How to Cite:
Chethan, L., Sunil, G., Atul, P., & Modi, M. (2022). Limited incision and traditional open carpal tunnel release: Comparison of clinical and neurological outcomes. *International Journal of Health Sciences*, *6*(S1), 6763–6778. https://doi.org/10.53730/ijhs.v6nS1.6431

Limited incision and traditional open carpal tunnel release: Comparison of clinical and neurological outcomes

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***Abstract*---**Background: Carpal Tunnel Syndrome (CTS) is the most common compression neuropathy of the upper extremity. Even though traditional open release has been considered as standard approach for median nerve decompression, various other techniques are gaining popularity. The aim of this study was to compare the clinical and neurological outcomes between traditional open approach and limited incision approach. Methods: Twenty-eight patients with isolated CTS have included in this study of which four patients had bilateral CTS thus constituting 32 hands (19-right; 13-left). The patients were divided for treatment into two groups, Group A included 21 hands underwent limited incision release, and Group B included 11 hands released by traditional open incision. Patient's were evaluated preoperatively and in six weeks and six months postoperatively, namely, (a) clinical outcomes including Boston carpal tunnel questionnaire (BCTQ), postoperative scar tenderness, hypertrophic scar, pillar pain & quality of scar by Vancouver scar scale (VSS). (b) sensory testing using two-point discrimination (TPD) (c)motor testing using grip and pinch dynamometer, (d) neurological outcome measurement using nerve conduction study (NCS). Results: In each section of BCTQ outcomes, patients in group A showed significant improvement than in group B at both six weeks and six months follow up. In postoperative scar sequelae like scar tenderness, pillar pain, hypertrophic scar are minimal in group A than group B,

and scar quality by VSS showed also showed better results in group A than group B patients at six months follow up. NCS outcomes showed significant improvement in group A than group B at six weeks and six months follow up. In hand grip, key pinch and TPD showed no significant improvements between the groups at groups at postoperative follow-up. Conclusion: Limited incision release approach is a better technique for achieving the release of the carpal tunnel. Functional outcomes of limited incision release are equivalent to the open method.

***Keywords*---**Carpal tunnel syndrome, traditional open approach, limited incision approach, Boston carpal tunnel questionnaire, Vancouver scar scale, Nerve conduction study.

Introduction

Carpal Tunnel Syndrome (CTS) is the most common compression neuropathy of the upper extremity and decompression of median nerve in the carpal tunnel is the most frequently done peripheral nerve surgery.[1,2] commonly affects the middle-aged female population[3,4] and constitute about 90% of all entrapment neuropathies.[5,6] Although a widely recognized disorder, the etiology of CTS is still unclear. It is not currently known whether the entrapment syndrome results from intermittent mechanical compression or as a result of compromise of the endoneurial vasculature due to increase in the pressure inside the CT or both.[7]

Clinically, the symptoms of CTS are the pain in the hand, tingling, pain or numbness in the lateral three digits and the radial aspect of the fourth digit and eventually, reduction of the grip power. The diagnosis is mainly based on clinical presentation and physical examination, which may be confirmed by electrophysiological testing, specifically electroneuromyography (ENMG), based on sensory and motor latency, and observation of conduction abnormalities.[8,9]

Treatment of CTS has been classified into surgical and nonsurgical. The surgical options for treatment include Traditional open CT release or Limited incision CT release or Endoscopic CT release. Surgical release is the standard management for moderate to severe cases of CTS.[10] Non-surgical treatments including splinting or corticosteroid injections, or use of oral steroids or anti-inflammatory drugs are used for patients with mild symptoms. The surgical treatment for CTS is more beneficial than non-surgical methods, especially of longer term benefit.[11]

The traditional open release has been considered as standard method universally since Phalen introduced in 1950. This method has some disadvantages including pillar pain, long healing period, unsightly and tender scar. Various other techniques have been introduced. They are limited incision approach, mini-incision approach, and endoscopic approaches. All are effective in preventing the excessive scar formation, reducing pillar pain and return to work early.[12,13] Limited incision method is considered to be easily performed, does not need any special types of equipment and cost-effective compared to the endoscopic method.[14] However, comparative studies are lacking.

This study compared the outcomes (both subjective and objective) of carpal tunnel release between Limited incision approach and Traditional open approach in carpal tunnel syndrome.

Materials and Methods

It was a randomized prospective study done in the Departments of Plastic Surgery and Neurology from 1st January 2016 to 31st December 2017. This study was approved by the Institute ethical committee. Informed consent was taken from every patients with the risks, and possible benefits of the procedure were fully explained to the patients before enrolment in the study. A total of 32 hands in 28 patients underwent carpal tunnel release based on inclusion criteria like diagnose cases of moderate to extreme CTS on NCS according to American association of Electrodiagnostic Medicine (AAEM) classification system. Patients with significant systemic illness, proximal neuropathy, cervical spondylosis were excluded from the study.

A total of 21 hands in group A underwent limited incision release, and 11 hands in group B underwent traditional open release. Both the procedures were performed by different surgeons, who had several years of experience in performing them. The mean age of the patients was 48.38 yrs (29-72yrs) in Group A and 51.64 (30-72yrs) in Group B. Mean duration of symptoms was 4.88 yrs (1-10yrs) in Group A and 3.55yrs (1.5-6yrs) in Group B. Female preponderance was seen with 27 female hands (84.4%) and 5 male hands (15.6%). The 20 female hands and one male hand were included in Group A and remaining seven female and four male hands in Group B. All patients were evaluated preoperatively and postoperatively at six weeks and six months follow up with BCTQ, TPD, hand grip, key pinch, and NCS. Scar sequelae assessment like tenderness, pillar pain, hypertrophic scar and quality of scar by Vancouver Scar Scale, done at six months follow up in both groups. Finally, outcomes between Group A and Group B were compared by statistical analysis.

In NCS parameters such as distal motor latency (DML), distal sensory latency (DSL), motor conduction velocity (MCV) and sensory conduction velocity (SCV) of the median nerve across the carpal tunnel and along the median nerve course were measured. Whenever supplementary information was required, comparative study of DML and MCV in the median and ulnar nerve in the same hand was done. Multiple compression neuropathies were excluded in this study.

Operative techniques

Patients in Group A underwent limited incision carpal tunnel release: The vertical line was drawn in 3rd inter digital space, the horizontal line joining the apex of 1st web space to the distal edge of the pisiform (Kaplan's cardinal line). Proximal incision site was marked as a 1cm horizontal line on the wrist crease at the base of the vertical line of 3rd interdigital space. Distal incision of 1cm was marked on the ulnar side at the intersection of the vertical line of 3rd interdigital space and the horizontal line.

The time of incision was noted. The wrist was placed in extension. The proximal incision was made first, and the ligament was visualized using blunt scissors. A probe was passed from proximal incision deep to the flexor retinaculum and felt at the distal incision marking on the palm then the distal incision was given and the probe was taken out through the distal incision. A plane was created superficial to ligament using blunt scissors. An Aufricht nasal retractor was used to retract skin superficial to ligament, and the whole retinaculum was visualized completely and cut under vision. The completeness of release was guaranteed by palpating the probe through the palmer skin in subcutaneous plane. Since whole ligament was cut under vision and median nerve was also under vision, collateral damage was minimized (Figure-1).

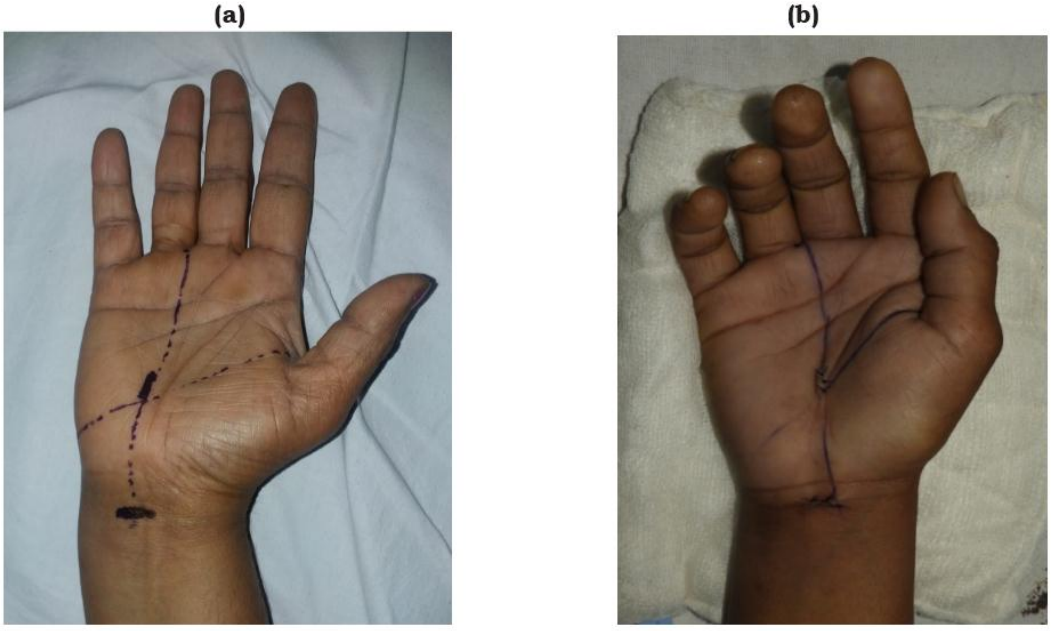

Figure-1: showing group A (a) incision marking and (b) suture line

Patients in Group B underwent traditional open carpal tunnel release: After noting the time of incision, a curved longitudinal incision parallel to thenar crease was made, distally at Kaplan's cardinal line, and was extended 2 – 4 cm proximally towards the wrist crease obliquely in an ulnar direction at a point in the line with the long axis of the flexed ring finger or just on the ulnar side of the Palmaris longus tendon. Under visualization transverse carpal ligament was incised and the carpal tunnel was released (Figure-2).

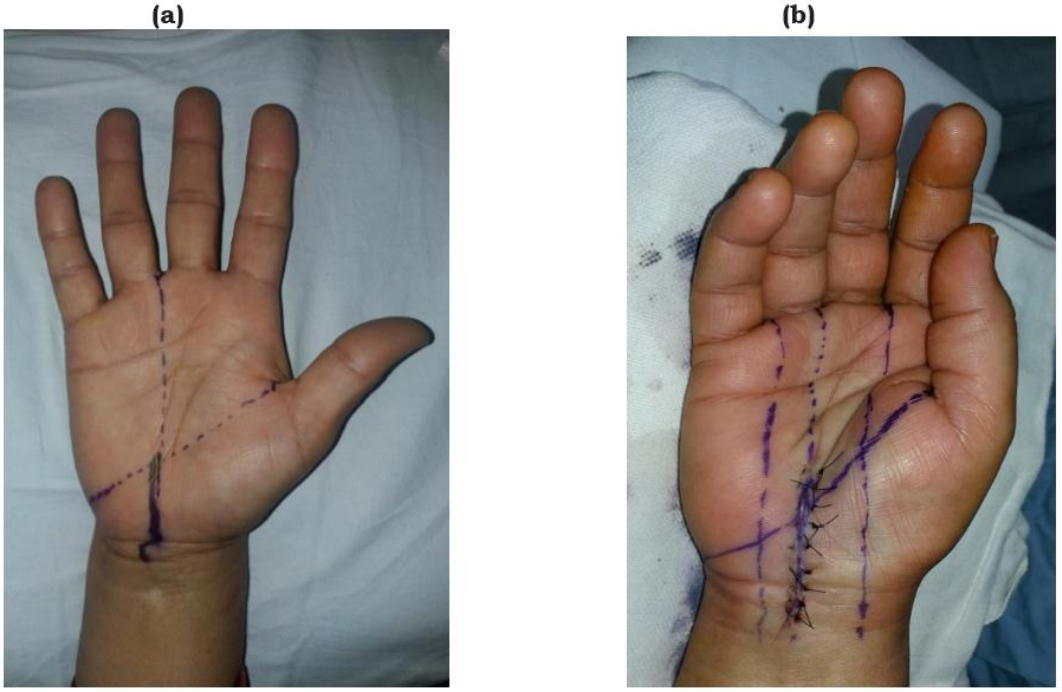

Figure-2: Showing group B (a) incision marking (b) suture line

Then in both groups, the incision was closed using interrupted 4-0 nylon sutures and pressure bandage was applied. After the closure of wound, time was noted once again and tourniquet released. No splint was given to patients, and all patients were encouraged to move their hands and fingers in the immediate postoperative period and were discharged within 24hours of surgery. The dressing was removed after three days and band-aid applied to suture line, and the stitches removed after 10 days.

Postoperatively, patients clinical outcome was measured using BCTQ, hand grip using Jamar dynamometer, key pinch using Sheehan's pinch meter and TPD at six weeks and six months follow up. Scar tenderness, pillar pain, hypertrophic scar and quality of scar by VSS were assessed at six months follow up. Neurological outcome was measured using NCS.

The data were analyzed using Statistical Package for the Social Sciences (SPSS) - Version 22.0. Data were expressed in mean ± SD and percentage. We compared preoperative and postoperative values by using repeated measures ANOVA and post hoc test for repeated measures within group A and B and then compared the preoperative and postoperative values between group A and B by using Student's t-test. Significance was set at $p \leq 0.05$.

Results

Clinical Outcome

Clinical outcomes were assessed by scar tenderness, pillar pain, hypertrophic scar, quality of scar by Vancouver scar scale at six months postoperatively and BCTQ at presentation, six weeks and six months post operatively in between groups.

In BCTQ, both Symptoms Severity Scale (SSS) and Functional Status Scale (FSS) were expressed by using scales "1 to 5", (1- none; 2- mild; 3- moderate; 4- severe; 5- very severe symptoms). The mean SSS at presentation was 3.35±0.33 and 3.10±0.36 in Group A and B respectively. In both groups, SSS and FSS at six weeks and six months follow up showed statistically significant improvements when compared with preoperative SSS and FSS within Group A, and B and also on comparing between groups, group A showed significant improvements than group B at six weeks and six months follow up with $p<0.05$. The mean changes in BCTQ outcomes at postoperative follow up within groups are shown in Table-1 and between groups in Table-2.

Table-1
Comparison of BCTQ within group A and B

Parameters	Time of measurements Group A (n-21) mean±SD			P value		
	preop	6 weeks postop	6 months postop	Preop vs 6 weeks postop	Preop vs 6 months postop	Postop 6 weeks vs 6 months postop
SSS	3.35±0.33	1.81±0.28	1.18±0.24	<0.001*	<0.001*	<0.001*
FSS	3.40±0.35	1.57±0.29	1.12±0.11	<0.001*	<0.001*	<0.001*
Parameters	Time of measurements Group B (n-11) mean±SD			P value		
	preop	6 weeks postop	6 months postop	Preop vs 6 weeks postop	Preop vs 6 months postop	Postop 6 weeks vs 6 months postop
SSS	3.10±0.36	2.17±0.25	1.45±0.24	<0.001*	<0.001*	<0.001*
FSS	3.10±0.44	2.12±0.36	1.48±0.35	<0.001*	<0.001*	<0.001*

*Significant

Table-2
Comparison of BCTQ between group A and B

BCTQ scores		Group A(n=21) (mean±SD)	Group B(n=11)) (mean±SD)	P value
SSS	preop	3.35±0.33	3.10±0.36	0.56
	6 weeks postop	1.81±0.28	2.17±0.25	0.002*
	6 months postop	1.18±0.24	1.45±0.24	0.005*
FSS	preop	3.40±0.35	3.10±0.44	0.61
	6 weeks postop	1.57±0.29	2.12±0.36	.000*
	6 months postop	1.12±0.11	1.48±0.35	0.007*

*Significant

Postoperative scar tenderness, pillar pain, hypertrophic scar and scar quality by VSS were assessed at six months. On comparing between groups, post operative tenderness, pillar pain, hypertrophic scar at six months are less in group A than group B, and scar quality by VSS was good in group A than group B with statistically significant with $p<0.05$. Comparison of scar sequelae at six months postoperatively is detailed in Table-3. Scar was inconspicuous in group A as compared to group B as shown in Figure-3.

Table-3
Comparing scar sequelae between group A and B

6 months postop		Group A (n-21) (%)	Group B (n-11) (%)	P value
Scar tenderness	Present	1(4.8)	8(72.7)	<0.001*
	Absent	20(95.2)	3(27.3)	
Pillar pain	Present	2(9.5)	10(90.9)	<0.001*
	Absent	19(90.5)	1(9.5)	
Hypertropic scar	Present	0	8(72.7)	<0.001*
	Absent	21(100)	3(27.3)	
6 months postop		Group A (n-21) mean±SD	Group B (n-11) mean±SD	P value
Total VSS		0.81±0.93	4.55±1.92	<0.001*

*Significant

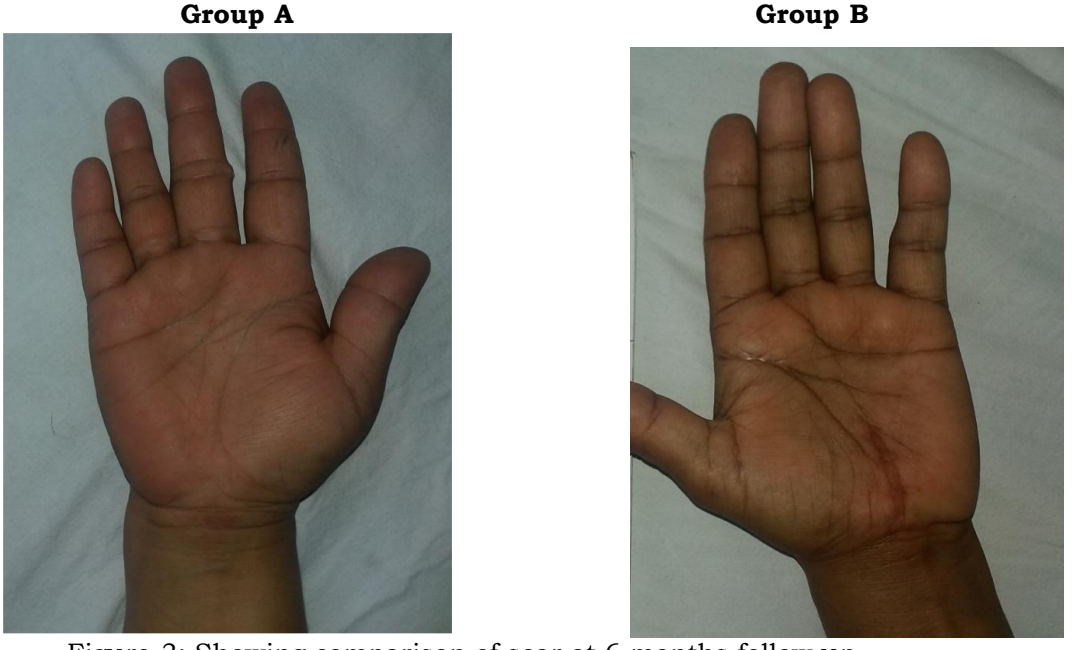

Figure-3: Showing comparison of scar at 6 months follow up

Sensory and Motor test

Two-point discrimination (TPD) showed no statistically significant improvement at six weeks and six months postoperatively on compared with preoperative TPD within group A and B and also between groups with p>0.05. Hand grip strength and key pinch showed statistically significant improvements within Groups A and B at six weeks and six months postoperatively. On comparing these motor tests between groups, there are no statistically significant changes with P>0.05. The changes in mean values of these parameters within groups are detailed in Table-4 and between groups in Table-5.

Table-4
Comparison of sensory and motor tests within group A and B

Parameters	Time of measurements Group A (n-21) mean±SD			P value		
	preop	6 weeks postop	6 months postop	Preop vs 6 weeks postop	Preop vs 6 months postop	Postop 6 weeks vs 6 months postop
TPD(mm)	3.71±0.96	3.71±0.96	3.57±0.68	1	0.249	0.249
Hand grip strength(kgs)	15.71±6.81	24.14±6.92	34.52±6.59	<0.001*	<0.001*	<0.001*
Key pinch(mm	80.05±11.1	90.24±10.1	103.90±8.0	<0.001*	<0.001*	<0.001*

of hg)	2	8	1			
Parameters	Time of measurements Group B (n-11) mean±SD			P value		
	preop	6 weeks postop	6 months postop	Preop vs 6 weeks postop	Preop vs 6 months postop	Postop 6 weeks vs 6 months postop
TPD(mm)	4.09±1.22	4±1.10	3.91±0.94	1	0.501	1
Hand grip strength(kgs)	14±10.69	21±10.29	31.45±12.14	<0.001*	<0.001*	<0.001*
Key pinch(mm of hg)	89.36±11.60	95.73±10.60	103±10.48	<0.001*	<0.001*	<0.001*

*Significant

Table-5
Comparison of sensory and motor tests between Group A and B

		Group A (n-21) mean±SD	Group B (n-11) mean±SD	P value
TPD(mm)	Pre op	3.71±0.96	4.09±1.22	0.344
	6 weeks post op	3.71±0.96	4±1.10	0.451
	6 months post op	3.57±0.68	3.91±0.94	0.251
Hand grip strength(kgs)	Pre op	15.71±6.81	14±10.69	0.636
	6 weeks post op	24.14±6.92	21±10.29	0.377
	6 months post op	34.52±6.59	31.45±12.14	0.449
Key pinch(mm of hg)	Pre op	80.05±11.12	89.36±11.60	0.041*
	6 weeks post op	90.24±10.18	95.73±10.60	0.163
	6 months post op	103.90±8.01	103±10.48	0.787

*Significant

Neurological outcomes

The patients were classified according to the AAEM criteria based on NCS finding. In 32 hands, 18 had severe, 13 had moderate, and 1 had extreme CTS. 13 severe and eight moderate CTS underwent limited incision release (Group A), remaining one extreme, five severe, 5 moderate CTS underwent traditional open release (Group B).

In Group A, motor response was absent in 3 hands. When motor response could be elicited, the distal motor latency (DML) ranged from 3.90 to 11 ms, and the motor conduction velocity (MCV) ranged from 32 to 72 m/s. The sensory response was absent in 15 hands. When sensory response could be elicited preoperatively, the distal sensory latency (DSL) ranged from 3.10 to 8.60 ms, and the sensory conduction velocity (SCV) ranged from 14 to 39 m/s. In group B, the motor response was absent in 4 hands preoperatively. When motor response could be elicited, the DML ranged from 5.40 to 8.70 ms, and the MCV ranged from 30 to

60 m/s. The sensory response was absent in 8 hands. When sensory response could be elicited preoperatively, then the MDSL ranged from 3.20 to 4.20 ms, and the MSCV ranged from 29 to 41 m/s.

In Group A, only one patient showed absent sensory response at six weeks postoperative follow-up. Improvement in DML was not statistically significant at six weeks postoperatively with P>0.05 (post hoc test for repeated measures). DML at six months and MCV, DSL, SCV at six weeks and six months postoperatively showed statistically significant improvements when compared with preoperative values with p<0.05. In Group B, DML, DSL at six weeks and six months and MCV, SCV at six weeks postoperative follow up showed no statistically significant improvement (Post hoc test for repeated measures). MCV and SCV at six months follow up showed statistically significant improvement. Three (27.3%) hands showed no improvement in sensory response at six months follow up in Group B. The mean changes in NCS parameters within Group A and B during postoperative follow up are depicted in Table-6.

Table-6
Comparison sensory and motor response within Group A and B

Parameters	Time of measurements Group A (n-21) mean±SD(ms)			P value		
	preop	6 weeks postop	6 months postop	Preop vs 6 weeks postop	Preop vs 6 months postop	Postop 6 weeks vs 6 months postop
MDML	6.21±3.23	5.68±1.21	4.03±0.47	1	0.026*	<0.001*
MDSL	1.33±2.39	4.19±1.40	3.0±0.58	<0.001*	0.021*	0.004*
MMCV	42.19±19.63	51.19±9.15	59.95±7.21	0.017*	<0.001*	<0.001*
MSCV	8.47±14.48	31.67±9.62	43.38±6.92	<0.001*	<0.001*	<0.001*
Parameters	Time of measurements Group B (n-11) mean±SD(ms)			P value		
	preop	6 weeks postop	6 months postop	Preop vs 6 weeks postop	Preop vs 6 months postop	Postop 6 weeks vs 6 months postop
MDML	4.14±3.45	4.90±1.79	4.85±0.68	1	1	1
MDSL	1.03±1.77	1.60±1.90	2.57±1.85	0.995	0.215	0.536
MMCV	32.45±26.87	42.82±18.55	52.55±10.52	0.127	0.020*	0.034*
MSCV	9.18±15.99	14.91±18.40	26.27±18.22	0.306	0.011*	0.042*

*Significant

On comparing between Group A and B, DML and MCV (motor response) did not show statistically significant improvements at preoperatively and at six weeks postoperatively. But we could find statistically significant improvements in DML and MCV at six months postoperatively in group A but not in Group B. The sensory response, DSL, and SCV did not show statistically significant improvements. But DSL at six weeks and SCV at six weeks and six months postoperatively showed significant improvements in group A than group B with $p<0.05$. The mean changes in these parameters are detailed in Table-7.

Table-7
Comparison sensory and motor response between group A and B

Neurological outcome		Group A (n-21) mean±SD(ms)	Group B (n-11) mean±SD(ms)	P value
MDML	preop	6.21±3.23	4.14±3.45	0.102
	6 week postop	5.68±1.21	4.90±1.79	0.155
	6 months postop	4.03±0.47	4.85±0.68	<0.001*
MDSL	preop	1.33±2.39	1.03±1.77	0.711
	6 week postop	4.19±1.40	1.60±1.90	0.001*
	6 months postop	3±0.58	2.57±1.85	0.470
		Group A (n-21) mean±SD(m/s)	Group B (n-11) mean±SD(m/s)	P value
MMCV	preop	42.19± 19.63	32.45±26.87	0.304
	6 week postop	51.19±9.15	42.82±18.55	0.183
	6 months postop	59.95±7.21	52.55±10.52	0.025*
MSCV	preop	8.47±14.48	9.18±15.99	0.900
	6 week postop	31.67±9.62	14.91±18.40	0.014*
	6 months postop	43.38±6.92	26.27±18.22	0.011*

*Significant

Discussion

Many surgical approaches have been described for CTS release in literature like the endoscopic method of carpal tunnel release, and non-endoscopic procedures comprise traditional release, limited incision release, and mini-incision release.[14,15-17] Effectiveness and safety of these procedures remain controversial. Traditional open carpal tunnel release approach still considered at the standard and most common approach since its introduction by Mackinnon.[18] This approach has been proven to have some disadvantages including ugly and tender scar, pillar pain, long healing time, increased duration to return to work.

Even Endoscopic CTS release has some advantages over tradition open method like decreased postoperative morbidity, early return to work, tender aesthetic scar. However, this approach does have some disadvantages such as injury to superficial palmer arch, median nerve transaction, damage of digital vessels, nerves and insufficient release of the carpal tunnel.[19-22] In 1993, Limited incision method came into the picture as a two-incision method, and in 1994 it was modified into a single incision method.[23,24] Limited incision method had some

drawbacks like the limited visibility of structures and transligamentous variation. This can be overcome by proper anatomical knowledge and instrumentation.

In our study, we compared both subjective and objective outcomes between limited incision approach and traditional open incision approach for the first time. Our study showed that limited incision release with two mini-incision approach was effective and safe as it offers direct visualization of transverse carpal ligament before the division of ligament. Thus, the risk for potential damage to superficial palmar arch, nerves and tendons were remarkably minimal. And also postoperative scar load, scar tenderness, pillar pain were significantly less in limited incision technique. The scar, pillar pain, and tenderness are less, similar to endoscopic release, and it provides all advantages of endoscopic and other mini-incision release with added benefits of safe, simple, short duration and cost-effective procedure. In Group A, we found that scar quality like the pigmentation, colour, height and elasticity of scar were more like of undamaged skin. The scar in group B was less elastic, thicker with more pigmentary changes (VSS $p<0.001$).

It is also important to note that, even traditional release is performed perfectly well under direct visualization of ligament and also even if the preoperative symptoms are decreased, patients may have postoperative complaints like pillar pain because of the discomfort at the base of the palm in the area of thenar and hypothenar region, scar tenderness, hypertrophic scar and decreased quality of scar.[25,26] The cause for pillar pain remains controversial. One of the reasons for pillar pain is because of violating the palmer skin, underlying palmer fascia and cutaneous nerves is responsible for this phenomenon; a theory proposed by proponents of endoscopic and mini-open techniques.[27]

Since BCTQ was considered as a specific outcome questionnaire, hence we used this questionnaire to evaluate clinical outcomes. The present study demonstrated the significant improvement in postoperative patient related SSS and FSS in Group A than Group B, even though both approaches resulted in good functionality and minimal pain. And also we could found significant improvements in postoperative SSS and FSS within Group A and B. MacDermid et al,[28] in his randomized clinical study comparing the Endoscopic carpal tunnel (ECTR) and Open carpal tunnel release (OCTR) demonstrated that there was no difference between the methods in CTQ symptom severity scale in postoperative period between the ECTR and OCTR. A Zyluk et al,[29] also showed that no significant improvement seen in BCTQ outcomes between single and double limited open technique. A similar study done by Murthy et al,[30] demonstrated the same results in BCTQ outcomes between mini-open and extended open release.

We have not found significant improvement in two-point discrimination (TPD) test, hand grip strength and key pinch within groups between the groups. Both Groups A and B showed no statistically significant improvement in TPD postoperatively (post hoc test for repeated measures). Similar results were seen in grip strength in a study done by Murthy et al,[30] between mini-open release and extended open release for severe CTS. Cellocco et al,[31] showed that the follow-up TPD was statistically not significant in his study between blind mini-open procedure and limited open technique in CTS patients. Resolution of symptoms of

CTS and improvement in a performance of daily living activities of the hand, assessed by TPD, hand grip strength and key pinch, generally improved throughout the follow up in each group and were not influenced significantly by any one method of operation.

Coming to previous studies, MacDermid et al,[28] in 2003, done a randomized clinical study comparing the Endoscopic carpal tunnel release (ECTR) and open carpal tunnel release (OCTR). This study showed that there was no difference between the methods in CT questionnaire outcomes and also no difference in the return to work outcomes. This study measured the outcomes only subjectively and neurological outcomes (NCS) were not included. Tarallo et al,[32] in 2014 made a prospective randomized comparative study between traditional access (Group A) and minimal access (Group B) technique in CTS. BCTQ outcome and scar assessment by VSS are significantly better in group B than in group A patients at both 6 and 12 months follow-up ($p<0.001$). In this study also no neurological outcomes were assessed and not considered. Murthy et al,[30] in 2014 demonstrated that there were no significant differences between the mini-open release and extended open release about patient-related symptoms severity or functional status outcomes (BCTQ) and post operative hand grip strength. Both techniques demonstrated to be effective treatment options for severe CTS, but they did not assess the preoperative BCTQ in his study which is necessary for quantifying the postoperative changes in symptom severity and functional status of patients. Gaba et al,[33] in 2017 showed that carpal tunnel release by limited incision using two mini-incisions with the use of nasal speculum and probe could be considered a feasible, safe alternative to traditional open release and endoscopic release with good clinical and neurological outcome in 33 hands. Even though this study showed good clinical and neurological outcomes postoperatively, the limitation of this study was that it was not a comparative study of different techniques to comment on which technique is better.

In our study, most of the patients in group B showed postoperative scar tenderness, pillar pain, hypertrophic scar. Three hands showed no improvements in sensory and motor response in NCS even though they showed improvement in clinical symptoms. This may be because of long incision which leads to more disruption of tissues,[34] endoneurolysis done in primary surgery which leads to the risks of adherences of median nerve to scar and devascularization of median nerve,[35] progressive entrapment of the median nerve in a perineural fibrosis scar, which is the reason for a syndrome of adherences or Hunter's traction neuropathy.[36,37]

Finally, our study showed that the limited incision release is considered as very effective and safe because of dividing TCL under vision the collateral damage is minimal. And also postoperative scar load, scar tenderness, pillar pain and hypertrophic scar are very minimal in limited incision release group, and NCS assessment showed significant improvement in limited incision approach than traditional open incision approach.

The limitations of this study are less sample size with short duration of follow up for only six months. We need further studies comparing endoscopic technique

with the limited incision technique since endoscopy is rapidly developing technique.

Conclusion

Limited incision release approach is a better method of achieving the release of the carpal tunnel. There is less likelihood of post-surgical complications. Functional outcomes of limited incision release are equivalent to the open method.

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