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Research Article

Comparison of Conventional versus Mini-Incision Technique for Carpal Tunnel Release

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Abstract: Background: Different surgical approaches are adopted for treating carpal tunnel syndrome (CTS) and these could be categorized as either endoscopic or non-endoscopic procedures. Data from Pakistan regarding these surgical techniques is very limited.

Objective: To compare the transverse mini-incision (TMI) with the conventional incision technique for the treatment of CTS.

Materials and Methods: This randomized controlled trial was carried out at the outpatient department of the Department of Orthopedics, Sahiwal Teaching Hospital, Sahiwal, Pakistan, from April 2022 to March 2023. A total of 46 patients were enrolled following the inclusion criteria of patients of both genders, aged between 18 and 70 years, presenting with symptoms of CTS for at least 3 months duration and having a visual analog scale (VAS) score of more than 4. Patients were randomly divided into conventional incision, and TMI group. Pre-procedure scores on the VAS, and the Functional Severity Scale (FSS) were noted to compare them postoperatively at the 2nd, 6th, and 12th weeks and at the 6- and 9-months follow-ups.

Result: In a total of 46 patients, 28 (60.9%) were females. The mean age was 41.8±6.9 years. The mean VAS pain scores were significantly lower among patients of TMI group at 12-week ($p=0.001$), 6-month ($p<0.001$), and 9-month ($p<0.001$) for TMI group. Comparison of functional levels among both study groups showed that TMI group had significantly better scores at 3-month ($p=0.023$), 6-month ($p<0.001$), and 9-month ($p<0.001$) follow-up intervals.

Conclusion: The TMI is better for relieving symptoms of CTS because its effects on pain and functional outcome are better than conventional incision.

Keywords: Carpal tunnel syndrome, Conventional incision, Functional severity scale, Transverse mini incision, Visual analogue scale, McDonald dissector, Functional outcome.

INTRODUCTION

Compression of the median nerve in the transverse carpal ligament was initially mentioned in 1854, but the name "carpal tunnel syndrome (CTS)" was not used until mid of 20th Century. Since 1960, CTS has become the most diagnosed compression neuropathy. Acroparesthesia is numbness, tingling, or a pricking sensation in the extremities due to an unknown cause or caused by compression of nerves during sleep [1-3].

Different surgical approaches are adopted for treating CTS, and these could be categorized as either endoscopic or non-endoscopic procedures. Non-endoscopic procedures include standard open technique, a wrist-incision technique, and mid-palmar incision technique. Ma *et al.* comparing two incision techniques concluded that the transverse mini incision (TMI) exhibited a significantly reduced time to return to work and activity, and had relatively less complication rates than open CTR. Malisorn *et al.* in 2023 found that mean visual analog scale (VAS) scores after 6-month following TMI, versus the conventional open approach among patients with CTS were 0.05±0.21 versus 0.31±0.50 ($p<0.01$). On the contrary, Gulsen *et al.* comparing conventional open surgical technique, or TMI techniques demonstrated comparable outcomes, with neither showing clear superiority over the other. A notable difference was the time taken to resume using their hands for daily activities, indicating a slight advantage in functional recovery for one of the techniques [4-8].

Data from Pakistan regarding these surgical techniques is very limited. Therefore, we planned this study with the objective of comparing the surgical outcomes of the conventional versus TMI technique for CTS in terms of pain and functional outcomes. It was hypothesized that TMI was better than the conventional incision when used for carpal tunnel decompression in terms of pain resolution, and better functional outcomes post-surgery. The study findings would be helpful in determining the superiority of one surgical technique over the other for CTR so that a quicker return to normal activities and work for those patients could be achieved, causing less pain and scarring. Due to frequent healthcare visits, quality of life can also be improved along with a decrease in morbidity.

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MATERIALS AND METHODS

This was a randomized controlled trial carried out at the department of Orthopedics, Sahiwal Teaching Hospital, Sahiwal, Pakistan, during April 2022 to March 2023. Permission from the ethical committee was sought (No. 609/DME/SLMC/SWL, dated: 25-05-2021). The trial was registered with trial number NCT07018011. Taking VAS pain scores in mini-incision versus open surgical technique as 0.05±0.21 and 0.31±0.50, [7] with 90% confidence level, and 70% power of the study, the sample size was calculated to be 42 (21 in each group). Additionally, 10% sample size was recruited to anticipate loss of follow-up. So, the final sample size taken for this study was 46 (23 in each group. Sample selection was done using a non-probability, convenient sampling technique. Inclusion criteria were age between 18-70 years, presenting with symptoms of CTS (minimum 3 months) with VAS score>4. Exclusion criteria were wrists with thenar atrophy, previous CTR surgery, local injection for CTS, or pregnant females. Patients were also excluded if they had inflammatory arthropathy, or of polyneuropathy. CTS was labeled as presence of at least 2 typical signs and symptoms of CTS, i) intermittent pain assessed by VAS>4 and numbness in the hand, ii) sensory deficit in the thumb, index, and middle finger of the hand assessed by clinical examination like fine touch, iii) positive Phalen's test, iv) positive Tinel's sign. The pain was defined as a bitter, unpleasant physical sensation resulting from illness or injury, linked to either actual or potential tissue damage, and expressed in relation to this damage. The severity of pain was estimated using the VAS scoring system. VAS scores were graded from 0-10 and were given percentages by simple multiplication with 10. A VAS score percentage of 0-40 was graded as good, 50-60 as fair, and 70-100 as poor. Thus a difference of at least 5 units in pain scores among the two groups was considered as clinically important difference. All of the patients were briefed about the study objective, safety, and data secrecy before obtaining informed written consents.

The patients were randomly allocated to either conventional incision, or TMI group by the lottery method. Plastic surgery procedure was performed by the consultant plastic surgeon with at least 5 five years of relevant experience. In conventional incision group, the conventional incision technique was applied, and in TMI group, the TMI technique was carried out. In conventional incision group, all procedures were performed under general anesthesia with the use of an arm tourniquet. Patients' wrists were positioned in slight extension over a rolled towel to facilitate access. The surgical technique involved two small transverse incisions. The first, measuring approximately 1 to 1.5 cm, was made at the distal wrist crease, just medial to the palmaris longus tendon. After identifying the PL, it was retracted in a radial direction. A 5-mm transverse cut was created at the proximal margin of the carpal ligament, providing entry into the carpal tunnel. A blunt dissector was then advanced beneath the carpal ligament in a distal direction to create a surgical path. The second incision was made in the palm, starting 0.5 cm distal to the intersection of Kaplan's cardinal line and a line drawn along the radial aspect of the ring finger. Once the skin was incised, the underlying subcutaneous tissue was carefully divided with a no. 15 blade, and two retractors were used to hold the wound edges apart. The palmar fascia was separated using blunt dissection. A dissector was introduced from the initial wrist incision toward the palmar incision, advancing between the median nerve and the flexor retinaculum to serve as a protective guide. Using the dissector as a shield, the flexor retinaculum was then incised with a no. 15 blade, cutting above the instrument in a distal direction. For TMI, the patient positioning and anesthetic approach mirrored that of the mini-incision technique. A transverse skin incision of length 1.5-2.0cm was placed along the third web space, ensuring it did not extend beyond the proximal palmar crease [9]. The proximal end of the incision was slightly angled radially, about 0.5 cm, to allow visualization and preservation of the palmar branch of the median nerve. Attention was given to identifying any anatomical variations in the motor branch of the median nerve to avoid nerve damage. A small opening was created in the flexor retinaculum, through which a McDonald dissector was inserted to protect the nerve. The flexor retinaculum was completely divided at both its proximal and distal ends under direct visualization. Stitches were removed on the 14th post-operation day (POD) in the outpatient department. Patients were encouraged to take-up a range of motion exercises from day-1. Follow-ups were done at the 2nd, 6th, and 12th weeks and 6, and 9 months post-operatively. The intensity of pain and functional outcome were noted. Functional outcome was defined as the ability to perform, work, and do household chores with ease. Functional outcome was measured using the Functional Severity Scale (FSS). FSS score percentage of 20-45% was graded as good, 46-60% was graded as fair, and 61-100% was graded as poor. Like VAS scores, FSS scores were used in the form of percentages too. A specifically predesigned proforma was used to record the required set of information.

STATISTICAL ANALYSIS

All statistical analyses were performed using "IBM-SPSS Statistics, version 26.0". Continuous variables were summarized as mean and standard deviation, while categorical variables were presented as frequencies and percentages. To control for potential confounding, data were stratified according to age, gender, and occupation in both study groups. Comparisons between groups for continuous variables were made using the independent samples t-test, whereas the chi-square test or Fisher's exact test was used for categorical variables, as appropriate. A p-value of less than 0.05 was considered statistically significant.

RESULT

In a total of 46 patients, 28 (60.9%) were females, and the mean age was 41.8±6.9 years. In conventional incision group, 8 (34.8%) patients were male, and 15 (65.2%) were female, while in TMI group, male and female distribution of the patients was 10 (43.5%) and 13 (56.5%), respectively (p=0.546). Household workers and government servants in conventional incision group were 7 (30.4%) and 8 (34.8%), versus 7 (30.4%) and 4 (17.4%) in TMI group, respectively. The mean baseline VAS scores

between conventional incision, and TMI groups were 65.2±12.6 vs. 65.7±10.5 (p=0.884), respectively. The mean functional scores in conventional incision, and TMI groups were 76.4±9.4 vs. 77.3±8.7 (p=0.738), respectively (Table **1**).

Table 1. Baseline Characteristics of Patients between Study Groups (N=46).

Characteristics		Conventional incision (n=23)	Transverse mini-incision (n=23)	P-value
Gender	Male	8 (34.8%)	10 (43.5%)	0.546
	Female	15 (65.2%)	13 (56.5%)	
Age (years) Mean±SD		42.0±6.7	41.5±7.4	0.811
Duration of symptoms (months)	3-5	8 (34.8%)	9 (39.1%)	0.977
	5-7	6 (26.1%)	6 (26.1%)	
	7-9	5 (21.7%)	5 (21.7%)	
	>9	4 (17.4%)	3 (13.0%)	
Occupation	Household worker	7 (30.4%)	8 (34.8%)	0.577
	Govt. Servant	7 (30.4%)	4 (17.4%)	
	Laborer	5 (21.7%)	3 (13.0%)	
	Business owner	1 (4.3%)	3 (13.0%)	
	Others	3 (13.0%)	5 (21.7%)	
Visual analog scale score (%), Mean±SD		65.2±12.6	65.7±10.5	0.884
Functional severity scale score (%), Mean±SD		76.4±9.4	77.3±8.7	0.738

The mean VAS pain scores were significantly lower among patients of TMI group at 12-week (p=0.001), 6-month (p<0.001), and 9-month (p<0.001) for TMI group (Fig. **1**).

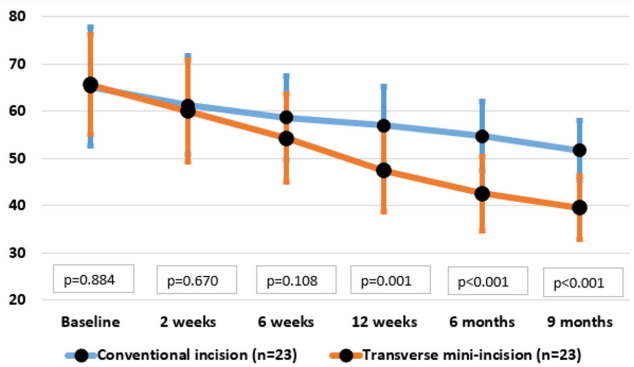

Fig. (1). Comparison of Mean VAS Scores of Two Groups during Follow-ups (n=46).

The Comparison of pain levels among both study groups showed that TMI group had significantly better scores at 3-month (p=0.037), 6-month (p=0.018), and 9-month (p=0.026) follow-up intervals, and the details are shown in Table **2**.

Table 2. Comparison of Pain Levels (VAS) between Study Groups during Follow-ups (N=46).

Evaluation Interval	Pain levels	Conventional incision (n=23)	Transverse mini-incision (n=23)	P-value
Baseline	Poor	9 (39.1%)	8 (34.8%)	0.760
	Fair	14 (60.9%)	15 (65.2%)	
	Good	-	-	
2-weeks	Poor	7 (30.4%)	7 (30.4%)	0.102
	Fair	16 (69.6%)	12 (52.2%)	
	Good	-	4 (17.4%)	
6-weeks	Poor	7 (30.4%)	7 (30.4%)	0.050
	Fair	15 (65.2%)	9 (39.1%)	
	Good	1 (4.3%)	7 (30.4%)	
3-months	Poor	7 (30.4%)	4 (17.4%)	0.037
	Fair	13 (56.5%)	8 (34.8%)	
	Good	3 (13.0%)	11 (47.8%)	
6-months	Poor	6 (26.1%)	3 (13.0%)	0.018
	Fair	14 (60.9%)	8 (34.8%)	
	Good	3 (13.0%)	12 (52.2%)	
9-months	Poor	6 (26.1%)	2 (8.7%)	0.026
	Fair	11 (47.8%)	6 (26.1%)	
	Good	6 (26.1%)	15 (65.2%)	

The mean VAS functional scores were significantly lower among patients of TMI group at 6-week (p=0.039), 3-month (p<0.001), 6-month (p<0.001), and 9-month (Fig. **2**).

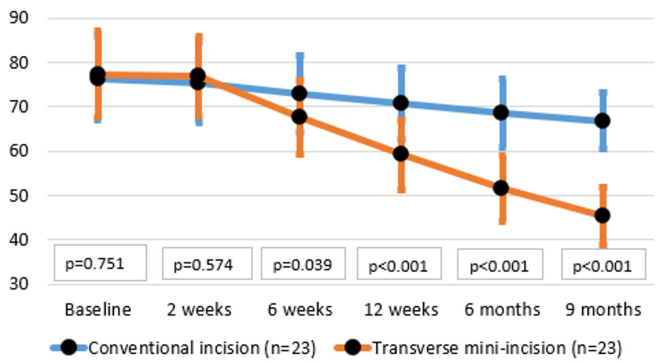

Fig. (2). Comparison of Mean Functional Scores among Both Study Groups at Follow-ups (N=46).

The Comparison of functional levels among both study groups showed that TMI group had significantly better scores at 3-month (p=0.023), 6-month (p<0.001), and 9-month (p<0.001) follow-up intervals (Table **3**).

Table 3. Comparison of Functional Outcomes between Study Groups during follow-ups (n=46).

Evaluation Interval	Functional levels	Conventional incision (n=23)	Transverse mini-incision (n=23)	P-value
Baseline	Poor	23 (100%)	23 (100%)	1
	Fair	-	-	
	Good	-	-	
2-weeks	Poor	23 (100%)	22 (95.7%)	0.312
	Fair	-	1 (4.3%)	
	Good	-	-	
6-weeks	Poor	18 (78.3%)	18 (78.3%)	0.574
	Fair	5 (21.7%)	4 (17.4%)	
	Good	-	1 (4.3%)	
3-months	Poor	18 (78.3%)	9 (39.1%)	0.023
	Fair	5 (21.7%)	13 (56.5%)	
	Good	-	1 (4.3%)	
6-months	Poor	18 (78.3%)	2 (8.7%)	<0.001
	Fair	3 (13.0%)	16 (69.6%)	
	Good	2 (8.7%)	5 (21.7%)	
9-months	Poor	15 (65.2%)	1 (4.3%)	<0.001
	Fair	6 (26.1%)	8 (34.8%)	
	Good	2 (8.7%)	14 (60.9%)	

DISCUSSION

In the present study, TMI group showed better VAS pain scores and functional outcomes with a clinically important difference. Contemporary data has shown that a limited release for CTS allows patients to return to activities early, reduces operative time, reduces the incidence of complications, and also improves the strength of activities postoperatively [10-13]. Hu *et al.* described that mini-incision was associated with a small incision, quick recovery, better scar appearance, and a low incidence of damage to the palmar cutaneous branch of the median nerve [14]. Wang *et al.* did a comparison of TMI with the midpalmar longitudinal incision, and they found that hospital stay was shorter for the patients of the longitudinal incision as compared to TMI. The VAS, and functional scores were better for the TMI group, but for the first 3 months only, and after 6 months, it was not statistically significant [15]. Korkmaz *et al.* compared TMI and longitudinal incision for CTS and found that symptoms and functional improvements were more profound with the longitudinal incision. TMI was associated with a relatively better wound outcomes, but the difference was not statistically significant [16]. Study by Ma *et al.* [6] compared TMI with conventional incision, and they found that TMI showed a significantly better VAS and FSS score than the conventional incision group at 1 and 3 months ($p<0.05$) but not at the 6th follow-up month except for FSS. But this was not the case in our study because VAS score improvement was significant for both groups when compared with pre-procedure scores at the 2nd week and even at the 9th month.

The superiority of TMI was possible because of several anatomical and technical reasons. Alignment of transverse incision with distal palmer crease provides more aesthetically favored approach to the flexor retinaculum. This alignment brings sufficient exposure with a small incision, minimizing tissue dissection and reducing operative time. Moreover, this alighlemnt also reduces the injury risk to the nearby structures and simultaneously allowing speedy functional recovery and lesser postoperative pain.

This study showed the mean age of the patients included in the study was 42 years in conventional incision group, and 41.5 years in TMI group, which justifies its prevalence in middle-aged people, like described by Polykandriotis *et al.* [17] In this study there were 34.8% males and 65.2% females in conventional incision group, and 56.5% females and 43.5% males in TMI group. The female contribution to this study was lower than demonstrated by different studies previously. It is an established fact that CTS affects more women than men [18]. Duration of symptoms of patients who were included in the study was also noted and a minimum duration of 3 months of symptoms was one of the inclusion criteria for the study. A study done previously showed that duration of symptoms of CTS until diagnosis ranged from 1 month to 20 years, and patients of different duration symptoms responded differently to different treatment options [19].

According to the present study, the majority of the patients (50.0%) were those who did some work by hand (household work and labor), which included repetitive hand movements. People of household work are mostly involved in work with repetitive hand movements like sewing and knitting, etc. and therefore, more prone to CTS. The association of CTS and repetitive hand movements is well established and has been documented previously in many studies like those of Ohnari *et al* and Palmer *et al.* [20-26].

LIMITATIONS

This study had some limitations. The current study was carried out with a relatively smaller sample size. The use of convenient sampling method could introduce selection bias. Patients were monitored only for pain status. Self-reporting of pain scores can cause personal bias in reporting of the results. Further research is needed to bring generalizability to the study findings and have better outcomes in patients undergoing the CTR procedure.

CONCLUSION

The TMI technique is better for relieving symptoms, and improving functional outcomes of CTS because its effects on pain and functional outcome are better than those of conventional incision.

ABBREVIATIONS

CTS: Carpal Tunnel Syndrome.

FSS: Functional Severity Scale.

POD: post-operation Day

TMI: Transverse Mini-incision.

VAS: Visual Analog Scale.

AUTHORS' CONTRIBUTION

Kashif Raza Khan: Conceptualization, Study Design, Methodology, Data Analysis and Interpretation, Writing Draft, Critical Review and Revision the Manuscript, Final Approval, Final Proof to be Published.

Muhammad Rashid: Study Design, Critical Review and Revision the Manuscript, Final Approval, Final Proof to be published.

Ghulam Sarwar: Study Design, Writing Draft, Final Proof to be published.

Muhammad Umair: Writing Draft, Final Proof to be published.

Tallal Ahmad Lodhi: Methodology, Data Analysis and Interpretation, Writing Draft, Final Proof to be published.

Arsalan Ali: Methodology, Data Analysis and Interpretation, Final Proof to be published.

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Declared none.

DECLARATIONS

Data Availability

Data will be available from the corresponding author upon a reasonable request

Ethical Approval

The study was commenced with the approval Ethical Review Committee of Sahiwal Medical College and Allied Hospital, Sahiwal (No: 609/DME/SLMC/SWL).

Clinical Trial Registration

The trial was registered with the National Clinical Trial Registry (NCT) under the identifier NCT07018011, and the details can be accessed at (https://clinicaltrials.gov/).

Consent to Participate

All the study participants were enlisted with their written informed consent.

Consent for Publication

All authors give consent for the publication of this work.

Conflict of Interest

Declared none.

Competing Interest/Funding

Declared none.

Use of AI-Assisted Technologies

The authors declare that no generative artificial intelligence (AI) or AI-assisted technologies were utilized in the writing of this manuscript, in the creation of images/graphics/tables/captions, or in any other aspect of its preparation.

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