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Plastic Surgery

Wrapping the tendon after repair with silicon sheet to minify adhesion: evaluation of a new idea

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ABSTRACT

Background: Adhesion is one of the most complications of tendon repairs.

Aim of the study: to evaluate the safety and effectiveness of using silicon sheet wrapping the tendon after primary repair to prevent adhesion.
Patients and Methods: This was a prospective case series study that included 20 patients with primary and delayed primary tendon repair. Repaired flexor or extensor tendon was wrapped in a silicon sheet. The study was conducted at Al-Azhar University Hospitals (Al-Hussien and Sayed Galal).
Results: Postoperative assessment and follow-up were done on the studied patients. Our results showed that one patient (5%) had mild soft tissue changes surrounding the tendon. None of the patients were complicated with adhesions. Mild to moderate edema surrounding the tendon compared with contralateral healthy one was found in 17 patients (85%). Dynamic imaging of the tendon movement (passive) to assess the suture site showed vascularization in all patients (100%). Also, the echogenicity of stumps was normal in all studied patients (100%).
Conclusion: The tendon repair site healed quickly and qualitatively well in the current study with silicon wrapping. The functionally improved range of motion obtained suggests that peritendinous fibrosis has been reduced. During the follow-up, the patient underwent an ultrasound examination. In silicon wrap cases, ultrasound confirmed objectively better tendon healing quality, less edema, and the absence of other complications.

Keywords: *Tendon injury; peritendinous, adhesion; wrapping.*

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INTRODUCTION

Tendon injuries are the most common soft tissue injuries seen in hand surgery. [1]

According to studies, 7–15 percent of patients who undergo tendon repair experience complications such as scar formation, increased tendon adhesions, and limited joint movement during the early healing stage. Up to ten percent of these patients will require additional surgery. Progressive peritendinous adhesions will bind the healed tendon to the surrounding tissue, resulting in functional disability, decreased workability, and high costs.[2]

Peritendinous adhesions are fibrous adhesions that form as a result of collagen deposition during the healing process of a tendon injury between tendons and surrounding tissues. Tendon adhesions were once thought to be a critical component of tendon healing[3], but a better understanding of tendon biology has revealed that this is not the case. Although the pathophysiology of adhesion formation is unknown, it is widely accepted that adhesion formation is associated with superior external tendon healing. [4]

Scientists have investigated numerous advanced treatment methods, including surgical and non-surgical options. [5], based on research into the mechanism of tendon adhesion, to inhibit exogenous healing, promote endogenous healing, reduce inflammation, and eventually restore full tendon sliding function. [6]

Repairing the tendon sheath has several benefits, including acting as a barrier to the formation of extrinsic adhesions, allowing for a faster return of

synovial nutrition, acting as a mould for the remodelling tendon, and improving tendon-sheath biomechanics. [7]

Autogenous saphenous vein grafts had been used for the prevention of the adhesion of tendons. [8]

The primary outcome variable was the range of motion of the operated finger 6 months after the operation; the study was halted due to unfavourable results after 5 patients were treated. In this study, we used a silicon sheet wrapping the tendon to reconstruct the tendon sheath after primary tendon repair.

The aim of the study was to evaluate the safety and effectiveness of using a silicon sheet wrapping the tendon after primary repair to prevent adhesion.

PATIENTS AND METHODS

This was a prospective case series study that included 20 patients with primary and delayed primary tendon repair. Repaired flexor or extensor tendon was wrapped in a silicon sheet. The study was conducted at Al-Azhar University Hospitals (Al-Hussien and Sayed Galal). Inclusion Criteria: All patients in this study had the following criteria: Age: Above 15 years old, sex: Both (male & female), flexor tendons and Extensor tendons injuries, acute clean-cut tendon, primary or delayed primary repair.

Exclusion Criteria: Age: below 15 years old, crushed or lacerated hand, previously injured hands or deformed hands, highly contaminated injuries, and co-morbidities: Autoimmune, DM, Renal, Hepatic and bleeding disorders.

Pre-operative: Full history taking and detailed physical examination had been performed. Routine hand X-ray was done to exclude associated fractures and routine labs such as CBC, PT, and INR.

Most cases got the surgery under regional anesthesia.

The pre-existing lacerations were extended to achieve surgical exposure using Bruner's incision, and if the proximal end of the tendon is retracted, we made an incision over the suspected proximal part of the tendon weather in the palm or the wrist and the tendon guided using silicon tube to the original wound to be repaired,

Tendons were repaired using a modified Kessler-loop lock suture technique (3-0 proline sutures) and reinforced by 4-0 proline peritendinous sutures. After completion of tenorrhaphy, we put a silicon sheet derived from a tissue expander wrapping the repaired tendon without any suture. Intraoperative passive movement of the involved joints to assess the efficiency of tendon repair was done. Following skin closure, below elbow splint according to the tendon cut, extensor, or flexor.

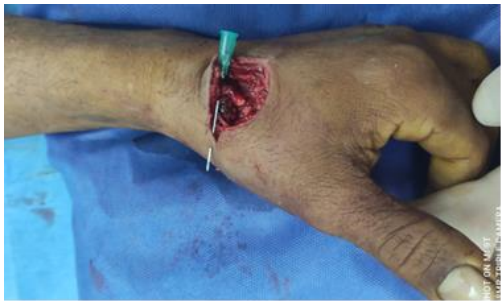

Fig 1: Pre-operative cut EPL ZV.

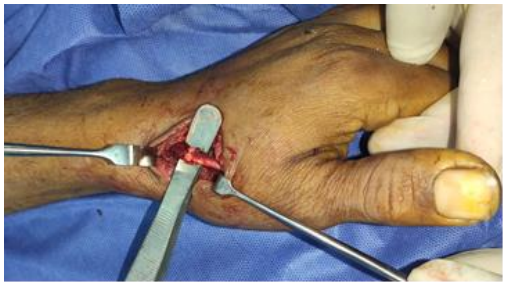

Fig 2: After repair.

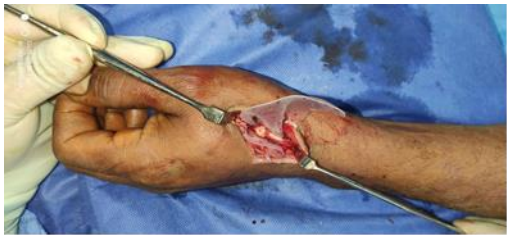

Fig 3: Silicon sheet wrapping the repaired tendon.

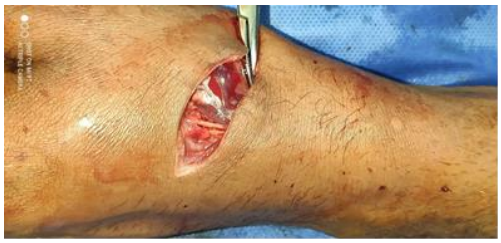

Fig 4: Silicon sheet wrapping the repaired tendon.

Post-operative therapy: Make sure the dressing, splint, and bandage are not so tight to avoid any distal ischemia.

Immobilization & Rehabilitation:

Flexor tendon: (Early active dynamic protocol) Patients are immobilized in a dorsal block with wrist up to 45 degrees of extension and hand in a comfortable position metacarpophalangeal joint in full extension. 1-Three days to 2nd week the patient worked toward half fist position. The Patients were taught passive flexion of all digit joints as a warm-up before active flexion. Then active interphalangeal (IP) joint extension with metacarpophalangeal (MP) joint blocked in flexion to prevent interphalangeal

joint flexion contracture. 2- From the 2nd week to the 3rd week, the patients worked toward full active fist position and active tenodeses exercises. 3- 3rd and 6th week: short splint discontinued and the patient can start blocking exercises and resistive exercises were initiated. All exercises were done for 10 repetitions.

Extensor tendon: (Early active dynamic protocol) Therapeutic exercises: MCP flexion that is active Rubber band recoil was used to extend PIPs and DIPs. Active MCP extension with PIPs and DIPs in hook position 0 and passive MCP joint flexion to 45 degrees were done. The therapist moves the wrist from full passive extension to 0 degrees, keeping all finger joints at 0 degrees. The therapist holds the wrist and MCP joints at 0 degrees, while the patient actively flexes the PIP joints to 60 degrees. Allow 60-degree active MCP flexion in dynamic orthosis during week 3 of dynamic orthosis. Allow 75-degree active MCP flexion to all fingers in dynamic orthosis on week four. In the 6th week, initiate active full power grip and start light fine motor activity.

Evaluation:

Clinical assessment: Assessment of signs of inflammation and allergy: itching, pain, redness, hotness, swelling, or tenderness. Wound dehiscence is either superficial or full-thickness dehiscence.

This is a simplification of the method postulated by Total Active Motion is measured by the American Society for Hand Surgery (ASSH).

(TAM) = [sum of active MP, PIP, and DIP joint flexion minus degrees of full extension] Although ASSH recommends using the contralateral finger (if uninjured) as the normal, they also published 260 degrees as the TAM normal for these three joints. The injured finger's TAM is divided by the normal, and the result is a percentage of them.

Radiological assessment: Ultrasonography: 2- and 4-weeks post-operative the patients got musculoskeletal ultrasound by a specialized radiologist to assess 6 points in the tendon Figure (4, 5, 6):

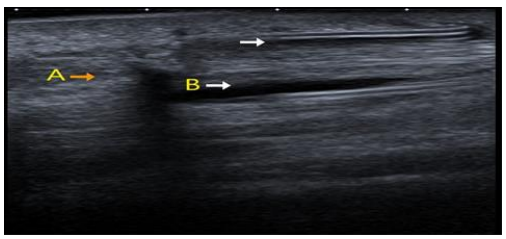

Fig 5: Tendon assessment by longitudinal section with intra implant fluid A: tendon core B: intra silicon fluid.

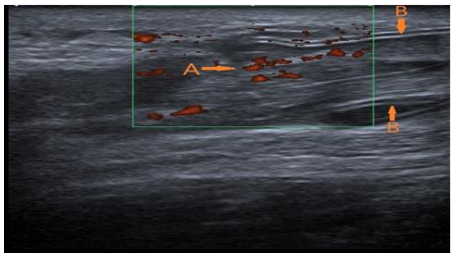

Fig 6: Tendon assessment transverse section A: vascularized tendon B: Intra silicon fluid.

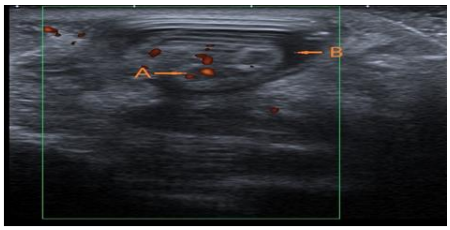

Fig 7: Assessment of tendon vascularity A: tendon core (vascularized) B: Silicon wrapping the tendon

As regards the removal of silicon, we remove it early if any complication occurred such as (infection, seroma, or wound dehiscence), if no complication we can remove it after 6 months.

We remove silicon by local anesthesia, a small incision of 1cm, and remove the silicon sheet easily by mosquito or forceps as we didn't use any suture during wrapping.

Statistical Analysis:

SPSS version 23 was used for data processing and was used to check, enter, and analyse the data. The following statistical methods were used to analyse the current study's findings.

RESULTS

This prospective case series study was carried out on 20 Patients with primary and delayed primary tendon repair that wrapped by silicon sheet. This study was carried out at Al-Azhar University Hospitals (Al-Hussein and Sayed Galal).

(Table 1) shows the demographic characteristics of the studied cases. The age of patients ranged from 15 to 36 years with mean ±SD was 25.67± 7.09 years and median was 27 years. The most common age group was age between 20 and 29 years representing 65% of cases. There were 16 (80%) males and 4 (20%) females with a male to female ratio was 4.0:1.

Post-operative assessment and follow-up were done on the studied patients. Our results showed that one patient (5%) had (mild soft tissue changes) surrounding the tendon. None of the patients were complicated with adhesions. Mild to moderate edema surrounding the tendon compared with contralateral healthy one was found in 17 patients (85%). Dynamic imaging of the tendon movement (passive) to assess the repair site showed tendon continuity in

all patients (100%). Also, the echogenicity of stumps was normal in all studied patients (100%) (Table 2).

F.P.L motion in the 1st, 3rd, and 6th weeks reached 62, 165, and 350 degrees. F. D. P. & F. D. S. L motion in the 1st, 3rd, and 6th weeks reached 57, 135, and 270 degrees. E. P. L. motion in the 1st, 3rd, and 6th weeks reached 20, 70, and 270 degrees. F. C. R. motion in the 1st, 3rd, and 6th weeks reached 300, 650, and 750 degrees. There was a highly significant improvement in TAROM after the 6th week compared to week 1 (Table 3).

(Table 4) US evaluation shows that 17 cases (85%) had excellent results, one case (5%) had fair results, 2 cases (10%) had good results and no cases (0%) had poor results.

(Table 5) shows that the median time needed to resume activity was 5 weeks and ranged from 4 weeks to 7weeks

Fig 8: Cut FDP and FDS of M.F and I.F (Zone II).

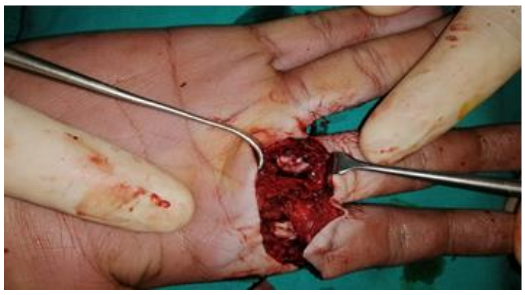

Fig 9: Wrapping the Tendon by Silicon Implant after repair of FDP of M.F.

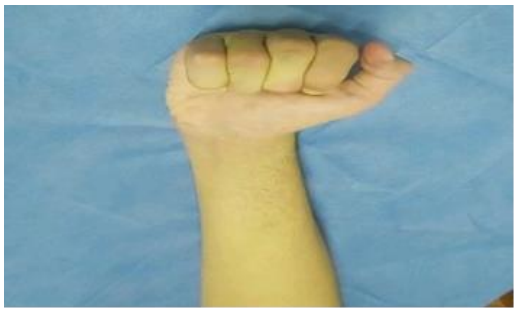

Fig 10: Six Months Post-operative, showing that the ROM of M.F is more than ROM of I.F

Parameters		**Studied patients (N=20)**	
		N	**%**
Age (years)	Mean± SD	26.20± 6.86	
	Median	27.0	
	Range	15.0- 36.0	
Age groups	<20 years	3	15.0%
	20- 29 years	13	65.0%
	≥ 30 years	4	20.0%
Gender	Male	16	80.0%
	Female	4	20.0%

Table 1: Demographic characteristics in the studied patients. SD= standard deviation.

Parameters		Studied patients (N=20)	
		N	N
Soft tissue changes surrounding the tendon	No changes or adhesion	19	95.0%
	Mild changes with no adhesion	1	5.0%
Presence of Adhesions	No	20	100.0%
	Yes	0	0.0%
Edema surrounding the tendon	No	3	15.0%
	Mild to moderate	17	85.0%
Dynamic imaging of the tendon movement	Good mobility	20	100.0%
	Impaired	0	0.0%
Visual assessment of vascularization of tendon	Vascularized	20	100.0%
	No	0	0.0%
Echogenicity of stumps	Normal	20	100.0%
	Abnormal	0	0.0%

Table 2: Distribution of the studied patients as regards U/S findings.

Tendon	Zone of Injury	No.	1st week	3rd week	6th week	Mean	Median
F.P. L	Z.II Z.III	4	62	165	350	192.33	165
F. D. P. & F. D. S.	Z.II Z.III	3	57	135	270	154	135
E.P. L.	Z.V Z.VI	4	20	70	270	120	70
F. C.R.	Z.VI Z.VII	7	300	65٠	750	566.67	650

Table 3: Total Active Range of Motion (TAROM) in studied patients.

Parameters		Studied patients (N=20) N	%
US	Excellent	17	85.0%
	Good	2	10.0%
	Fair	1	5.0%
	Poor	0	.0%

Table 4: Distribution of the studied patients as regards US assessment.

Parameters		Studied patients (N=20) N	%
Time resuming activity (weeks)	Mean± SD	5.50± 1.0	
	Median	5.0	
	Range	4.0- 7.0	

Table 5: Time resuming activity in the studied patients.

DISCUSSION

Use of silicone sheets appears to be effective for preventing adhesion formation following primary tendon repair. To the best of our knowledge, no studies in the literature have used silicon sheets as a mechanical barrier to prevent adhesion after primary tendon repair. In this discussion, we will compare our results with others who utilized mechanical barriers of different Martials.

The main aim of this study was to evaluate the safety and effectiveness of using a silicon sheet wrapping the tendon after primary repair to prevent adhesion. This prospective case series study was carried out on 20 Patients with primary and delayed primary tendon repair wrapped by silicon sheet. This study was carried out at Al-Azhar University Hospitals (Al-Hussien and Sayed Galal). Regarding the demographic characteristics of the studied patients, the current study showed that the age of patients ranged from 15 to 36 years with mean ±SD was 25.67± 7.09 years and median was 27 years. The most common age group was age between 20 and 29 years representing 65% of cases. There were 16 (80%) males and 4 (20%) females with male to female ratio were 4.0:1.

The study by Prakash et al., [9] Wrapped the tendon repair site in human amniotic membrane (HAM) to reduce fibrotic response and tendon adhesion. The study included 19 patients who had flexor tendon injuries that were repaired surgically. In nine cases, the repair site was wrapped in human amniotic membrane (HAM). Because no HAM wrap was used, the remaining ten cases served as controls. The patients' median age was 22 years, with a range of 18 to 42 years. There were two female patients among the nineteen. As well the study by Moosavi et al., [8] described repair the sheath defects, a segment of the vein through which the tendon had previously passed or a patch of the vein was used as a tendon sheath substitute. The study enrolled, 210 patients who were randomly assigned to one of two groups: test or control. There was a highly significant improvement in TAROM after 3rd week compared to week 1 ($p<0.001$).

Prakash et al., [9] Between 6 weeks and 3 months, there was a significant (p-value 0.05) improvement in the total active motion (TAM) score in both HAM cases and controls when comparing the control and amnion groups. The amnion group's results differed significantly (p 0.05) from the control groups, indicating a better functional outcome in HAM cases. Moosavi et al., There were significant differences in grades between the two groups (p 0.005).

Post-operative assessment and follow-up by U/S were done on the studied patients. Our results showed that one patient (5%) had mild soft tissue changes surrounding the tendon. None of the patients were complicated with adhesions. Mild to moderate edema surrounding the tendon mainly intra implant fluid which acts as lubricant and nutrition helping in healing mechanism like normal synovial fluid (this point needs further investigation) and changing our concept on the healing mechanism. Compared with

contralateral healthy one was found in 17 patients (85%). Dynamic imaging of the tendon movement (passive) to assess the suture site showed no gaping and normal healing which depends completely on the intrinsic mechanism, and vascularization in all patients (100%) means that our implant did not affect tendon vascularity. Also, the echogenicity of stumps was normal in all studied patients (100%).

However, the study by Prakash et al., [9] reported only one case of post-operative tendon rupture in one patient with amniotic membrane wrapping. The distal repair site had dehisced. One of their patients developed a nail bed infection as a result of a piece of pull-out suture that had become lodged in the nail bed. In our study, there was no complication such as (infection or wound dehiscence, or reaction to silicon implant) are detected.

Regarding the VAS Pain scale in studied patients, our results showed that the median pain scale was 7.85 in week1, decreased to 6.30 in week 2 and became 5 in week 3. There was high significant decrease in pain scale after week 3 compared to week 1($p<0.001$). Our study supposed that the intra silicon fluid play role in decreasing pain scale. The study reported by Prakash et al., [9] revealed that the Buck–Gramcko evaluation revealed that 42 percent of the 19 patients had an excellent result, and 33 percent had a good result. Despite our promising results, our study has some limitations. First, the limited number of patients in our study, however, we are currently working on another subsequent study with a larger sample size of patients including a control group for comparison. Second, a longer follow-up time may be needed for further evaluation of the functional outcome of our tendon repair technique.

CONCLUSION

The tendon repair site healed quickly and qualitatively well in the current study with silicon wrapping the functionally improved range of motion obtained suggests that peritendinous fibrosis has been reduced. During the follow-up time, the patients underwent an ultrasound examination.in silicon wrap cases, ultrasound confirmed objectively better tendon healing quality, less edema, and the absence of other complications.

Conflict of interest : none

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