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Reconstruction of Tendon Sheath by a Vein Graft in Flexor Tendon Repair in Adjacent Digits

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ABSTRACT

Background: Adhesion formation after tendon injury is a challenging clinical problem.

Aim: We compare the outcome of reconstructing the flexor tendon sheath after primary flexor tendon repair using an autogenous vein graft to reduce post-operative peritendinious adhesions.

Methods: Eight patients have acute flexor tendon injuries of both FDS and FDP in zone II in more than one digit. Primary tenorrhaphy was done using traditional technique. In one-digit vein graft was used to reconstruct tendon sheath window, while in the other digit, the tendon sheath left untreated. Post-operative physiotherapy program of controlled active motion is used for both group. All patients were assessed using the second Buck-Gramcko scale at 2 and 6 months.

Results: For the vein graft group, 2 patient had excellent result, 2 had very good, and 4 patients had good result. In group II, 2 patients had very good result, 2 patients had good result, and 4 patients had fair result.

Conclusion: The use of autologous vein graft as a substitute of tendon sheath is a good treatment modality. Compared to conventional tendon repair technique, it was associated with less adhesion formation and less joint contracture.

Evidence Based Medicine: Level IV, vase series.

Key Words: *Hand – Flexor tendon – Finger – Plastic surgery – Trauma.*

INTRODUCTION

The functional biomechanics of the flexor tendons depends on number of factors including an intact pulley system, synovial fluid, supple joints, and tendon excursion. The synovial fluid provides nutrients to the tendons and lubrication, permitting frictionless gliding for the tendons. Adhesions among tendons and other tissues restrict excursion **[1]**.

The zone (II) of the flexor tendons lies within the digital fibro-osseous tunnel and it's difficult to be repaired because the healing tendon tends to adhere to its tunnel. It has been termed "no man's land" by Bunnell (1948) because of the poor outcome in range of motion following tendon repair **[2]**.

Four approaches are suggested to improve the outcome of the repairs, which include stronger surgical repairs, appropriate pulleys or sheath management, optimization of rehabilitation regimens, and modern biological approaches **[3]**.

Adhesion formation after tendon injury in zone II represents a major clinical problem. Disruption of the synovial sheath at the time of the injury or surgery allows granulation tissue from surrounding tissue to invade the repair site resulting in adhesion formation **[4]**.

The tendon sheath repair has advantages such as serving as a barrier to the formation of extrinsic adhesions, quicker return of synovial nutrition, acting as a mold for the remodeling tendon, and better tendon-sheath biomechanics **[5]**.

Several techniques were described for primary reconstruction of the tendon sheath defects in experimental animals by means of various autogenous and synthetic materials **[6-11]**. There were few clinical trials done using an autologous vein graft for tendon sheath defects in primary flexor tendon repair in zone II **[12-15]**.

This study reports eight patients with flexor tendon injury in zone II involving more than one digit in the same patient. One of the digits underwent flexor tendon repair only and the other digit underwent flexor tendon repair plus reconstruction of the flexor tendon sheath using autogenous vein graft.

PATIENTS AND METHODS

This study included eight adult patients with acute sharp injuries of both FDS and FDP in zone II. All patients had 2 digits injury in the same hand. All patients had no concomitant fractures, bilateral neurovascular injuries, injured extensor mechanism, and associated soft tissue loss.

Full history taking, and detailed physical examination had been performed. Routine hand X-

ray was done to exclude associated fractures. Below elbows dorsal blocking splint was applied to avoid further retraction of the tendon ends until the time of surgery.

After proper patient counselling, a written informed consent was obtained. All patients were operated within 24 hours after admission.

Operative procedure (Fig. 1):

All procedures were done under general anaesthesia with the aid of pneumatic tourniquet control. Tendons were explored at site of injury to deliver the tendon ends. Sometimes, additional opening in the flexor sheath or remote incisions to deliver the retracted tendon ends were needed.

Tendons were repaired using modified Kessler locking suture for both FDP & FDS tendons (3-0 Prolene sutures and reinforced by 6-0 Prolene epitendinous suture). Intraoperative tendon gliding was tested to ensure free movement.

After completion of tenorrhaphy, digits were divided into two groups; in group I, the tendon sheath was reconstructed by a vein patch. In group II, tendon sheath was not reconstructed.

Harvesting vein graft: A suitable size donor vein was marked usually in forearm before the application of the arm tourniquet. About 2cm from the vein was harvested then incised longitudinally. The patch was used to reconstruct the disrupted tendon sheath over the tendon repair site (Fig. 1c).

Following skin closure, dorsal blocking below elbow splint was applied with the wrist flexed 15-30 degrees, the MCP joints in 55-70 degrees' flexion, and IPs extended.

All patients were exposed to controlled passive rehabilitation program (Fig. 1f). All fingers involved in the study were assessed postoperatively at 2 and 6 months regarding the range of motion using the Buck-Gramcko II method of assessment [16]. It measures the composite flexion pulp to palm distance, total range of motion, and extension deficit. The tools of assessment include 180-degrees short arm goniometer (Fig. 1g) and a measuring ruler (Fig. 1h).

The data were statistically analyzed using SPSS (statistical program for social science version 15).

Figs. (1): (A) Flexor tendon injury of both rt index and ring fingers, (B) Tendon repair in middle finger, (C) harvesting of vein graft from same forearm, (D) Repair of tendon sheath defect using vein patch graft for middle finger, (E) Tendon repair in index finger, (F) Post-operative splint with dynamic rubber band exercises passed under palmar pulley, (G) Measuring active flexion range of motion using short arm goniometer, (H) Measuring fingernail to palm distance using ruler.

RESULTS

The epidemiologic data of the patients including age, sex, and affected digits are shown in Table (1).

The buck-Gramcko scale results in group I showed 2 excellent, 2 very good, 4 good results (Table 2). Average score at 8 weeks assessment was 8±2, and 11.5±4.5 at 6 months (Table 3).

In group II, there was no excellent result, 2 very good, 2 good, and 4 fair results (Table 2). The average score at 8 weeks was 7±2, and 10.5±3.5 at 6 months (Table 3) (Figs. 2-4).

The percentage of change in Buck-Gramcko scale after 8 weeks and 6 months in both groups showed 57% change in group I and 50% in group II after application of controlled active mobilization program. There is no statistically significant difference in both groups in Buck-Gramcko scale at 8 weeks and 6 months. The reported complications are shown in Table (4) & Fig. (5).

Table (1): Epidemiological data of the patients of both groups.

Variables	Group 1 N=8	Group 2 N=8
Age	23±2	
Gender:		
Males	7	
Females	1	
Affected digit:		
Index	0	2
Middle	6	1
Ring	2	3
Little	0	2

Table (2): Results of both groups using Buck-Gramcko scale.

Variables	Excellent	Very good	Good	Fair	Poor
Group I	2 digits (25%)	2 digits (25%)	4 digits (50%)	0 digits	0 digits
Group II	0 digits	2 digits (25%)	2 digits (25%)	4 digits (50%)	0 digits

Table (3): Statistical difference in both groups in Buck-Gramcko scale at 8wks and 6 months.

Variables	Group 1 N=8	Group 2 N=8	Mann-whitney U	*p*
After 8 weeks	8±2	7±2	3.000	.068
After 6 months	11.5±4.5	10.5±3.5	4.000	.068
% of change	57%	50%		

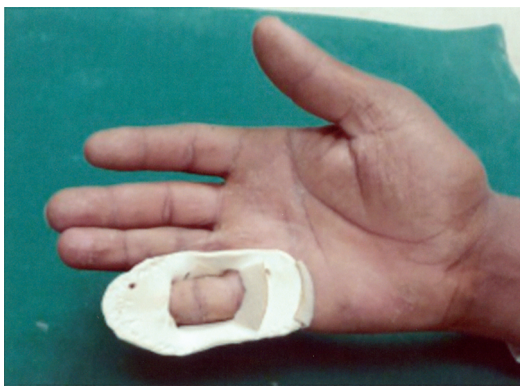
Table (4): Recorded complications in both groups.

Variables	Repair rupture	Repair adhesion	DIP joint contracture	Wound infection
Group 1	0	0	0	0
Group 2	0	0	1	0

Figs. (2): Preoperative and postoperative views of cut flexor tendon zone II in right ring and middle fingers. Reconstruction of tendon sheath is done in ring finger. There is very good outcome in ring finger and good outcome in middle finger.


Figs. (3): Preoperative and postoperative views of cut flexor tendon zone II in right ring and little fingers. Reconstruction of tendon sheath is done in ring finger. There is excellent outcome in ring and very good outcome in little fingers.


Figs. (4): Preoperative and postoperative views of cut flexor tendon zone II in right index and middle fingers. Reconstruction of tendon sheath is done in middle finger. There is very good outcome in middle finger and good outcome in index finger.

Figs. (5): Postoperative DIP joint contracture treated by reverse splinting of DIP.

DISCUSSION

The fact that digital canal in zone II is narrow increase the risk of adhesion formation specially for combined FDS and FDP tendon lacerations **[17,18]**. Furthermore, un-repaired tendon sheath lacerations leave an edge that can produce triggering and/or possible rupture. This free edge also an stimulate adhesions formation and even can progress to contracture **[19]**.

Theoretically and experimentally, restoration of tendon sheath after tendon repair reestablishes proper environment for tendon nutrition. Therefore, adhesion formation between the repaired tendon and adjacent tissues can be minimized **[12,20]**. However, primary sheath repair is technically challenging. Moreover, the repaired sheath may narrow the canal and restrict tendon gliding **[21,22]**.

The autologous tissues include fascia lata, free tendon grafts, vein grafts, or extensor retinaculum

[12,21,23-26]. Other studies used biologic and synthetic materials like Teflon, silicone membranes, seprafilm, and expanded polytetrafluoroethylene (E-PTFE) **[27-29]**. Venous graft also used as a tendon sheath substitute to reduce the rate of restrictive tendon adhesion **[12]**.

The clinical outcome was generally better in group I than group II; 2 excellent results, 2 very good, and 4 good results compared to 2 very good, and 2 good, and 4 fair results. However, our results showed that there is no statistically significant difference between tendon sheath repaired with a vein patch graft (group I) and those without tendon sheath repair (group II). This finding maybe attributed to small sample size of the patients.

The advantage of our study is that it evaluates the results of tendon injuries in zone II only. In addition, it addresses only injuries in the same patient; therefore, the variables of patient compliance and cooperation is eliminated which can influence the clinical outcome markedly. In addition, it includes only acute tendon injury in the first 24 hours without concomitant fractures, neurovascular injuries, or skin loss.

For sheath reconstruction using the vein graft technique, the vein can be used as a tube to envelope the tendons or as a patch to seal the sheath over the repair site. None of the authors gave any difference in the use of both techniques when studied. We didn't rely on the vein graft as a tube, as the tendons in zone II are bulky and enveloping the tendons with a vein tube will increase the bulk and decrease the tendon gliding. Also, revascularization of a small patch graft will be better than larger tube graft.

Comparison of results with other published studies seems very difficult because of the investigators' different standards used in their studies. The end results were affected by patient's compliance, the technique of vein graft repair, the rehabilitation program, and the method of assessment.

The Buck-Gramcko scale II was our preferred method of assessment; it has the benefit of combining the ROM assessment in the form of TAM and extension lag measurements, with the linear methods using the pulp to distal palmar crease measurement. The Buck-Gramcko II scale avoides the drawbacks of measuring the range of motion (ROM) alone.

In our study, the percentage of change in Buck-Gramcko scale of assessment after 8wks versus 6 months among both groups was; 57% in group I and 50% in group II after application of controlled active mobilization program. Buck-Gramcko scale was improved among booth groups especially group I without statistically significant difference. This also maybe due to small sample size.

Post-operative complications occurred in only one patient in group II. He developed DIP contracture and managed by reversed physiotherapy and gradual reversed splinting.

The vein graft procedure in group I increased operative time by about 30 minutes more than group II. The other issue is the donor site morbidity of the vein graft; the patients must be informed during consent taking as they may refuse to be included in the test group.

Finally, we believe that tendon sheath reconstruction cannot be considered routine procedure in tendon repair. We think that it should be considered in selected patients and selected injuries where tendon adhesion formation is highly suspected and in tenolysis procedures.

Conclusion:

The use of autologous vein graft as substitute of tendon sheath is a good treatment modality. Compared to conventional tendon repair technique, it was associated with less adhesion formation and less joint contracture. We believe that tendon sheath repair should be considered in cases where tendon adhesion is highly suspected. Larger patients' population is needed to validate these findings.

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