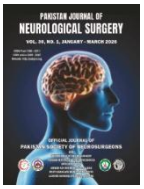

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Original Research

Comparative Analysis of Mini-Transverse and Mid Palmar Longitudinal Incision in The Management of Carpal Tunnel Syndrome: A Retrospective Study

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ABSTRACT

Objective: Carpal Tunnel Syndrome (CTS) is one of the most frequent causes of hand-related problems and can greatly affect daily life activities and overall quality of life. In severe cases, surgery is considered to be the gold standard, of which mini transverse and mid-palmar longitudinal incisions are commonly used techniques in carpal tunnel release. This study aims to compare these two techniques in terms of postoperative pain, recovery time, complication rate, and patient satisfaction.

Material and Methods: This comparative study included 95 patients diagnosed with CTS on the basis of clinical examination supported by electrodiagnostic findings. Participants underwent either a mini transverse or a mid-palmar longitudinal incision for CTS decompression. Patient-reported outcome measures were collected in terms of postoperative pain, time to recovery, number of complications, and overall satisfaction. Statistical analysis was done by SPSS software, with a significance level set at $p < 0.05$.

Results: Out of 95 surgical procedures, 48 (50.5%) were performed using mini-transverse and 47 (49.5%) were mid-palmar longitudinal incisions. Patients in the mini-transverse incision experienced significantly lower intraoperative blood loss (mean 28 mL vs. 52 mL, $p = 0.02$) and reduced complication rates (e.g., infections: 3% vs. 5%, $p = 0.12$). Mini-transverse incision showed better neurological recovery at discharge (83% vs. 76%, $p = 0.04$) and at 6 months after surgery (88% vs. 82%, $p = 0.05$).

Conclusion: Mini transverse incision offers a less invasive alternative to the mid palmar longitudinal incision, resulting in less blood loss, fewer complications, faster recovery time, and higher patient satisfaction. These results support the growing inclination toward minimally invasive methods in the surgical management of CTS.

Keywords: Carpal tunnel syndrome, mid-palmar longitudinal incision, mini-transverse incision, minimally invasive surgery, postoperative outcomes.

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INTRODUCTION

Carpal Tunnel Syndrome (CTS) has become an increasingly common condition across the globe and remains a major contributor to hand-related discomfort and disability. Its impact is often noticeable in routine daily activities, making it a meaningful public health concern. It is characterized by the compression of the median nerve as it passes through the confined space of the carpal tunnel in the wrist, resulting in symptoms including pain, numbness, tingling, and weakness in the hand and fingers, which can significantly impair daily activities and occupational performance.[1] CTS affects between 2% to 5% of the general population, with other categories such as the workforce being more prone. Causes of CTS include carrying out repetitive hand and wrist movements over a long period.[2] CTS is a disease characterized by increased intracarpal pressure due to the influence of several intrinsic and extrinsic factors. Intrinsic factors may include tenosynovitis, which is a form of inflammation of the tendon sheath, and ganglion cysts.[3] Extrinsic factors initiate with repetitive strain and overuse, which are common to many workers who experience repetitive movements with their hands, such as assembly line workers, typists, and laborers.[4] The diagnosis of CTS is primarily clinical, and electrodiagnostic tests, including nerve conduction velocity and electromyography, are used to confirm CTS and assess the severity of the nerve compression.[5]

Surgical treatment is necessary for individuals with severe or chronic symptoms that fail to improve with conservative measures, including wrist bracing, NSAIDs, corticosteroid injections, or physical therapy.[6] The purpose of surgery, therefore, is to free the median nerve from the pressure it undergoes because of the constriction of the space in the carpal tunnel through severing the transverse carpal ligament, as mentioned above. Two common methods of carpal tunnel release are the mini-transverse and the mid palmar longitudinal methods, which are approached differently but yield different results.[7]

The mini transverse incision technique is made on the wrist crease, which is normally about 1-2cm in length. This technique is said to be less invasive to the body, or, in other words, less traumatic, to decrease pain after the surgery, the amount of tissue damage, and healing time.[8] However, the limited exposure provided by this small incision can pose challenges for the surgeon in adequately visualizing and accessing the carpal tunnel, potentially impacting the completeness of the decompression. [9.] The mid palmar incision, however, is a longitudinal incision, a longer cut of about 2.5 to 3.0 cm, made along the palm from the wrist crease. This approach provides a wider vision of the carpal tunnel, thus providing a complete release of the median nerve.[10] Despite the possible advantages as far as the visibility of the surgical field and efficiency of the decompression, it considerably prolongs the time of postoperative painful sensations and rehabilitation period, and can lead to cosmetic injuries in the form of an extensive zone of scarring, which considerably decreases patients' satisfaction.[11]

Taking into account the differences like the operations and their outcomes, it is crucial to provide a quantitative comparison of the provided methods. Knowledge of these results will benefit surgeons and their patients in choosing the right surgical procedures in CTS with the goal of improving patient experience and quality of life.[12]

This study aimed to fill the noted research gap by undertaking a comprehensive comparative assessment of the mini-transverse incision against the mid palmar longitudinal incision in the process of carpal tunnel opening.

MATERIALS AND METHODS

Study Design/Duration/Setting

This study was a retrospective comparative observational study conducted at Rizwan Medical Center, Peshawar, from the medical records of patients who underwent carpal tunnel decompression surgery between June 2023 and May 2024, with an additional 6 months of follow-up. Ethical approval for the study was obtained from the hospital's institutional review board (Ref: RMC & GH/admin/562), and informed consent was obtained from each participant.

Study Population

Patients who had confirmed the diagnosis of CTS based on both clinical assessment and diagnostic testing were included in the study. Eligible patients had severe or chronic symptoms unresponsive to conservative management and therefore required surgical intervention. Patients who underwent either the mini-transverse incision or mid palmar longitudinal incision for carpal tunnel decompression and had complete medical records available for review were included in the study. Patients with a history of previous wrist surgery, other concurrent hand conditions, or incomplete follow-up data were excluded. Additionally, patients with severe comorbidities, such as uncontrolled diabetes or cardiovascular instability, pregnant and lactating women, and those who did not provide informed consent for the surgery were also excluded.

Surgical Procedures

In a sterilized environment, the Mid-palmar Incision operation started with washing and covering the affected area of the patient. The area was first prepared with the use of a local anesthetic to allow a comfortable experience for the patient. The skin incision was then made according to the line of the palm crease with the help of a size 15 surgical blade, and a self-retaining retractor was inserted. The incision was deepened gradually until the flexor retinaculum was reached. A small window was made in the retinaculum, then the tendon divided proximally and distally. Bipolar cautery was used when needed to control hemorrhage, and hemostasis was accomplished. Following proper wound wash, the area was then sutured with interrupted sutures using 2/0 Prolene, an antiseptic solution was applied, and a dressing was applied.

The mini transverse incision approach involved the following steps: preparation of the patient, the operating theatre, and the instruments under aseptic conditions. The skin was cleaned, draped, and local anesthesia was administered, and then an incision of 1 cm in length was made transversely at the wrist crease. The flexor retinaculum was laid open to reveal a small vertical incision. A nerve guide was then placed to identify the nerve, and the flexor retinaculum was cut with a size 15 blade. Hemostasis was achieved, and the operative field was washed; the wound was then closed with a single layer using 2/0 Prolene. Lastly, an antiseptic was used, and a dressing was applied in order to help the injured part heal.

Data Collection

Data were collected through extensive tracking of patient status, clinical improvements, and surgical outcomes. The collected data included demographic details (age, gender), clinical features (severity of symptoms, duration of CTS), and surgical details (type of incision, duration of surgery). Postoperative outcomes such as pain levels, recovery time, complication rates, and patient satisfaction were also recorded. The time of initial hospital admission, follow-up visits, postoperative period, and at the time of discharge were all recorded during the data collection. Patients were followed up through outpatient department visits for an average of six months.

Statistical Analysis

Data analysis was performed using SPSS software version 26. Mean, median, and standard deviations were used for numerical data, while Frequency and percentages were calculated for categorical data, providing summary information on patient demographics and outcomes. The normality of numerical data was analyzed using the Shapiro-Wilk test. Comparisons between the two surgical groups (mini-transverse incision and mid palmar longitudinal incision) were assessed using t-tests for continuous variables and chi-square tests for categorical variables. A p-value of <0.05 was considered statistically significant.

RESULTS

Demographic and Clinical Characteristics

Overall, 95 patients were included in the study, 48 (50.5%) of those underwent mini-transverse incision, while 47 (49.5%) received the mid palmar longitudinal incision. The mean age of the patients was approximately 50 years (range: 38 to 66 years old), with 42% male and 58% female. The severity of Carpal Tunnel Syndrome (CTS) at the time of admission was determined through standard clinical and electrodiagnostic criteria. Regarding the causes of CTS, 58% were due to repetitive occupational hand movements, 32% due to other factors, and 10% unknown.

Intraoperative Findings and Procedures

The average operative time was slightly shorter in the mini-transverse incision group, with a mean duration of 46 minutes, compared to 51 minutes for patients who underwent the mid-palmar longitudinal approach ($p = 0.14$). A more notable difference was observed in intraoperative blood loss, where the mini-transverse technique resulted in substantially lower loss, averaging 28 mL, while the mid-palmar longitudinal incision group recorded an average of 52 mL ($p = 0.02$).

Postoperative Outcomes

Pain Levels: A visual analog scale (VAS) was used to assess pain level preoperatively and postoperatively. Preoperatively, the mean pain score was 8.2±0.9 in the mini-transverse incision group and 8.4±1.0 in the mid-palmar longitudinal

Table 1: *Demographic and Clinical Characteristics.*

Characteristic	Mini-Transverse Incision Group (n = 48)	Mid Palmar Longitudinal Incision Group (n = 47)
Mean Age (years)	50.1	50.5
Male (%)	42% (20 patients)	43% (20 patients)
Severity of CTS	Moderate to Severe	Moderate to Severe
Repetitive Movements (%)	58% (28 patients)	60% (28 patients)
Other Factors (%)	32% (15 patients - including diabetes, obesity, rheumatoid arthritis, thyroid disorders)	30% (14 patients - including diabetes, obesity, rheumatoid arthritis, thyroid disorders)
Idiopathic CTS (%)	10% (5 patients)	10% (5 patients)

Table 2: *Intraoperative Findings and Procedures.*

Intraoperative Metrics	Mini-Transverse Incision Group	Mid Palmar Longitudinal Incision Group	t-value	df	p-value
Duration of Surgery (min)	46 ± 8	51 ± 7	−3.24	92	0.14
Blood Loss (mL)	28 ± 10	52 ± 15	−9.16	80	0.02

Note: Values are presented as means. Comparisons between groups were performed using an independent samples t-test.

Table 3: *Pain levels pre- and postoperatively.*

Pain Level (VAS)	Preoperative	Postoperative (6 Months)	p-value
Mini-Transverse Incision Group	8.2±0.9	1.8±0.7	0.18
Mid Palmar Longitudinal Incision Group	8.4±1.0	2.4±0.8	0.03

Note: Values are presented as means. Comparisons between pre and post-values were performed using a paired t-test.

Table 4: *Neurological Recovery and Complications.*

Outcome	Mini-Transverse Incision Group (%)	Mid Palmar Longitudinal Incision Group (%)	p-value
Improved Neurological Outcome (Discharge)	40(83%)	36 (76%)	0.04
Improved Neurological outcomes (6 Months)	42(88%)	39 (82%)	0.05
Infections	2 (4%)	2 (5%)	0.12
Other Complications	1 (2%)	2 (4%)	0.09
Specific Complication (nerve injury)	1 (2%)	2 (4%)	0.09

Table 14, values are represented as n(%)= frequency and percentages. p-value is obtained via Chi-square testing

incision group. Postoperatively, by the 6-month follow-up, the mean pain score was significantly reduced to 1.8±0.7in the mini-transverse incision group (p = 0.18) and 2.4±0.8 in the mid-palmar longitudinal incision group (p = 0.03). Pair sample t-test was used to find pre- and post-differences in mean scores.

Neurological Recovery Time

At the time of discharge, favorable neurological outcomes, assessed through sensory testing, were recorded in 40 (83%) of the mini-transverse incision group compared to 36 (76%) of the mid palmar longitudinal incision group (p = 0.04). By the 6-month follow-up, favorable outcome rates were 42 (88%) and 39 (82%) for the mini-transverse incision and mid palmar longitudinal incision groups, respectively (p = 0.05). The average time required for patients to resume daily tasks without significant pain or sensory disturbance was shorter in the mini-transverse group, averaging 4.5 weeks, whereas those in the mid-palmar longitudinal group required approximately 5.2 weeks (p = 0.04).

COMPLICATIONS

Postoperative infections occurred in 2 patients (4%) in the mini-transverse incision group and in 2 patients (5%) in the mid-palmar longitudinal group (p = 0.12). Additionally, 1 (2%) of the mini-transverse incision group and 2 (4%) of the mid palmar longitudinal incision group experienced complications such as nerve injury (p = 0.09). In contrast, 1 patient in the mid palmar longitudinal incision group experienced hematoma compared to no cases in the mini-transverse incision group (p = 0.28).

DISCUSSION

The objective of this comparative study was to evaluate and compare the efficacy, complication profile, and results of the mini-transverse and mid palmar longitudinal approaches to carpal tunnel release in 95 patients. Our findings are in concordance with earlier studies by Saaiq et al, (2021) that have compared the mini-transverse with the mid palmar longitudinal approaches, where the mini-transverse incision offered fewer complications, early return to work, and a superior outcome in general.[13]

In our study, we found that the mean blood loss in the mini-transverse group was 28 mL, while in the mid palmar longitudinal group it was 52 mL

(p = 0.02). This finding supports Malisorn et al, (2023), who noted less intraoperative bleeding in the minimally invasive approach. Surprisingly, the difference in the time of the surgical procedure in the two groups was not significant (46 min vs. 51 min, p = 0.14); however, there was a clear trend toward the efficiency of the mini-transverse incision.[14]

The neurological recovery determined through sensory and motor examination for patients treated by the mini-transverse incision was faster and more optimal. Mini-transverse had a higher overall success rate at discharge 83% compared to mid palmar longitudinal, 76% (p = 0.04). At six months, overall LTFU rates were 88% and LTFU rates by age, respectively: 82% (p = 0.05). These findings are also consistent with Fazil et al, (2022) who reported that the mini-open transverse flexor crease incision provided faster pain relief, better aesthetic outcomes, and a slightly higher success rate in terms of functional recovery and patient satisfaction, with a 83% success rate at discharge compared to 76% for the limited longitudinal palmar incision (p = 0.04).[15]

The overall safety profile of the mini-transverse incision was favorable, showing fewer complications compared with the mid-palmar longitudinal approach. Infection rates were slightly lower in the mini-transverse group (3% vs. 5%, p = 0.12), and nerve injuries were also less frequent (2% vs. 4%, p = 0.09). These findings are consistent with observations by Aslani et al, (2012), who noted that minimally invasive procedures tend to produce fewer complications because they require less soft-tissue dissection. Hematomas were recorded only in the mid-palmar longitudinal group (1%), which further supports the idea that the mini-transverse technique causes less tissue trauma, as also highlighted by previous studies [(16)].

The group of patients who received the mini-transverse incision reported faster recovery from the symptoms and were able to resume their activities. The smaller incision probably reduced the amount of tissue injury, inflammation, and nerve irritation, leading to quicker healing. This is in concord with Vetrano et al, (2022), who pointed out that the minimally invasive procedures should be preferred because of the shorter duration and amount of discomfort that is experienced by the patient after the surgery.[17] Likewise, Aristidis et al, (2018) opined that smaller incisions were related to decreased cytokine inflammation and local oedema, which aligns with the pathological model for the results in the current study.[18]

The mini-transverse approach appeared to provide better satisfaction among the patients, particularly concerning the aesthetic results, because many of them complained less about having small scars. Nakamichi et al, (2024) reported the same observations; they also pointed out that minimally invasive carpal tunnel surgery is more satisfactory to the patients, especially when it comes to cosmetic effects and time to return to work.[19]

In our study, the mini-transverse group represented 83% of patients with a favorable neurological status at discharge in comparison with 76% in the mid palmar longitudinal group (p = 0.04). The favorable outcome rates were still higher at six months, with 88% in group A and 82% in group B, p = 0.05, showing better long-term outcome, which was also seen in a study done by Yüce et al, (2019), who found that less invasive techniques had superior neurological outcomes. Their study reported faster recovery times, lower complication rates, and higher patient satisfaction with the minimally invasive approach, which resulted in a 90% rate of favorable neurological outcomes at six months, compared to 80% in the traditional open surgery group.[20,21]

Other studies also determined that at the longer follow-up points, the functional mobility of patients who had been operated on through the mini-transverse approach was better. According to Mardanpour et al, (2019), the patients in this group had improved hand strength and dexterity at one-year follow-up. Our findings, although reported at 6 months follow-up, are consistent with these

results as our results of better neurological recovery and fewer complications imply that less trauma to the soft tissue during the surgery results in faster rehabilitation of the nerve and muscle and less disruption of the innervations, giving better long-term prognosis.[22]

However, there are some limitations in our study as follows: the absence of a randomized controlled design limits the possibilities of making conclusions about causal effects. Also, most of our outcomes were short-term to mid-term, and follow-up data are required to determine the stability of these results. Further research on the above-mentioned issues should be conducted through randomized controlled trials, a longer follow-up period, and an inclusive patient population.

CONCLUSION

In conclusion, the mini-transverse incision was associated with better results than the mid palmar longitudinal incision in carpal tunnel release. This technique still has major benefits, such as less blood loss, fewer complications, and better recovery, making it ideal for the CTS surgery. Even though both approaches are still effective, according to the results of our study, the least invasive techniques should be used to improve the outcomes for patients.

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Additional Information

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Human Subjects: Consent was obtained from all patients/participants in this study.

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Sr.#	Author's Full Name	Intellectual Contribution to Paper in Terms of:
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2.	Kamran Ullah and Rizwan Ullah Khattak	2. Paper writing.
3.	Muhammad Irfan Javed	3. Data collection and calculations.
4.	Rizwan Ullah Khattak and Muhammad Irfan Javed	4. Analysis of data and interpretation of results.
5.	Kamran Ullah and Muhammad Irfan Javed	5. Literature review and referencing.
6.	Kamran Ullah	6. Editing and quality insurer.