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Research Article

Simple Suture vs. Vertical Mattress: Choosing the Best Suture for Palmar Incision Based on a Randomized Clinical Trial

Abbas Abdoli Tafti[1], Milad Gholizadeh[2,*]

[1] Associate Professor, Department of Orthopedics, Trauma Research Center, Shahid Sadoughi Hospital, School of Medicine, Shahid Sadoughi University of Medical Sciences, Yazd, Iran
[2] Resident, Department of Orthopedic Surgery, Trauma Research Center, School of Medicine, Shahid Sadoughi University of Medical Sciences, Yazd, Iran

[*] Corresponding author: Milad Gholizadeh; Department of Orthopedic Surgery, Trauma Research Center, School of Medicine, Shahid Sadoughi University of Medical Sciences, Yazd, Iran. Tel: +98-9135212393; Email: miladghz15255@gmail.com

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Abstract

Background: Despite the prevalence of palmar injuries and surgeries, no consensus exists regarding the type of wound closure. The present study compares simple sutures and vertical mattresses sutures in carpal tunnel release (CTR), trigger finger release (TFR), and trigger thumb release (TTR).
Methods: A total of 89 surgeries were randomized to either simple or vertical mattress sutures. Outcomes including pain, infection, Patient and Observer Scar Assessment Scale (POSAS), satisfaction level, and Quick Disabilities of the Arm, Shoulder and Hand (QuickDASH) were evaluated on postoperative day 3, week 3, and month 3. Month 3 assessments were mostly performed remotely due to coronavirus disease 2019 (COVID-19).
Results: The mean pain was higher in the vertical mattress sutures group compared with simple sutures, though the pain difference was statistically significant only on day 3. No significant mean difference was found between the two groups regarding POSAS items. Some patients underwent bilateral CTR with simple sutures on the one hand and vertical mattresses sutures on the other. The results of their investigation were consistent with the other findings.
Conclusion: Vertical mattress suture in palmar surgeries is associated with greater short-term pain. Other variables did not differ between the two groups at different times. Hence, conclusively, regardless of the short-term pain associated with simple suture, both types of sutures can be used in hand surgeries with similar long-term results.

Keywords: Sutures; Trigger Thumb; Trigger Digits; Carpal Tunnel Release

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Background

Palmar surgeries such as carpal tunnel release (CTR), trigger finger release (TFR), and trigger thumb release (TTR) are among the most common procedures performed by hand surgeons. Despite their routine nature, there is no clear consensus regarding the optimal suture technique for skin closure in these surgeries (1).

The appropriate outcome after wound closure depends on patient-associated factors, wound-associated factors, and technical factors (2).

The surgeon can only influence the results through technical factors, and choosing the best kind of suture is an important technical factor, which is done based on the surgeon's preference (3). Simple and vertical mattress (Donati) sutures (4) are among the most common suturing methods.

Various studies have been conducted on the other technical factors in palmar surgeries, for example, the outcomes of using absorbable versus non-absorbable sutures (5, 6). But, few clinical trials have investigated the effect of suture technique on outcomes in palmar surgeries. Scar aesthetics and functional impairments are to be considered in this area.

The present study compares simple and vertical mattress sutures in elective palmar surgeries (including CTR, TFR, and TTR) in terms of aesthetics, complications, functional outcome, and patient satisfaction. The findings aim to guide evidence-based selection of suture technique in hand surgery practice.

Methods

Study Design: The present randomized clinical trial (RCT) was conducted in a general hospital from March 2020 to July 2021. The study was approved by the University Research Ethics Committee (IR.SSU.MEDICINE.REC.1398.352) and by the Iranian Registry of Clinical Trials (IRCT) (registration number: IRCT20180627040252N2).

Patient demographic information was recorded before the surgeries, and the suture type was determined using a random number table. For bilateral carpal tunnel syndrome (CTS) surgeries, the type of suture for one hand was determined by a random number table, and the other suture type was used for the other hand. Due to the nature of the study and the clarity of the interventions, blinding could not be done. Nylon 4-0 Cut (monofilament polyamide-6, Supalon, SUPA, Iran) was used, and the same hand surgeon did all sutures. Operating room dressing was maintained for 3 days.

Patient Selection: According to the inclusion and exclusion criteria, patients were enrolled in this study with informed consent. Inclusion criteria were patients undergoing elective CTR, TFR, and TTR who could complete postoperative follow-ups. Study exclusion criteria were previous palmar surgeries, hand diseases [such as Dupuytren's contracture and rheumatoid arthritis (RA)], vascular disorders, systemic diseases (diabetes, malignancies, renal failure), skin diseases (eczema, psoriasis), taking corticosteroids and cytotoxic drugs, pregnancy, and a history of keloid and hypertrophic scars.

Assessments: On postoperative day 3, the patients were assessed in terms of pain using the Visual Analogue Scale (VAS), for infection, using the Southampton Wound Assessment Scale (SWAS), and for other complications based on physical examination. A similar assessment was performed at the week 3 follow-up, during which sutures were also removed. The final evaluation occurred at postoperative month 3 and included assessment of scar aesthetics using the Patient and Observer Scar Assessment Scale (POSAS), pain using VAS, functional outcome using Quick Disabilities of the Arm, Shoulder and Hand (QuickDASH), and patient satisfaction using a satisfaction VAS. Due to the coronavirus disease 2019 (COVID-19) pandemic restrictions, in-person visits were minimized, and most month 3 follow-ups were conducted remotely. The SWAS Scale was first designed for hernia surgery wound assessment, grading wounds from 0 to 5 based on complications (7). QuickDASH consists of eleven items scored 1 to 5 (8). In cases of two simultaneous surgeries, the same score was recorded for both. Patient satisfaction was evaluated using VAS. Patients were asked to rate their level of satisfaction from 0 to 10. POSAS consists of two numeric scales, Patient Scar Assessment Scale (PSAS) and Observer Scar Assessment Scale (OSAS); each includes 6 parameters scored by the patient and observer, respectively. Each parameter is scored up to 10 (a score of 10 determines the worst possible scar) (9, 10).

In this study, pliability and thickness were excluded from OSAS since these items require direct inspection (11), and OSAS scoring was done by an observer based on the surgical site image.

Statistical Analysis: The primary outcome was pain, measured using the VAS (0-10). The sample size calculation was based on detecting a clinically significant difference in VAS pain scores between the simple and vertical mattress suture groups. Assuming a mean difference of 1.9 points on the VAS [with a standard deviation (SD) of 2.5, yielding an effect size of 0.75], a significance level of 0.05, power of 80%, and accounting for a 20% loss to follow-up over 3 months, the required sample size was calculated as approximately 36 patients per group (total: 72 patients). Data were collected in Microsoft Excel and analyzed using SPSS software (version 22, IBM Corporation, Armonk, NY, USA). The normality of continuous variables (e.g., VAS pain scores, QuickDASH, and POSAS scores) was assessed using the Shapiro-Wilk test. For normally distributed data, such as VAS pain scores on day 3 and month 3, an independent t-test was used to compare means between the simple and vertical mattress suture groups. For non-normally distributed data, such as QuickDASH scores and certain POSAS items, the Mann-Whitney U test was applied. The chi-square test was used for categorical variables, such as infection rates, as it does not require normality assumptions. For the subset of 15 patients who underwent bilateral CTR with different suture types on each hand, outcomes were initially analyzed as independent observations using an independent t-test. However, this approach does not account for the within-subject correlation between hands of the same patient, violating the assumption of independence (see Limitations). These test selections ensured robust analysis for the overall cohort while adhering to the underlying assumptions of each statistical method, except in the case of bilateral cases where alternative methods are recommended.

Results

Participant Flow: A total of 75 patients were initially assessed for eligibility based on the inclusion and exclusion criteria. Of these, 12 patients were excluded due to not meeting inclusion criteria (e.g., previous palmar surgeries, systemic diseases, or skin conditions) or declining to participate. The remaining 63 patients underwent a total of 89 surgeries (including CTR, TFR, and TTR), as some patients had bilateral procedures. Follow-up assessments were conducted on postoperative day 3, week 3, and month 3, with 17 patients (23 surgeries) lost to follow-up by month 3, primarily due to COVID-19-related restrictions, resulting in 46 patients (66 surgeries) completing the final evaluation. Participant flow, including exclusions and losses to follow-up, is illustrated in figure 1. The demographic characteristics of the patients are presented in table 1.

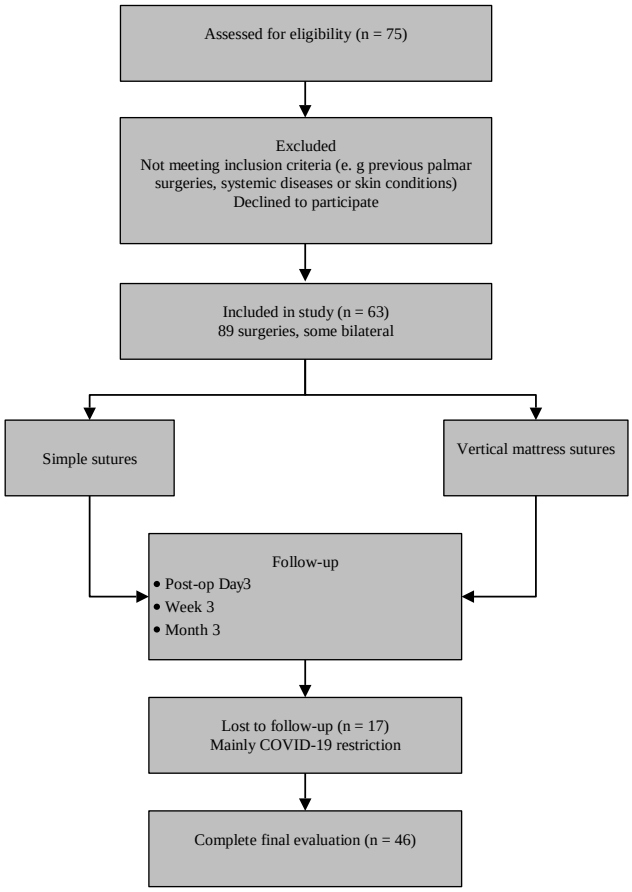

Figure 1. Consolidated Standards of Reporting Trials (CONSORT) flow diagram illustrating participant flow through the study, including enrollment, allocation, follow-up, and analysis phases for simple and vertical mattress suture groups

Day 3: On day 3, one case of grade II-A infection was observed in the simple suture group. No other complications were observed. According to table 2, the absolute mean pain score was significantly higher in patients with vertical mattress sutures compared with simple sutures (P = 0.031). Moreover, fifteen patients in this study underwent bilateral CTS release with a simple suture on one hand and a vertical mattress suture on the other hand.

Table 1. Demographic characteristics

Time		Simple suture	Vertical mattress	Total	P-value
Day 3 and week 3	Number (%) of operations	48 (53.9)	41 (46.1)	89 (100)	
	Age (year) [Mean (range)]	50.17 (26-82)	52.51 (29-82)	51.25 (26-82)	0.350
	Gender				0.859
	Men	4	3	7 (7.9)	
	Women	44	38	82 (92.1)	
	Type of surgery				0.966
	CRT	37	31	68 (76.4)	
	TFR	6	5	11 (12.4)	
	TTR	5	5	10 (11.2)	
Month 3	Number (%) of operations	35 (53.0)	31 (47.0)	66 (100)	
	Age (year) [Mean (range)]	47.51 (26-82)	51.65 (29-82)	49.45 (26-82)	0.169
	Gender				0.818
	Men	4	3	7 (10.6)	
	Women	31	28	59 (89.4)	
	Type of surgery				0.978
	CRT	27	24	51 (77.3)	
	TFR	5	4	9 (13.6)	
	TTR	3	3	6 (9.1)	

CTR: Carpal tunnel release; TFR: Trigger finger release; TTR: Trigger thumb release

Table 2. Comparison of mean pain, satisfaction, and Quick Disabilities of the Arm, Shoulder and Hand (QuickDASH) score between the two groups

Variable	Simple suture	Vertical mattress	P-value
Day 3 pain	2.43 ± 1.54	3.29 ± 2.50	0.031
Week 3 pain	1.99 ± 0.90	2.82 ± 1.51	0.372
Month 3 pain	0.40 ± 1.51	0.71 ± 2.05	0.365
Month 3 satisfaction	8.58 ± 2.75	8.25 ± 3.08	0.502
Month 3 QuickDASH	15.12 ± 24.55	19.20 ± 24.76	0.257

Data are presented as mean ± standard deviation (SD)
QuickDASH: Quick Disabilities of the Arm, Shoulder and Hand

A separate statistical analysis was done on these patients, which showed no significant difference in absolute mean pain score (P = 0.468) (Table 3). No infection or complication was found among these patients.

Table 3. Comparison of mean pain, satisfaction, Patient Scar Assessment Scale (PSAS), and Observer Scar Assessment Scale (OSAS) between the two groups with bilateral carpal tunnel syndrome (CTS)

Variable	Simple suture	Vertical mattress	P-value
Day 3 pain	2.47 ± 3.35	2.93 ± 3.51	0.468
Week 3 pain	0.40 ± 0.63	1.00 ± 1.51	0.331
Month 3 pain	0.00 ± 0.00	0.25 ± 0.62	0.149
Month 3 satisfaction	8.62 ± 2.91	7.58 ± 3.82	0.438
PSAS			
Painful	1.08 ± 0.28	1.25 ± 0.62	0.514
Itching	1.00 ± 0.00	1.08 ± 0.28	0.317
Color	2.83 ± 2.08	2.75 ± 2.05	0.923
Stiffness	2.00 ± 0.42	2.08 ± 0.66	0.965
Thickness	1.92 ± 0.28	2.00 ± 0.42	0.580
Irregularity	2.08 ± 0.66	2.00 ± 0.42	0.965
Sum of PSAS	10.29 ± 2.96	11.17 ± 2.98	0.926
Overall score	2.25 ± 0.75	2.25 ± 0.75	> 0.999
OSAS			
Vascularity	1.75 ± 0.75	1.58 ± 0.79	0.527
Pigmentation	1.33 ± 0.49	2.00 ± 0.95	0.056
Relief	1.50 ± 2.08	1.00 ± 0.90	0.052
Surface area	1.25 ± 0.62	1.25 ± 0.45	0.713

Data are presented as mean ± standard deviation (SD)
PSAS: Patient Scar Assessment Scale; OSAS: Observer Scar Assessment Scale

Week 3: The number of surgeries and the demographic characteristics were similar to day 3 (Table 1). In the week 3 follow-up, two cases of grade I-A infection, one case of grade I-B infection, one case of grade III-A infection, two cases of maceration, and one case of wound dehiscence were found in the simple suture group. On the other hand, one case of grade I-A infection, one case of grade III-A infection, one case of grade V infection, two cases of wound dehiscence, and one case of wound necrosis were observed in the vertical mattress suture group. Suture threads were left in two cases of the vertical mattress suture group after suture removal. The difference in the total number of complications between the two groups was not significant. The absolute mean pain score was higher in the vertical mattress suture group than in the simple suture group, though the difference was not statistically significant (P = 0.372) (Table 2).

In week 3, fifteen patients had bilateral CTS release with different suture types on different hands. Statistical analysis showed no significant difference in absolute mean pain (Table 3). One patient had a grade III-A infection and wound dehiscence bilaterally.

Month 3: A total of seventeen patients did not complete month 3 follow-ups. Forty-six patients with 66 surgeries were evaluated in month 3. The demographic characteristics of the patients are presented in table 1. The absolute mean pain score was not significantly different between the two groups (P = 0.365). Moreover, no significant difference was found between the two groups in terms of QuickDASH and satisfaction scores (P = 0.257, P = 0.502, respectively) (Table 2).

Mean scores of PSAS items, PSAS total scores, and 4 items of OSAS items were compared between the two groups, which showed no significant difference (Table 4).

Table 4. Comparison of Observer Scar Assessment Scale (OSAS) and Patient Scar Assessment Scale (PSAS) items between the two groups

Variable	Simple suture	Vertical mattress	P-value
OSAS			
Vascularity	1.66 ± 0.87	1.65 ± 0.79	0.898
Pigmentatio	1.57 ± 0.81	1.97 ± 1.04	0.106
n			
Relief	1.46 ± 0.88	1.68 ± 0.90	0.158
Surface area	1.37 ± 0.73	1.45 ± 0.88	0.669
PSAS			
Painful	1.37 ± 1.28	1.65 ± 1.81	0.765
Itching	1.26 ± 1.35	1.06 ± 0.25	0.926
Color	2.63 ± 1.28	3.00 ± 1.98	0.928
Stiffness	2.49 ± 1.19	2.19 ± 0.87	0.181
Thickness	2.31 ± 1.27	2.00 ± 0.36	0.251
Irregularity	2.20 ± 0.99	2.03 ± 0.48	0.722
Sum of PSAS	12.26 ± 5.88	11.49 ± 3.99	0.487
Overall score	2.51 ± 1.17	2.45 ± 0.88	0.925

Data are presented as mean ± standard deviation (SD)
PSAS: Patient Scar Assessment Scale; OSAS: Observer Scar Assessment Scale

In month 3, twelve patients had bilateral CTS release, with different suture types on different hands. Statistical analysis showed no significant difference in absolute mean pain score, patient satisfaction, and POSAS items (Table 3).

Discussion

Factors related to the wound (including blood supply and quality of surrounding tissues, flexibility and tension of nearby soft tissues, its location, and level of contamination), related to the patient (including the patient's general health and comorbid conditions, age, ethnicity, and hereditary predisposition), and technical factors (including the planning of incisions, care of tissue handling, adequacy of debridement, sutures used, method and tension of wound repair, the period of time that sutures are left in situ, and postoperative scar management) are three categories of factors affecting the results of a wound closure (2). The last one is the only

factor that is under the surgeon's control. Choosing the kind of suture is an important technical factor.

Various studies have evaluated technical factors in palmar surgeries; yet, few studies have been conducted to compare different suturing techniques. On the other hand, suture techniques have been compared on other anatomical sites, such as the forehead, scalp, neck, and leg (11, 12). Thus, a study was required to assess and compare suturing techniques in the palmar area.

In our study, no statistically significant difference was found between the study groups regarding the type of surgery, age, and gender; thus, these factors did not contribute to the results of the two groups.

On day 3, patients' pain was significantly higher in those with vertical mattress sutures than in those with simple sutures. In other words, the vertical mattress suture is associated with a higher short-term pain rate than the simple suture. However, this difference was not significant at the third-week or third-month follow-ups, and the pain of the two groups was not significantly different.

Generally, the number of infections was higher in the simple suture group, and the severity of infection was higher in the vertical mattress suture group. But this difference was not significant. Moreover, two patients experienced suture thread left after suture removal in the vertical mattress suture group.

Scar aesthetics was investigated in month 3. Although wound healing and remodeling continue up to 6 months (13), studies have shown that the wound's aesthetics does not change between month 3 and year 1 (14).

Although OSAS under standard conditions must be assessed in person, due to the COVID-19 pandemic, it was scored based on wound photographs. Pliability and thickness items could not be directly assessed; thus, only four OSAS items were compared, showing no statistically significant difference. Moreover, no significant differences were found regarding PSAS items. Thus, despite the common belief that vertical mattress sutures provide higher aesthetics due to higher eversion (11), no significant aesthetic difference was found between the vertical mattress and simple suture groups in POSAS items.

No significant difference was found between the two groups regarding the mean QuickDASH score in month 3. Patient satisfaction was higher in the simple suture group than in the vertical mattress suture group, which may be attributed to the lower pain and QuickDASH scores in the simple suture group. However, the difference was not statistically significant, which may have been affected by factors other than suturing technique.

Literature search showed that only one study compared simple and vertical mattress sutures in palmar surgeries. In 2010, Bolster et al. conducted a study on patients undergoing merely CTR surgery. Seventy-one patients were compared regarding scar aesthetics, QuickDASH, pain, and satisfaction only in week 8. Results of this study showed that both sutures resulted in excellent aesthetics and proper patient satisfaction, except for the higher pain on week 8 in patients with the vertical mattress sutures (15). The results of this study are similar to the results of the present study. But our study evaluated various surgeries, including CTR, TTR, and TFR. In addition, it has numerous and longer follow-ups.

Several explanations could account for these outcomes. The short-term pain increase with vertical mattress sutures might be attributed to their deeper tissue bites and increased tension, which could stimulate nociceptors more intensely in the early postoperative period. The lack of aesthetic or functional differences by month 3 may reflect the palmar skin's robust healing capacity, potentially overshadowing suture-specific effects over time. The remote month 3 assessments due to COVID-19, relying on photographs for POSAS scoring, might have limited the precision of scar evaluation, particularly for pliability and thickness, which could explain the absence of significant differences.

As previously discussed, outcomes such as wound infection rate and scar aesthetics may be affected by genetic factors. Genetic factors are adjusted by comparing bilateral surgeries. The literature search showed that bilateral CTS release surgeries with different suturing techniques had not been compared. In the present study, some patients had bilateral CTS in whom simple sutures and vertical mattress sutures were used in different hands and compared with each other. The results of this comparison were consistent with the total analysis. In such cases, the absolute mean pain score was higher in the vertical mattress suture group compared with the simple suture group, though the difference was not statistically significant. No significant difference was observed regarding QuickDASH, satisfaction, and POSAS items.

The strengths of this study include wound assessment three times, considering different aspects such as pain, QuickDASH, satisfaction, assessment of different elective palmar surgeries, and comparison of bilateral CTR surgeries.

Limitations: This study has several limitations that should be considered. A key limitation is the lack of blinding, which was not feasible due to the visible nature of the suture techniques (simple vs. vertical mattress). This introduces potential performance bias, as the surgeon's awareness of the suture type might influence technique application or postoperative care, and detection bias, as subjective outcomes like pain (VAS), patient satisfaction, and POSAS scores could be influenced by the patients' or assessors' knowledge of the intervention. Another significant limitation is the use of online follow-ups for the month 3 assessment due to COVID-19 restrictions, which relied on patient-reported data and photographs. This approach may have introduced detection bias, as remote evaluations likely underestimated subtle clinical signs such as infection severity or scar characteristics (e.g., pliability and thickness), which require physical examination. The exclusion of these POSAS items from the analysis may have masked potential differences in scar aesthetics between suture types. Additionally, the loss of 17 patients (23 surgeries) to follow-up could indicate selection bias, as those lost might differ from retained participants in terms of healing or compliance, potentially affecting the generalizability of the findings. Furthermore, in the subset of 15 patients who underwent bilateral CTR with different suture types on each hand, outcomes were analyzed as independent observations using an independent t-test. This approach violates the assumption of independence, as the two hands of the same patient are not independent, leading to potential underestimation of variance and overestimation of statistical significance. Statistical methods such as paired t-tests or mixed-effects models, which account for within-subject correlation, would have been more appropriate. This limitation may have affected the accuracy of the bilateral subgroup analysis, though the consistency of these findings with the overall results suggests the impact may be limited. The sample size, while calculated to detect a significant

difference in pain, may also have been insufficient to identify subtle differences in complications or aesthetics. Future studies should prioritize in-person follow-ups where feasible, implement blinded assessments, use appropriate statistical methods for paired data, and include larger cohorts to mitigate these biases and enhance the robustness of the results.

Conclusion

Results of the present study suggest no significant difference between the simple suture and vertical mattress suture in terms of scar aesthetics, wound complications, functional outcomes, or patient satisfaction following palmar surgeries. Conclusively, regardless of the higher short-term pain of vertical mattress suture, both types of sutures can be used in hand surgery according to the surgeon's preference with similar results.

Conflict of Interest

The authors declare no conflict of interest in this study.

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