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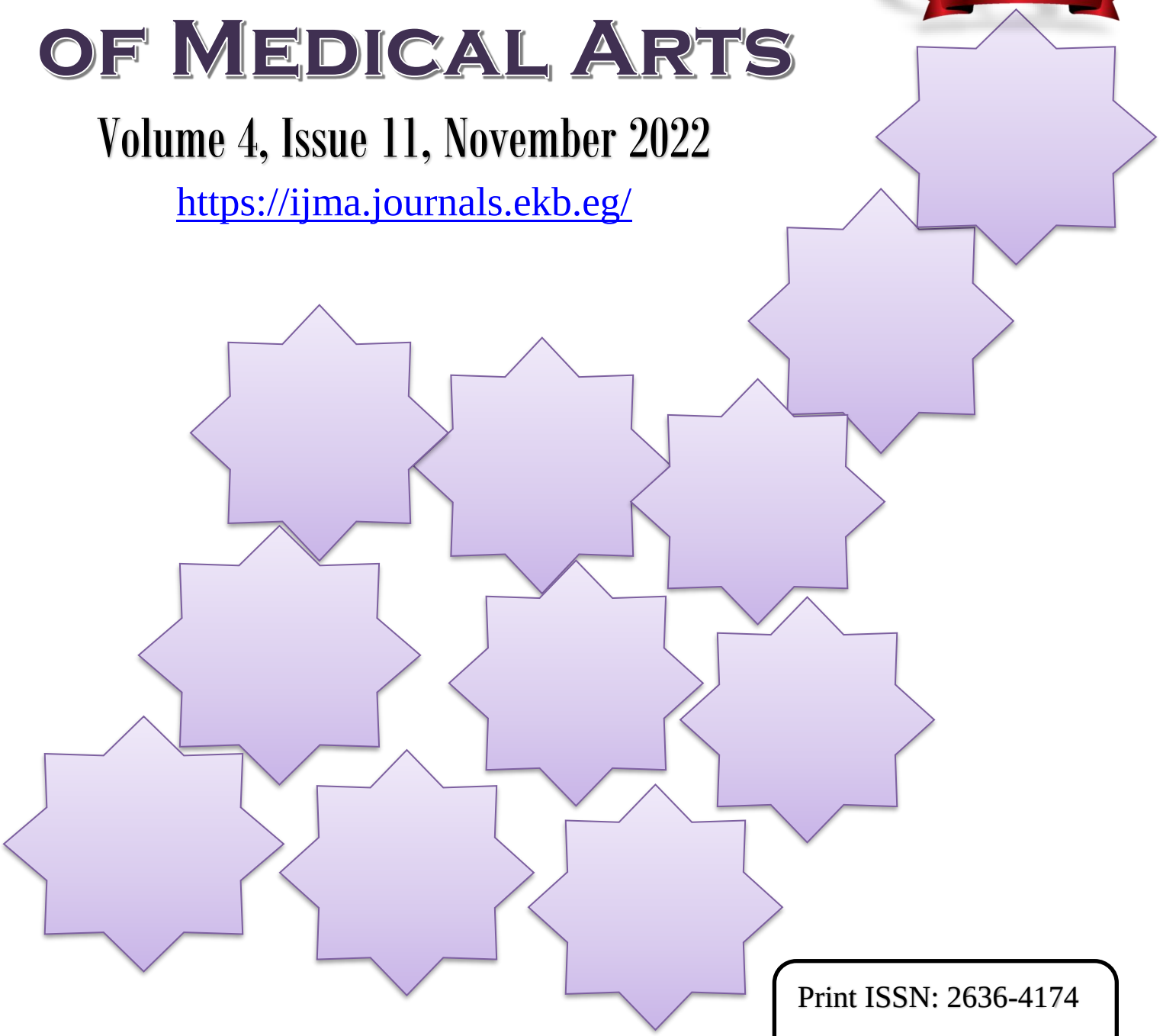

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Original Article

A Clinical Outcome of Median Nerve Neurolysis For the Treatment of Carpal Tunnel Syndrome: Conventional S-Shaped Versus Transwrist Mini-Incision Techniques

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ABSTRACT

Background: Carpal Tunnel Syndrome [CTS] is the commonest entrapment syndrome of peripheral nerves. Many surgical approaches are in use for median nerve release. However, there is no consensus on the optimal approach.

The aim of the work: The current work aimed to evaluate the outcome of two surgical approaches: the open longitudinal mini-incision and conventional approach.

Methods: This was a retrospective study compared conventional to mini-incision approach for CTS treatment. Ninety patients were included, 45 in each group. The collected data included general patient characteristics, median nerve conduction electrophysiological study, operative and postoperative data. The final assessment at the end of the third postoperative month.

Results: Patient's age ranged between 30 and 65 years, and females were predominant in both groups. there were no significant differences between conventional and mini-incision groups regarding patient characteristics, operable side, clinical signs, duration of symptoms, preoperative pain scores, functional scores and electrophysiological results. However, the operative time and incision length were significantly shorter among mini-incision than conventional group [19.02 ± 1.60 vs. 22.53 ± 3.62 minutes and 14.44 ± 2.34 vs. 33.49 ± 3.28 mm]. Patients experiencing surgical wound pain were significantly lower among mini-incision than conventional group [6.7% vs. 24.4%], and pain scores were significantly lower among patients in mini-incision group.

Conclusion: The open mini-incision surgical approach for treatment of CTS is as effective as the conventional approach and it had advantages over it [mainly, shorter operative time and better aesthetic results].

Keywords: Surgical decompression; Carpal Tunnel Syndrome; Median Nerve; Mini-incision; Pain

INTRODUCTION

Carpal tunnel syndrome [CTS] is the most common peripheral nerve entrapment syndrome. It is due to median nerve compression during its passage through the inelastic, carpal tunnel. Thickening of the transverse carpal ligament due to daily repeated flexion and extension of the wrist, with resulting compression of the median nerve in the carpal tunnel is the pathogenic mechanism responsible for the development of CTS [1, 2]. Other possible mechanisms include synovial hyperplasia, ganglion cysts or schwannoma, due to increased content in the carpal tunnel. Clinically and early in the disease course, the symptoms include abnormal sensations associated with numbness in the area received median nerve innervation [e.g., thumb, index, middle fingers and the medial half of the ring finger]. The first symptom in most patients is the nocturnal numbness of the fingers. With the advancement of the disease, the patient may complain of thenar muscle atrophy, limited opposition of the thumb, sleep disturbances, shortness of the daily activities and psychiatric disorders in severe cases [3-5].

The treatment consisted of conservative treatment in the early stages of CTS [e.g., physical therapy and splints to relief inflammation and to limit the wrist activity, respectively]. Additionally, the recovery of functional and electrophysiological variables was reported with the use of paraffin treatment [6-8]. However, with the failure of conservative treatment [reported in more than 20% of CTS cases], the surgical treatment is indicated to prevent persistent damage caused by compression degeneration of the median nerve. The conventional surgical median nerve neurolysis is usually associated with complete decompression of the median nerve. However, it had a long incision and higher complication rate [e.g., wound infection or painful scar]. Some patients have a limitation of their wrist movement due to hyperplastic scar and pain, and some need a secondary surgery [9, 10].

Recently, the median nerve release by wrist arthroscopy or endoscopy was introduced and gain popularity. However, this technique has a long-learning curve, need the availability of sophisticated instruments, with increased liability for injury of median nerve or its branches during surgery, with unfavorable outcome [11, 12].

Ucar *et al.* [13] reported that, the cutting of the transverse carpal ligament through open mini-incision is a definite treatment option. It is also associated with less trauma and scarring of the incision with rapid recovery after surgery. However, the therapeutic potential of the open mini-incision needs further evaluation.

Here, we addressed the clinical and physiological outcome after open mini-incision in comparison to conventional open S-shaped surgery. This was achieved by a retrospective evaluation of the results of both techniques for 90 patients with CTS who underwent surgery in our institution, between March 2018 to March 2022.

PATIENTS AND METHODS

This was a retrospective evaluation of the clinical outcome and comparison of two techniques used for neurolysis of median nerve for treatment of CTS. The first is conventional S-shaped and the second is the open palmar mini-incision. The study included 90 patients and for the purpose of comparison, an equal number of patients was included in each group.

The required administration consent was obtained and files were reviewed for patient characteristics, pre-and postoperative electro-physiological studies and clinical outcome. The diagnosis of CTS was performed on the basis of clinical characteristics and electrophysiological studies.

For inclusion in the study, the patient met the diagnostic criteria of CTS, with failed conservative therapy [had no improvement after 3 months of strict continuous treatment]. They must have a moderate to severe CTS according to the American Association of Electro diagnostic Medicine [AAEM]. On the other side, exclusion criteria included, CTS which was associated with other peripheral neuropathy [e.g., diabetic neuropathy, cervical spondylosis, or hypothyroidism], patients with gouty arthritis or rheumatoid tenosynovitis, patients with wrist trauma or deformity and those with previous brachial plexus injury.

The collected data included general characteristics of the patients [e.g., patient gender, age, and occupation].

Surgical techniques: The conventional "S"-shaped open technique [figures 1-3]: The hand,

wrist and forearm were scrapped by povidone iodine solution. A pneumatic tourniquet was applied and the skin was incision followed by blunt dissection of the subcutaneous tissue and palmar aponeurosis, under nerve block anesthesia. Then, median nerve was released after the incision of the transverse carpal ligament under direct vision. External epineurotomy was performed in the presence of severe epineurial fibrosis. The tourniquet was then released and the skin was sutured in layers after complete hemostasis.

Figure [1]: S-shaped marking of the incision across the wrist

Figure [2]: Retraction of the skin, dissection of subcutaneous tissues and palmar aponeurosis with exposure of the transverse carpal ligament [note the wide field]

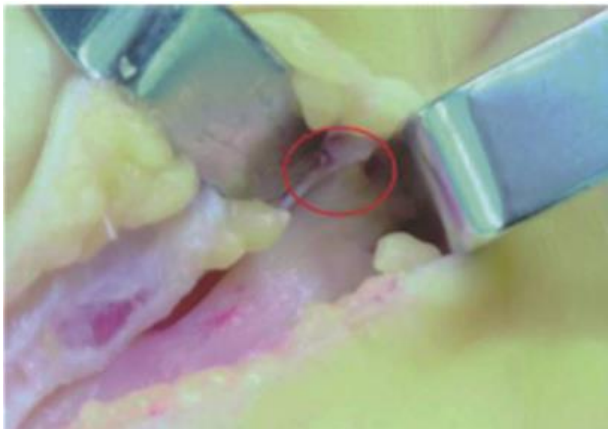

Figure [3]: Exposure of the median nerve

The Transwrist open mini-incision technique [Figures 4-6]: A surgical skin incision [2-2.5 cm] was placed in the radial border of the ring finger line under nerve block anesthesia. The line starts about 1 cm to the distal flexor wrist crease. Then, a blunt dissection of the subcutaneous tissue and palmar aponeurosis was performed until the exposure of the transverse carpal ligament. The ligament was cut with a surgical blade and careful identification of its position at the median nerve was carried out. To protect median nerve, a nerve stripper was inserted under the transverse carpal ligament. Then, the ligament was incised along the ulnar side of the median nerve under direct vision. After that, the wrist joint was flexed palm forward, and a retractor was used to pull up the skin at the proximal end of the incision. The ligament was released to the level of the distal flexor wrist crease, followed by dorsal extension of the wrist joint. A retractor was used to pull up the skin at the distal end of the incision, and the transverse carpal ligament was released to the level of the branch of the median nerve, and the epineurium was released if required. Finally, the tourniquet was released and under complete hemostasis, the skin was sutured intermittently after flushing.

Figure [4]: A mini incision was placed in the radial border of the ring finger line; it begins 1 cm to the distal flexor wrist crease

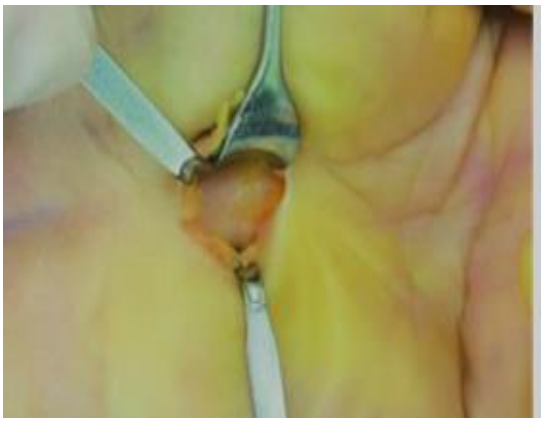

Figure [5]: Retraction of the skin, dissection of the subcutaneous tissues and the ligament was ready to be cut

Figure [6]: Dorsal extension of the wrist joint, with release of median nerve branch under direct vison

The preoperative electromyographic studies were performed one week before surgery. Then, they were repeated postoperative on regular intervals. For the purpose of statistical comparison, values obtained at the end of the third postoperative month were included [available data for included cases]. Preoperative grading of CTS severity was performed according to AAEM classification [14]. The electromyographic studies were performed after that described by **Keser *et al.*** [15].

For each patient, the following nerve conduction parameters were documented. The sensory conduction velocity [SCV] by milliseconds, the peak distal sensory latency by milliseconds, the sensory nerve action potentials amplitude [SNAPa] by millivolt, median distal motor latency [DML] by milliseconds; and motor compound muscle action potential amplitude [CMAPa] by millivolt.

For both groups, the operative time and incision length were recorded. The time passed to return to normal daily work is registered and any postoperative complications were recorded, and compared between both groups. The postoperative pain was evaluated by the visual analogue scale [VAS] at the first postoperative day, and at the end of the first and third postoperative months. Finally, the Kelly grading scale [16] was used to evaluate the surgical outcome into excellent [with complete relief of symptoms], good [with occasional and persisted mild symptoms], fair [with some persistent or distressing symptoms], and poor [with unchanged or worsened symptoms].

Statistical methods: The collected data were statistically analyzed by the statistical package for social sciences [SPSS] version 16 [SPSS Inc., Chicago, USA], for windows. Data were presented by their mean and standard deviation [for quantitative data], relative frequency and percentages [for qualitative data] and groups were compared by ANOVA test for quantitative data and Chi square [for qualitative data]. P value < 0.05 was considered significant.

RESULTS

Table [1] presented preoperative data including patient demographics. Patient's age ranged between 30 and 65 years. The mean age was 48.04 ± 6.35 years and there was no significant difference between conventional and mini-incision groups. Females were prevalent in both groups with no significant difference. In addition, both groups were comparable regarding operable side, clinical signs, duration of symptoms, pain score, disability and electrophysiological results.

Regarding the outcome, the operative time was significantly shorter among mini-incision than conventional group [19.02 ± 1.60 vs. 22.53 ± 3.62 minutes, respectively]. In addition, the incision length was significantly shorter in mini-incision than conventional group [14.44 ± 2.34 vs. 33.49 ± 3.28 mm, respectively]. The Levene's score for symptoms and functions was significantly lower among mini-incision than conventional group. Patients experiencing surgical wound pain were significantly lower among mini-incision than conventional group [6.7% vs. 24.4%], and VAS score at the end of the third postoperative months was significantly lower among patients in the mini-incision group. Finally, only DML and DSL were significantly lower among mini-incision than conventional group [Table 2].

Table [1]: Preoperative data among study groups

Variables		Conventional [n=45]	Mini-incision [n=45]	Total [n=90]	Test	p
Age [years]		48.38±7.03	47.71±5.65	48.04±6.35	0.49	0.62
Gender [n, %]	Male Female	17 [37.8%] 28 [62.2%]	11 [24.4%] 34 [75.6%]	28 [31.1%] 62 [68.9%]	1.86	0.17
Side [n, %]	Right Left	30 [66.7%] 15 [33.3%]	26 [57.8%] 19 [42.2%]	56 [62.2%] 34 [37.8%]	0.75	0.38
Positive clinical signs [n, %]	Tinel	40 [88.9%]	37 [82.2%]	77 [85.6%]	0.80	0.36
	Phalen	45 [100.0%]	45 [100.0%]	90 [100.0%]	-	-
	Durkan	43 [95.6%]	44 [97.8%]	87 [96.7%]	0.34	0.55
DoS [months]		8.20±2.68	8.69±2.50	8.44±2.59	0.89	0.37
Two-point discrimination		8.96±2.23	9.40±1.78	9.18±2.01	1.05	0.30
Preoperative VAS score		4.78±0.82	4.73±0.75	4.76±0.78	0.27	0.79
Preoperative DASH		33.27±4.48	32.29±3.85	32.78±4.19	1.11	0.27
Levene's score	Symptoms	2.67±0.42	2.63±0.24	2.65±0.34	0.49	0.62
	Function	2.45±0.25	2.54±0.30	2.50±0.28	1.50	0.13
Electrophysiology [Median nerve]	DML	5.67±1.58	5.96±1.33	5.81±1.46	0.94	0.35
	CMAPa	6.84±1.91	6.60±1.63	6.72±1.77	0.65	0.51
	DSL	4.51±0.48	4.49±0.44	4.50±0.46	0.16	0.87
	SNAPa	5.17±1.38	5.20±1.56	5.19±1.47	0.09	0.92
	SCV	23.69±4.06	23.07±2.52	23.38±3.37	0.87	0.38

DoS: Duration of Symptoms; DASH: Disabilities of the Arm, Shoulder and Hand

Table [2]: Outcome among study groups

Variables		Conventional [n=45]	Mini-incision [n=45]	Total [n=90]	Test	p
Operative time [min]		22.53±3.62	19.02±1.60	20.78±3.29	5.96	**<0.001***
Incision length [mm]		33.49±3.28	14.44±2.34	23.97±9.99	31.70	**<0.001***
Two points Discrimination		3.44±0.69	3.38±0.78	3.41±0.73	0.43	0.67
VAS score		131±0.47	1.13±0.59	1.22±0.54	1.59	0.12
DASH score		8.44±0.62	8.73±1.12	8.59±0.91	1.52	0.13
Levene's score	Symptoms	1.35±0.14	1.21±0.12	1.28±0.15	5.40	**<0.001***
	Functions	1.28±.16	1.16±0.12	1.22±0.16	3.96	**<0.001***
Surgical wound pain		11 [24.4%]	3 [6.7%]	14 [15.6%]	5.41	**0.020***
VAS score at 3 months		2.33±1.31	1.31±0.85	1.82±1.21	4.38	**<0.001***
Postoperative Electrophysiology [Median nerve]	DML	4.43±0.50	4.10±0.79	4.27±0.68	2.35	**0.021***
	CMAPa	7.81±1.35	8.01±1.21	7.91±1.28	0.71	0.47
	DSL	3.82±0.66	3.40±0.70	3.61±0.71	2.96	**0.004***
	SNAPa	10.13±1.15	10.25±1.09	10.19±1.11	0.52	0.61
	SCV	38.40±9.25	39.07±7.64	38.73±8.44	0.37	0.71

DISCUSSION

The surgical treatment of CTS has witnessed the development of different minimally invasive procedures, to release the median nerve. These include, for example, endoscopic techniques and open minimally invasive approaches. For example, **Amin and Al-Shazly** [2] said that, they thinking out of the box, on the basis of the available evidence. They used swivel knife with a blunt edge to prevent mucosal destruction of perineurium during median nerve release. Thus, avoid complications due to this mucosal destruction. They reported shorter operative time and better outcome with the use of this knife with mini-incision. However, the safety and efficacy of such surgical approaches remains controversial [17]. Here, we retrospectively evaluated the value of open mini-incision approach when compared to conventional open approach.

The current work showed that, middle aged patients were affected with female sex predominance by CTS. This is in line with previous studies indicated that, CTS affected the middle-aged females [18-21].

In addition, **Hu *et al.*** [22] reported that, CTS was more prevalent among women [female/male: 4.2] and with a mean age of 54.6 years. Their results coincide with the current one regarding female predominance, but their patients were older than the current one. This could be explained by different inclusion and exclusion criteria.

Here, we used the longitudinal S-shaped incision in the conventional approach rather than the transverse incision. This is in line with **Vella *et al.*** [23] who reported that, the longitudinal incision is more effective for the treatment of CTS as it is associated with complete symptoms relief and better functional outcome than the transverse incision.

The open mini-incision approach was associated with a better outcome than conventional technique [e.g., it had shorter operative time, shorter incision length, better symptoms and functional Levene's score, lower direct postoperative surgical wound pain, lower VAS score at 3 months after surgery and significant improvement in some electro-physiological measurements for the median nerve, mainly DML and DSL]. However, other electrophysiological measurements, two-point discrimination, and DASH score were improved in both groups to comparable results with no significant differences. These results are in line with previous studies used mini-incision techniques [24-27].

The conventional median nerve release is the classic surgery for the treatment of CTS. This method had sufficient surgical exposure and complete decompression. But it is also associated with certain complications, such as scar pain, and neurovascular injury, as reported by **Badger *et al.*** [28]. The current work revealed increased pain with conventional approach, but no neurovascular injury was reported with conventional or mini-incision techniques.

Hu *et al.* [22] used a mini-open incision and compared results to the conventional approach and reported that, the mini-incision approach achieved median nerve release similar to open approach with lower postoperative pain and scar hyperplasia. Additionally, the operative time was significantly shorter with mini-incision approach, and sooner recovery to normal daily activity and work. They concluded that, the mini-open incision approach in the CTS treatment had a small incision, quick recovery, and mild postoperative pain with good scar appearance. With the mastery of the approach, it effectively decreases the incidence of nerve injury.

Anbarasan *et al.* [29] recommended the mini-incision approach for median nerve release in treatment of CTS. They reported improved functional scores and hand grip at the end of the third postoperative month. Their patients reported complete satisfaction with the aesthetic outcome, irrespective of the fact that, 7.5% of them had reported a scar tenderness. They used the vertical incision as in the current one.

Polat [30] evaluated the open mini-incision approach in the treatment of CTS. They reported that, this method is an effective and safe approach for median nerve release. It provides lower rate of complications and significantly higher patient satisfaction. Also, they used the vertical incision as in the current work. In a study of **Bai *et al.*** [31] with a longer duration of follow up [one year], the authors reported a comparable outcome between mini-incision and conventional approach. All variables yielded non-significant differences between both approaches.

Overall, we could conclude that, the open mini-incision surgical approach for the treatment of CTS is as effective as the conventional approach and it had advantages over it [mainly, shorter operative time and better aesthetic results]. However, the results of the current work must be treated with caution due to study limitations. The main limitations include the retrospective nature of the study and small sample size. In addition to the shorter duration of postoperative follow up. Future wide-scale prospective studies with longer duration of follow up are recommended.

Conflict of Interest and Financial Disclosure: None

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