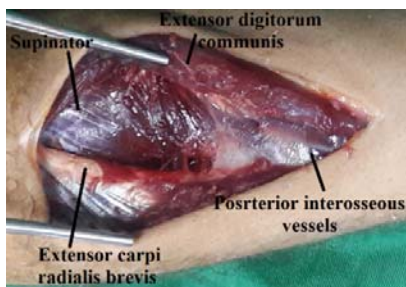


Figure 9: Deep surgical dissection (upper radius).

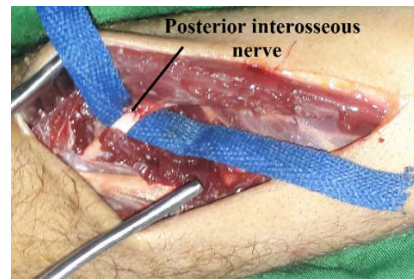


Figure 10: Exploration of posterior interosseous nerve

In patients with middle third and lower third radial fractures, proximally the insertion of pronator teres was exposed. In most patients there was no need to detach it especially when it didn't interfere with the reduction.

More distally the abductor pollicis longus and extensor pollicis brevis were elevated to identify the plane between extensor carpi radialis brevis and extensor pollicis longus. The bone was reduced and the plate was applied. (Fig. 11)

In both approaches, the tourniquet then was removed and good homeostasis was done. In patients with excessive muscular bleeding, suction drain was inserted. The subcutaneous tissue and skin were closed carefully by vertical mattress sutures. Sterile dressing was applied and an above elbow slap was done.

Immediately postoperative, the distal circulation and neurological functions were assessed. At two weeks follow up, the stitches were removed. At first month follow up, splint was removed. At second month follow up, clinical assessment and physiotherapy were done. At three months follow up, the wound scar and range of motion were assessed. At six months, the patients and complications were evaluated.

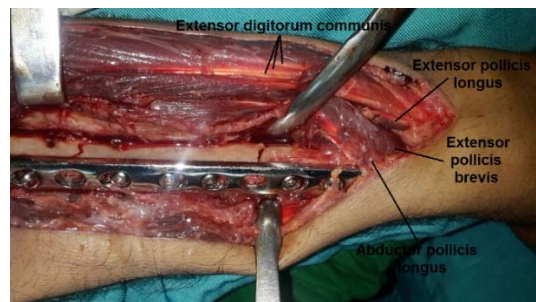


Figure 11: Plate application.

The patients were evaluated according to the DASH score [6] at the end of the follow up period. The best possible result was a score of 0 and the worst was 100.

According to Anderson's criteria [7], the results were considered excellent in case of union with $<10^\circ$ loss of flexion-extension and $<25^\circ$ loss of pronation-

supination, satisfactory in case of union with $<20^\circ$ loss of flexion-extension and $<50^\circ$ of pronation-supination, unsatisfactory in case of union with $>30^\circ$ loss of flexion-extension and $>50^\circ$ loss of pronation-supination or failure in case of nonunion with or without loss of movement.

Results

The mean operative time in the Thompson group was 46.67 ± 11.13 (range, 30 - 70) minutes and in the Henry group was 63.67 ± 22.24 (range, 35 - 120) minutes. The duration of the procedure was highly significant shorter when Thompson approach was used ($p=0.01$).

The mean of radiological union in the Thompson group was 10.93 ± 3.79 (range, 4 - 19) weeks, while it was 12.5 ± 6.91 (range, 4- 35) weeks in the Henry group. There was no significant difference between the two groups ($p=0.452$).

The mean of the elbow extension in the Thompson group was 4.67 ± 6.4 (range, 0 - 20) degrees and it was 7.33 ± 7.99 (range, 0 - 30) degrees in the Henry group. There was no significant difference ($p=0.322$), while the mean of the elbow flexion in the Thompson group was 136 ± 4.71 (range, 130 - 140) degrees and it was 137.33 ± 5.94 (range, 120 - 140) degrees in the Henry group. There was no significant difference ($p=0.501$).

The mean of the wrist dorsiflexion in the Thompson group was 64.67 ± 6.4 (range, 50 - 70) degrees and it was 65.67 ± 6.23 (range, 50 - 70) degrees in the Henry group. There was no significant difference ($p=0.668$), while the mean of the wrist palmer flexion in the Thompson group was 67.67 ± 5.94 (range, 60 - 75) degrees and it was 69 ± 6.32 (range, 50 - 75) degrees in the Henry group. There was no significant difference ($p=0.556$).

The mean of the forearm supination in the Thompson group was 78.33 ± 10.29 (range, 50 - 85) degrees and it was 81.33 ± 8.96 (range, 50 - 85) degrees in the Henry group. There was no significant difference ($p=0.402$), while the mean of the forearm pronation in the Thompson group was 67.67 ± 4.17 (range, 60 - 70) degrees and it was 62.33 ± 13.48 (range, 20 - 70) degrees in the Henry group. There was no significant difference ($p=0.162$).

The mean of the DASH score In the Thompson group was 22.89 ± 16.43 (range, 0 - 52), while in the Henry group it was 20.75 ± 12.67 (range, 5.17 - 48) with no significant difference ($p=0.82$).

According to Anderson's criteria, in nine patients (60%) of the Thompson group, the results were considered excellent, 4 (26.7%) satisfactory, two (13.3%) unsatisfactory, while in the Henry group, the result were considered excellent in 8 (53.3%) patients, satisfactory in 6 (66.7%) and one (6.7%) failure. There was no significant difference between the two groups according to degree of satisfaction.

There was posterior interosseous nerve palsy in one (6.7%) patient of the Thompson group. The function was completely regained after 5 months. There was superficial radial nerve palsy in one (6.7%) patient of the Henry group. the sensation was completely regained after 4 months. There was tourniquet palsy in one (6.7%) patient of the Thompson group. The patient had full improvement after 2 months. There were tendons irritations: in 2 (13.3%) patients of the Thompson group and one (6.7%) patient of the Henry group. There was Dislocated in the DRUJ in one (6.7%) patient of the Thompson group. After 5 months the patient had good range of forearm rotation (up to 150 degree) despite of the dorsally displaced ulna. There was Infection in one (6.7%) patient of the Thompson group, was superficial, relieved with a 2 weeks course of levofloxacin and in one (6.7%) patient of the Henry group, deep infection, needed further interventions. There was a delayed union in 2 (13.3%) patients of the Thompson group and one (6.7%) patient of the Henry group. There was a Non-union in one (6.7%) patient of the Henry group.

Discussion

The outcomes were observed to be compared with other studies of the same concern.

In the study of Nasab et al. (2013), the mean operative time was 62.6 (range, 50-90) minutes in the Thompson group, while it was 67.3 (range, 45-105) minutes in the Henry group with no significant difference. [8] Haseeb et al. (2018) found that the mean operative time in isolated radius fractures was 37.5 minutes. [9]

In this study, the mean operative time in the Thompson group was 46.67 ± 11.13 (range, 30 - 70) minutes and in the Henry group was 63.67 ± 22.24 (range, 35 - 120) minutes. The duration of the procedure was highly significant shorter when Thompson approach was used.

In Hadden et al. (1983) union was achieved in 97% of patients. [10] Hertel et al. (1994) 127 (96.6%) with complete union. ⁽¹¹⁾ In Nasab et al. (2013), union was achieved in 96.8% of the patients of the Thompson group at a mean time of 15.74 ± 2.8 weeks, while it was achieved in 97.4% of Henry group at a mean time

of 15.69 ± 3 weeks with no significant difference. ⁽⁸⁾ With Iacobellis and Biz (2013) 43(91.5%) patients achieved complete consolidation at a mean time of 16.2 (range, 12.8- 21.4) weeks. ⁽¹²⁾ Ali et al. (2014) found that 98% of patients have reach union at a mean time of 15.4 weeks. ⁽¹³⁾ Marcheix et al. (2016) found that 122 (93.1%) of patients had achieved union at a mean time of 19.7 ± 11.14 weeks. [14] In Haseeb et al. (2018), union was achieved in all (100%) patients at a mean time of 17.25 weeks. [9]

In this study, all (100%) patients of the Thompson group had achieved union at a mean time of 10.93 ± 3.79 (range, 4 – 19) weeks, while 14 (93%) of the Henry group had achieved union at a mean time of 12.50 ± 6.91 (range, 4– 35) weeks. There was no significant difference between the two groups.

Goldfarb et al. (2005) noticed significant decrease in forearm pronation. [15] Droll et al. (2007) found that the mean of supination was 82 ± 18 and pronation was 80 ± 18 . ⁽¹⁶⁾ In Nasab et al (2013), the mean of forearm rotation in the Thompson group was 138.87 ± 7.03 degrees, while it was 135.6 ± 11.13 degrees in the Henry group with no significant difference. [8] In Ali et al. (2014), restriction in supination and pronation was noticed in 20 among 60 (33.3%) patients. [13]

In this study, the mean of the forearm supination in the Thompson group was 78.33 ± 10.29 (range, 50 – 85) degrees, while it was 81.33 ± 8.96 (range, 50 – 85) degrees in the Henry group. The mean of the forearm pronation in the Thompson group was 67.67 ± 4.17 (range, 60 – 70) degrees, while it was 62.33 ± 13.48 (range, 20 – 70) degrees in the Henry group.

The normative value of the DASH score in the United States is 10.10 points. [17] In the study of Goldfarb et al. (2005) the mean of the score was 12 (range, 0-42) [15], in Droll et al. (2007), it was 18.6 ± 18 (range, 0 – 61)[16], in Bot et al. (2011) it was 8 (range, 0 – 54) [18], while in Iacobellis and Biz (2013) it was 13.5 (range 0-46.7) [12]

In this study, the mean of the score was 22.89 ± 16.43 (range, 0 – 52) In the Thompson group, while it was 20.75 ± 12.67 (range, 5.17 – 48) in the Henry group. There was no significant difference between the two groups.

Regarding functional outcomes (according to Anderson's criteria) 92% of the patients achieved an excellent or satisfactory result in Chapman et al. (1989). [19], Bot et al. (2011) studied 71 patients, 97% of them had excellent or satisfactory results [17], Iacobellis and Biz (2013) showed 37 (79%) excellent results and 6 (12.7%) satisfactory and one (8.3%) fail-

ure [12], while the results in Haseeb et al. (2018) (all Thompson) were excellent in 10 (63%) patients, satisfactory in 5 (31%) patients, and unsatisfactory in 1 (6%) patient. [9]

In this study, there were 9 (60%) excellent, 4 (26.6%) satisfactory and 2 (13.4%) unsatisfactory results in the Thompson group, while there were 8 (53.3%) excellent, 6 (40%) satisfactory and one (6.7%) failure in the Henry group.

Two (6.5%) patients of the Thompson group in Nasab et al. (2013) had postoperative posterior interosseous nerve palsy. [8] Perretta et al. (2013) noticed 2 (18%) patients. [20] Also the palsy occurred in two (2%) patients of Ali et al. (2014). [13] Haseeb et al (2018) reported no case of palsy. [9] Droll et al (2007) reported one (3%) patient with palsy via Henry approach which resolved spontaneously. [16]

In this study, one (6.7%) patient of the Thompson group had post-operative posterior interosseous nerve palsy. The function was completely regained after 5 months.

Kwasny et al. (1992) reported 2 (2.5%) patients with superficial radial nerve palsy. ⁽²¹⁾ Droll et al. (2007) reported 2 (6%) patients with palsy spontaneously resolved. [16] Three (7.7%) patients of the Henry group in Nasab et al. (2013) had postoperative palsy. [8]

In this study, one (6.7%) patient of the Henry group had post-operative superficial radial nerve palsy. The sensation was completely regained after 4 months.

Hadden et al. (1983) reported deep infection in 6 (5.5%) patients. [10] Chapman et al. (1989) reported infection rate of 2.3% [19], Kwasny et al. (1992) reported one (1.2%) patient with infection. [21] Hertel et al. (1994) reported one (.07%) patient with superficial infection. [11] In Nasab et al. (2013), one (3.2%) patient of the Thompson group and another one (2.6%) of the Henry group complained of infection. [8] Two (2%) patients had superficial infection, which subsided by antibiotics and irrigation in Ali et al. (2014). [13] Mastan Basha et al. (2015) reported one (1.7%) patient with infection. [22]

In this study, There were 2 patients complicated with infection one (6.7%) from each group.

Kwasny et al. (1992) reported two (2.5%) patients with delayed union ⁽²¹⁾, Hertel et al. (1994) reported 2 (1.5%) patients. [11], Iacobellis and Biz (2013) reported 2 (4.2%) delayed unions in which consolidation took 72 and 48 weeks [12] Mastan Basha et al. (2015) reported one (1.7%) delayed union. [22]

In this study, two (13.3%) patients of the Thompson group had delayed union, while one (6.7%) patient of the Henry group united after 35 weeks.

Hadden et al. (1983) reported 7 (6.4%) patients with nonunion. [10] Hertel et al. (1994) reported 2 (1.5%) [11], Iacobellis and Biz (2013) reported 4 (6.2%) non unions.[12] Two (2%) patients of Ali et al (2014) had nonunion. [13] Mastan Basha et al. (2015) reported one (1.7%) patient [22], Marcheix et al. (2016) reported 9(6.9%) patients [14].

In this study, there was one (6.7%) patient of the Henry group had infected nonunion.

To knowledge, this is the first study to compare between Henry and Thompson approaches in isolated radial shaft fractures regarding outcomes and complications.

The study highly recommends the Thompson approach as the approach of choice especially in the isolated middle third radial shaft fractures as it has the following advantages: short operative time, away from the important neurovascular structures especially in the middle third fractures, very obvious plane, allow good exposure to posterior interosseous nerve in the proximal third fracture (especially with more experience) to avoid over traction to the nerve, application of the plate on tensile surface of the bone and the scar is on the dorsum of the forearm hidden by hair especially in males.

Small sample, relatively short follow up period and shortage of data about implant removal were considered limitations to the study.

It is recommended to work on isolated radial fractures, larger samples and longer follow up period.

Conclusion

The operative time is highly significant shorter when the Thompson approach is used than the Henry approach.

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