

Relative Motion Protocol Versus Place and Hold Protocol After Hand Zone II Flexor Tendon Repair: A Prospective Randomized Controlled Trial

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ABSTRACT

Background: Flexor tendon injuries in zone II are very challenging and till now there no consensus on a particular therapy protocol to provide the best outcomes postoperatively.

Aim: The present study was introduced to explore the effect of a relative motion protocol and compare it to those of a place and hold protocol on the outcomes after zone II flexor tendon repair.

Patients and Methods: Sixty patients who underwent zone II flexor tendon repair participated in this study. Their ages were between 20 to 35 years. They were collected from Cairo University Hospitals and distributed randomly into two groups: **Group (A)** contained 30 patients who received a relative motion protocol, and **Group (B)** contained 30 patients who received place and hold protocol. At 12th postoperative week, finger goniometer; hand dynamometer; and Michigan Hand Questionnaire (MHQ) were used to evaluate outcomes.

Results: Relative motion protocol showed significant improvement over place and hold protocol in terms of IP joints active ROM of the operated fingers, operated hand grip strength, and all scales of MHQ.

Conclusion: Relative motion protocol is superior to place and hold protocol in improving the outcomes after zone II flexor tendon repair.

Key words: Relative motion, Place and hold, Flexor tendon repair.

INTRODUCTION

A formidable challenge faces hand surgeons and therapists in repair and rehabilitation of tendons in zone II. Adhesions are highly anticipated to occur there leading to limited tendon excursion that causes a limitation in the ROM and a reduction in hand strength and function^(1,2).

One of the major purposes in rehabilitation is to achieve better tendon gliding by inhibiting the adhesions and an Early Active Mobilization (EAM) protocol can clearly achieve that⁽¹⁻³⁾.

Relative motion protocol is firstly described for rehabilitation after extensor tendon repair. Its concept is simple, it depends on the presence of a single muscle that has multiple tendons through which it transmits its force to the four medial fingers. By placement of the digits with repaired tendons in 15-20° differential Metacarpophalangeal (MCP) joints angle than the adjacent digits, the repaired tendons will receive less force from the muscle which encourages immediate postoperative active fingers movement resulting in earlier use of the hands in the Activities of Daily Living (ADL) without risk of tendon rupture⁽⁴⁻⁶⁾.

Place and hold protocol is one of the most evident protocols but seeking for better outcomes, a start to study relative motion protocols post flexor tendon repair has been recently developed due to their advantageous nature and promising effects^(7,8).

Depending on the conclusions of recently published studies, it was recommended to prospectively investigate the effects of a relative motion protocol^(4,9).

AIM OF THE STUDY

The need for this study has been developed to be, up to our knowledge, the first prospective study to investigate the effect of a relative motion protocol post flexor tendon repair.

PATIENTS AND METHODS

Participants:

Sixty patients, who underwent zone II flexor tendon primary direct four-strand repair with ages between 20 to 35 years, participated in this study. They were collected from Cairo University Hospitals. Participants were excluded if they had more than one operated finger, concurrent major vascular injuries, crush injuries, nerve injuries, fractures, tendon injuries in other zones or the other hand, flexor pollicis longus repair, previous post-repair tendon rupture, or reduced cognitive capacity.

Ethical Approval:

After explanation of the all rights, an informed consent was signed by each patient before participation in this study. Before conducting the study, an ethical approval (No. P.T. REC/012/002689) was provided by the Institutional Review Board of Faculty of Physical Therapy at Cairo University. The conduction of the current study was matched with the Declaration of Helsinki Guidelines for Human Research^(Ref).

Study Design:

The current study was designed to be a prospective, randomized, single-blind, controlled trial. The study was conducted from April 2020 to May 2022.

Randomization:

Participants were allocated randomly to either Group A or B by using sealed opaque envelope procedures. Usage of block randomization ensured equal number of patients in each group. No subject was dropped out after randomization.

Assessment Procedures:

At 12th postoperative week, active IP joints ROM of each involved digit was measured using finger goniometer (Baseline 12-1011 Finger Goniometer, Metal, 180 Degree - 6" Deluxe)⁽¹⁾. Hand grip strength of each patient both hands was measured using hand dynamometer (Takei Analog Hand Grip Strength Dynamometer T.k.k.5001 GRIP-A General Type, Made in Japan). The percentage of the operated hand grip strength from the normal hand one was calculated. In case of the operated hand was the non-dominant, 10% of the dominant hand grip strength value was discounted before dividing the grip strength of the operated hand on it as the dominant hand is normally about 10% stronger⁽¹⁰⁻¹²⁾. An Arabic version of MHQ was provided for each patient to answer the questions of its 6 scales. The raw scale score was normalized to a scale score ranges from 0 to 100 according to MHQ scoring algorithm^(13,14).

Therapeutic Procedures:

All patients were discharged postoperatively with a dorsal blocking cast to place wrist in 0° extension, MCPs of the 4 medial digits in 60° flexion, and IPs in extension with the thumb free⁽¹⁵⁾. Patients in group A received relative motion protocol while patients in group B received place and hold protocol.

Relative motion protocol:

The protocol consisted of 4 stages^(4,7,9,16):

Stage 1: From 3rd day till 4th week. In the 1st visit, the cast was removed and a relative motion splint (Fig. 1) was fabricated which consisted of; A dorsal blocking part (Fig. 1. A) designed to place the wrist at 0° extension and MCPs at 30° flexion with IPs and thumb free, and a relative motion part (Fig. 1. B) designed to keep the operated digit in 30° more MCP flexion than the non-operated digits. This part was then attached to the back of the first part across the MCPs block. Out of splint, while wrist was rested on neutral extension and MCPs were held on flexion, the patient performed passive composite IPs flexion and extension for 15 repetitions 3 times/day. Then the patient performed gentle active wrist extension and passive wrist flexion also for 15 repetitions 3 times/day. The patients wore the relative motion splint during daytime and moved their fingers actively in flexion and extension throughout the day. They were asked also to utilize the operated hand in very light function with

avoidance of strenuous lifting or squeezing. The patients took off the relative motion splint and re-wear the cast during sleep.

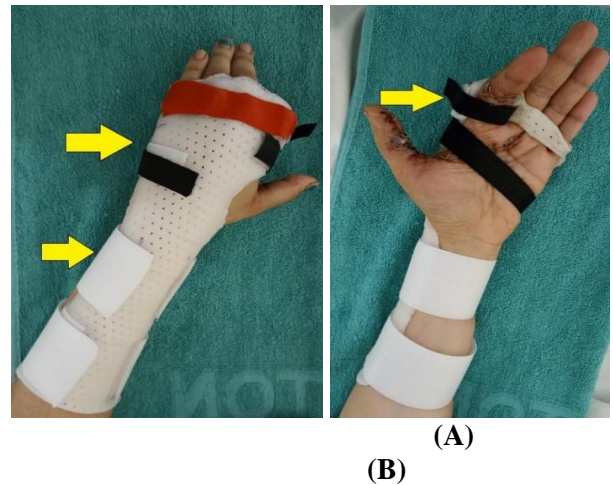


Fig. (1): A relative motion splint. (A) Dorsal blocking part. (B) Relative motion part.

Stage 2: From 4th to 6th week. In the 2nd visit, the relative motion splint was modified by cutting the relative motion part with the MCPs block off the dorsal blocking part. Patients wore both separate parts during daytime and continued to move their fingers actively in flexion and extension throughout the day. The patients were permitted to use their operated hands in light ADL and still not to use them in strenuous lifting or squeezing. Out of the splint, patients continued performing the previous stage exercises in addition to active tenodesis exercises for 15 repetitions 3 times/day. The patients continued to wear the cast during sleep.

Stage 3: From 6th to 8th week. In the 3rd visit, patients discontinued wearing the remaining of the dorsal blocking part and continued to only wear the relative motion part with the MCPs block for full time and to move their fingers actively in flexion and extension throughout the day. The hand use was more progressed to be described as bilateral lift weighing no more than 3.5 Kg. The cast was discontinued at all. Out of the splint, patients continued performing the previous stages exercises in addition to flexor tendon gliding and blocking exercises for 15 repetitions 3 times/day.

Stage 4: From 8th to 12th week. In the 4th visit, the patients discontinued wearing the splints at all. The patients continued performing the previous stages exercises in addition to progressive composite stretching exercises for the extrinsic flexors (3 stretch cycles of 30 seconds stretch then relax for 30 seconds then repeat, 3 times/day) and progressive intrinsic and extrinsic finger flexion muscles strengthening exercises by squeezing therapy putty for 5 seconds, relax then repeat (3 sets of 15 squeezes with 30-60 seconds rest between each set for 3

times/day). At this stage, patients were allowed to progressively use their affected hands in resistive and heavier hand functions and ADL. They were also allowed to return to their work progressively.

Place and hold protocol:

The protocol consisted of 4 stages (1,2,15,17,18):

Stage 1: From 3rd day till 4th week. With the cast in place, the subsequent exercises were done within the cast limits; Passive Distal Interphalangeal (DIP) flexion and extension, passive Proximal Interphalangeal (PIP) flexion and extension, passive composite finger flexion and extension, and place and hold exercises.

Stage 2: From 4th to 6th week. In addition to stage 1 exercises, the cast was taken off for the following exercises; Active IPs flexion with MCPs extension followed by full digits extension all from neutral wrist extension and active tenodesis exercises. At this stage, the dorsal blocking cast was only placed during sleeping or out of home.

Stage 3: From 6th to 8th week. The cast was totally discontinued. In addition to the earlier stages exercises, the patient performed flexor tendon gliding and blocking exercises. During this phase, patients started to use their affected hands in non-resistive and light hand functions and ADL.

Each previous exercise in each stage was performed 15 times/session and same per each 2 waking hours.

Stage 4: From 8th to 12th week. In addition to the previous stages exercises, the same exercises and

instructions in stage (4) of group A were followed by patients in this group.

Patients in this group received 3 sessions/week.

Ethical approval:

The study was approved by the Ethics Board of Faculty of Physical Therapy, Cairo University and an informed written consent was taken from each participant in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical Analysis

Comparison of age between groups was done through unpaired t test. Chi- squared test was used for comparison of gender, dominant hand, injured hand and operated finger distribution between groups. Unpaired t test was used for comparison of IP joints active ROM of operated digits, operated hand grip strength and MHQ scales scores at 12th postoperative week between groups. The level of significance for all statistical tests was set at $p < 0.05$. All statistics were done via Statistical Package for Social Sciences version 25 for windows.

RESULTS

Subjects’ baseline data were demonstrated in Table 1. There was no significant difference between groups in age, gender, dominant hand, injured hand and operated finger distribution.

Table (1): Subjects’ baseline data.

		Group A	Group B	p-value
Age, Mean ± SD (years)		26.26 ± 4.15	27.53±5.23	0.30
Gender, n (%)	Females	10 (33.3%)	13 (43.3%)	0.42
	Males	20 (66.7%)	17 (56.7%)	
Dominant hand, n (%)	Right	26 (86.7%)	24 (80%)	0.73
	Left	4 (13.3%)	6 (20%)	
Injured hand, n (%)	Dominant hand	17 (56.7%)	19 (63.3%)	0.59
	Non-Dominant hand	13 (43.3%)	11 (36.7%)	
Operated Finger, n (%)	Index	6 (20%)	9 (30%)	0.32
	Little	4 (13.3%)	8 (26.7%)	
	Middle	11 (36.7%)	6 (20%)	
	Ring	9 (30%)	7 (23.3%)	

SD: Standard deviation

p-value: Probability Value

There was a significant increase in IP joints active ROM of operated fingers and operated hand grip strength (% of normal hand) of group A compared with that of group B at 12th postoperative week (Table 2).

Table (2): Mean IP joints active ROM of operated digits and operated hand grip strength (% of normal hand) at 12th postoperative week of group A and B:

	Group A	Group B	MD (95% CI)	t- value	p value
	Mean ± SD	Mean ± SD			
Active ROM	150 ± 8.81	142.46 ± 10.96	7.54 (2.39: 12.67)	2.93	0.005
Grip strength (% of normal hand)	75.7 ± 5.38	69.33 ± 5.65	6.37 (3.51: 9.21)	4.46	0.001

SD: Standard Deviation; MD: Mean Difference; CI: Confidence Interval; p-value: Probability Value

There was a significant improvement in all MHQ scores of group A compared with that of group B at 12th postoperative week (Table 3).

Table (3): Mean MHQ scales scores at 12th postoperative week of group A and B:

	Group A	Group B	MD (95% CI)	t- value	p value
	Mean ± SD	Mean ± SD			
Overall hand function	82.83 ± 15.41	69.33 ± 14.74	13.5 (5.71: 21.29)	3.46	0.001
Activities of daily living	78.06 ± 10.21	71.5 ± 11.56	6.56 (0.92: 12.2)	2.33	0.02
Work	71 ± 7.12	62.33 ± 9.71	8.67 (4.26: 13.06)	3.94	0.001
Pain	29.5 ± 6.21	36.33 ± 7.87	-6.83 (-10.49: -3.16)	-3.73	0.001
Aesthetics	68.96 ± 9.14	62.1 ± 9.58	6.86 (2.02: 11.71)	2.83	0.006
Satisfaction	70.46 ± 8.93	63.53 ± 9.79	6.93 (2.08: 11.78)	2.86	0.006

SD: Standard Deviation; MD: mean difference; CI: Confidence Interval; p-value: Probability Value

DISCUSSION

Despite great evolution in approaches used in repair or rehabilitation of flexor tendons, complications continue to develop. Postoperative formation of adhesions is still the most occurring complication that restricts the active ROM which affects hand strength and functions (19,20).

Postoperative therapy significantly affects the outcomes of a flexor tendon repair. Up to now, there is no consensus on a single protocol to be optimal, however, there is no doubt that EAM has the best outcomes (19,21).

In the present study, relative motion protocol showed significant improvement over place and hold protocol in terms of IP joints active ROM of the operated fingers, operated hand grip strength, and all scales of MHQ.

The superiority of relative motion protocol in the current study is matched with the results of the studies which compared the relative motion protocols with others following extensor tendon repairs and also concluded relative motion superiority in outcomes like what found in studies of Collocott *et al.* (22) and Hirth *et al.* (23).

Collocott *et al.* (22) concluded that participants managed using a relative motion extension protocol showed significantly better early hand function, total active motion, and splint satisfaction than those managed by the controlled active motion protocol post extensor tendon repairs in zone V & VI.

Hirth *et al.* (23) compared the outcomes of a modified Relative Motion Splinting (mRMS) protocol to those of an immobilization splinting protocol following zone V and VI extensor tendon repairs. The results showed a privilege for the mRMS protocol in earlier ROM

restoration and earlier return to work. The main pros of mRMS protocol were the small unsophisticated orthosis design, and direct patient instructions that facilitate earlier motion, functional hand use and coming back to both ADL and work.

Considering the current study relative motion protocol is an early dynamic active flexion postoperative protocol in its core, the results of the current study would be mismatched with other studies which concluded equivalence in effectiveness of both early dynamic active flexion and early static place and hold protocols post flexor tendon repairs and that what found in studies of Chevalley *et al.* (24) and Allam *et al.* (25).

The contradiction between the results of Chevalley *et al.* (24) and Allam *et al.* (25) to the results of the current study explains that early dynamic active flexion itself may not be the key of superiority but the excellence, from our point of view, can be attributed to the following characteristics: Firstly, allowance of unlimited, but safe, early dynamic active flexion of the operated fingers throughout the day postoperatively; Secondary, a nearly unrestricted early movement of the uninjured fingers; Thirdly, early controlled progressive usage of the operated hand in ADL; and finally, replacement of traditional form of many repetitions of exercises and multiple sessions by an early, free, safe, and unlimited active motion, an early, safe, progressive engagement in hand functions, and following clear instructions with performance of essential exercises by a reasonable number of repetitions. All the previous distinguished the relative motion protocol in the current study.

The current study was limited by the differences between surgeons' preferences, physical and psychological statuses of participants, individual variations between participants, and possible human errors.

CONCLUSION

In conclusion, Relative motion protocol is superior to place and hold protocol in improving the outcomes after zone II flexor tendon repair.

Conflict of interest: Nil

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