

Autogenous Vein Wrapping for Treatment of Recurrent Carpal Tunnel Syndrome

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ABSTRACT

Recurrent symptoms after carpal tunnel release are a significant challenge to hand surgeons. Scarring of the median nerve is often the cause of recurrence. Re-exploration of the median nerve and neurolysis carried poor results. This non-randomized, prospective study was designed to evaluate the outcome of autogenous saphenous vein wrapping of the median nerve as an alternative option to treat recurrent carpal tunnel syndrome. The study comprised 12 patients (10 females, 2 males) within age range of 21-49 years. All patients had both subjective and objective evaluations. There were significant pain relief and improvement in the sensory disturbances. Two-point discrimination and the findings of nerve conduction studies also improved. Eleven (91.6%) patients were satisfied with management by this technique. This technique offers an effective and elegant alternative to the classic operations for recurrent carpal tunnel syndrome. It is simple; reliable; produces excellent results; the donor vein is readily available; harvesting is easy with minimal complications in the donor area.

INTRODUCTION

Carpal tunnel syndrome (CTS) is the most common entrapment neuropathy in the human body afflicts up to 10% of the general population with a prevalence of 2.7% based on symptoms, clinical signs, and neurophysiology. The procedure to cure these patients, whether it is open or endoscopic, is usually successful in returning sensation, abolishing numbness, paraesthesia, and improving manual dexterity. However, 14%-32% of patients may have persistent symptoms [1-3].

The most commonly cited causes for initial failure include incomplete release of the transverse carpal ligament, reformation of the flexor retinaculum, postoperative adhesions, fibrous proliferation, scarring within carpal tunnel, intraneural fascicular scarring, recurrent inflammatory flexor tenosynovitis, entrapment of the palmar cutaneous branch, laceration or neuroma of median nerve or palmar cutaneous branch, incorrect diagnosis, double crush syndrome [4]. Of these the most common pathologic

finding was perineural fibrosis at the site of decompression surrounding the nerve. The median nerve may be pushed toward the palmar arch by the flexor tendons, or it may be trapped in fibrous scar tissue of the transverse carpal ligament itself [5-7].

The general treatment of patients with recurrent carpal tunnel syndrome is re-exploration of the median nerve and neurolysis. Unfortunately, the results have been equally disappointing in relieving hand pain in most cases [8-10].

Complex procedures, such as local muscle flaps, pedicle flaps, fat grafts and flaps, synovial flaps and silicon sheath have been described to provide coverage of the nerve at reexploration to mitigate the residual compression and prevent adherence of the median nerve to the carpal canal [3,11-14], however they are technically demanding, may require the sacrifice of normal tissue and muscles or use of synthetic material, long operation time and extended hospital stay.

The use of autogenous vein graft wrapping of median nerve has been described as a supplementary technique to treat chronic nerve compression secondary to cicatrix. This method constitutes a simple surgical technique that causes minimal complications in the donor area. In addition, the donor vein is readily available and harvesting is easy [15-17].

This study was designed to evaluate the outcome of autogenous saphenous vein wrapping of the median nerve as an alternative option to treat recurrent carpal tunnel syndrome.

PATIENTS AND METHODS

This non-randomized, prospective study was conducted at Neurosurgery & General Surgery

Departments, Benha University Hospital over a period of 3 years, started March 2007 and comprised 12 patients (10 females, 2 males) within age range of 21-49 years. All patients had recurrent carpal tunnel syndrome after open surgery. The mean number of previous procedures was 1.25, range (1-3). The involved hand was dominant in 5 of the 12 patients. All patients failed an initial trial of conservative treatment for one month.

Preoperative evaluation:

Each patient had both subjective and objective evaluations. Subjective evaluation included pain; nocturnal pain; numbness; tingling and muscle weakness. Objective evaluation included measurement of 2-point discrimination; Tinel' sign and Phalen's test. All patients underwent preoperative nerve conduction studies (sensory & motor) which confirmed continued compression of the median nerve at the level of the wrist.

With Ethics Committee approval, all patients were informed and consented for this indication of the venous graft after explanation & discussion of the procedure and possible complications of various surgical modalities for treatment of recurrent carpal tunnel syndrome.

Surgical technique:

All operations were performed under general anaesthesia. All patients received a single dose of broad-spectrum antibiotic before induction of anaesthesia.

The standard surgical approach for carpal tunnel release was performed with slight extension of the incision proximally and distally, to expose the median nerve in an unscarred area. Haemostasis was done using bipolar diathermy.

After identification of the median nerve, a cleavage plane was developed by sharp dissection starting from an unscarred region. The involved nerve was first decompressed and separated from all the scarred tissues (Figs. 1-3).

With respect to the vein graft, the ipsilateral or contralateral lower limb was used for harvesting of the greater saphenous vein (GSV). A transverse incision was made 1cm anterior to the medial malleolus. A vein stripper was passed through the vein via small incision in its anterior wall to about hand breadth below knee as the required length of the vein is 3 to 4 times the scarred length of the nerve (approximately 30cm). The remaining saphenous vein was ligated both proximally and distally before the excision of the graft. The excised graft was held straight over the stripper to facilitate its

incision longitudinally, using sharp scissor, to form a rectangle (Figs. 4-7).

After then, the vein intima was placed next to the nerve, and circumferential wrapping distal to proximal was performed. The vein-to-vein junctures were sutured carefully with 6/0 polypropylene. During the wrapping procedure, care was taken to avoid nerve tightening, traction or suturing of the vein to the median nerve. The distal end of the vein graft was tacked on an immobile tissue, generally in one of the lips of the opened transverse carpal ligament, while the other end of the vein graft was tacked proximal to the scarred segment of the nerve on unscarred tissue (Figs. 8,9).

Postoperative care:

The wrist was immobilized after surgery for 1 week in slight extension. Active and passive motion exercises were started immediately after the splint was removed. Walking was allowed from the first day postoperatively with below knee elastic stocking for 4 weeks after surgery.

The follow-up was performed as outpatient clinic visits 1, 2 & 4 weeks & 3 months after surgery and 6-monthly thereafter. Follow-up items included the same preoperative subjective and objective evaluations. Nerve conduction studies were done 6 months postoperatively.

Pain, numbness and tingling were assessed on a visual pain scale of 10: 0 (no symptoms) to 10 (very severe symptoms). Weakness of the thenar muscles was scored according to the severity of the weakness: none=0; mild=2; moderate=3; severe=4; very severe=5 [18]. Patients were inquired about their satisfaction regarding the operative outcome and their answers were graded as yes (+ve) or no (-ve).

Statistical analysis:

Data were analyzed using Chi-square test and Z-test. Statistical analysis was conducted using the SPSS (Version 16) for Windows statistical package. Values of $p < 0.05$ were considered significant.

RESULTS

The study comprised 12 patients; 10 (83.3%) females and 2 (16.7%) males, with mean age 32.2 ± 1.6 years; range 21-49 years. The average interval between the original carpal tunnel release and reexploration was 21.5 months (range 9-36 months). The involved hand was dominant in 5 (41.7%) of the 12 patients, preoperative subjective and objective evaluations were described in Table (1).

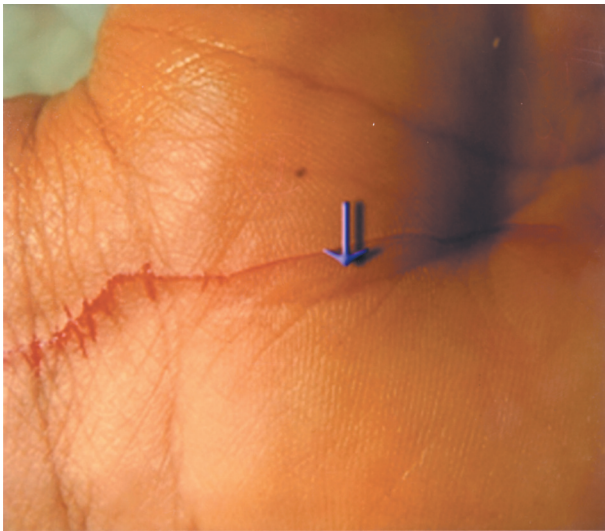


Fig. (1): Extension of the incision proximally and distally beyond the previous scar (arrow).

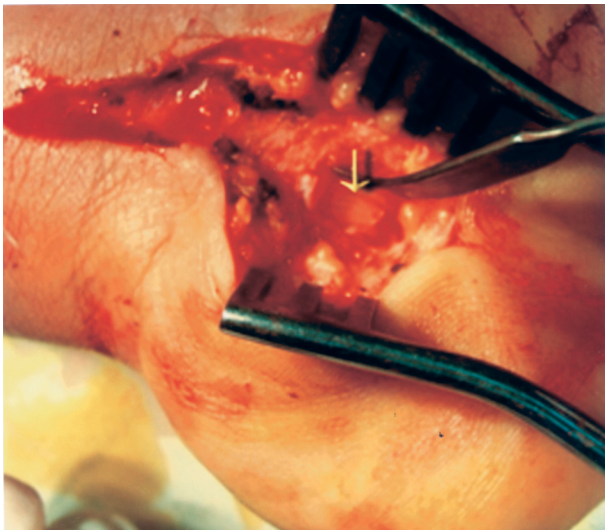


Fig. (2): Median nerve identification (arrow) under excessive fibrous tissue.

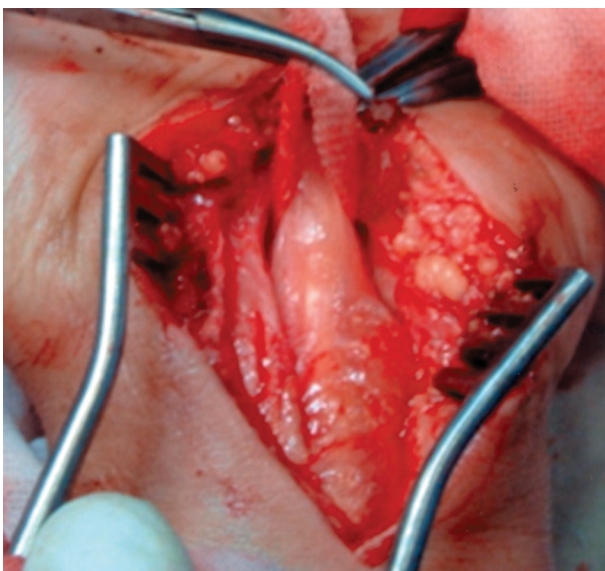


Fig. (3): Complete neurolysis of the median nerve.

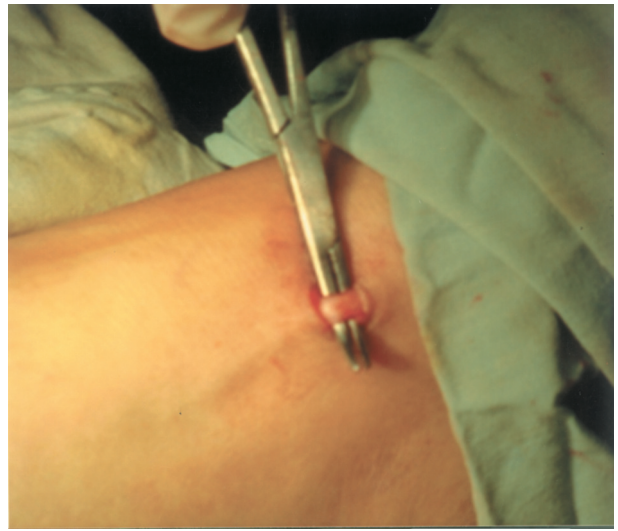


Fig. (4): The GSV in front of medial malleolus.



Fig. (5): The GSV hand breadth below knee.

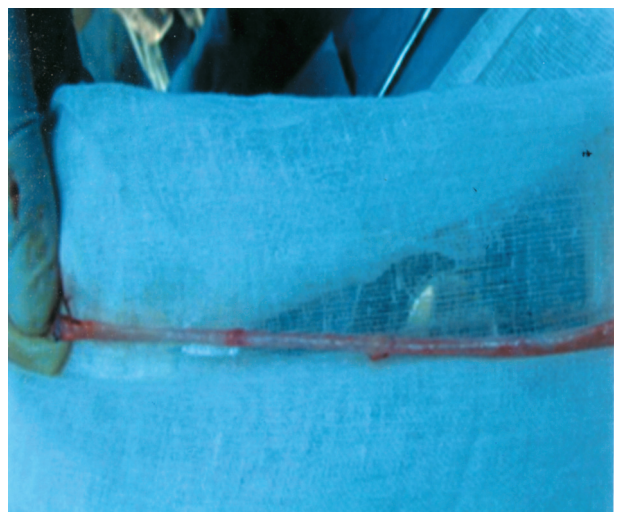


Fig. (6): Straightening of the GSV after stripping.

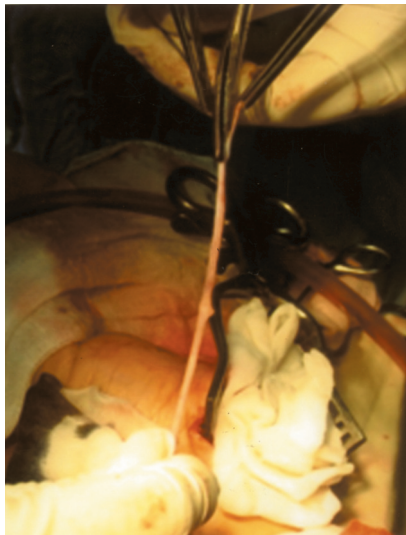


Fig. (7): The excised graft was held straight over the stripper to facilitate its incision longitudinally, using sharp scissor, to form a rectangle.

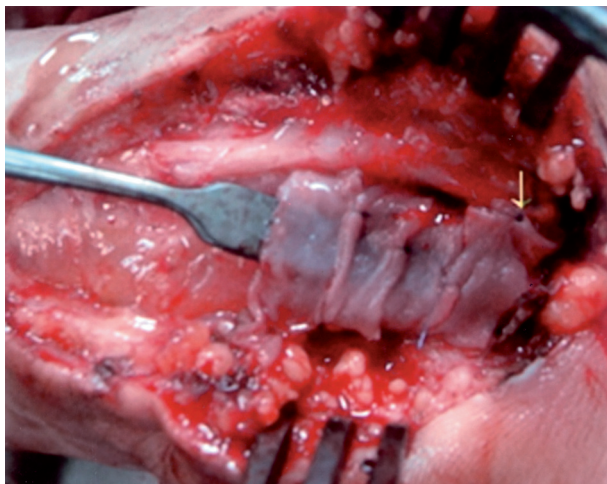


Fig. (8): A dissector was passed between the nerve and the graft to avoid tightening on the nerve. Each ring of the vein was tacked to the adjacent rings with a 6-0 polypropylene; The distal end of the vein graft was tacked on immobile tissue (arrow).



Fig. (9): Complete coverage of the median nerve by the vein graft.

Table (1): Patient's preoperative subjective and objective evaluations.

Variables	No. (N=12)	%
<i>Symptoms:</i>		
Pain	10	83.3
Nocturnal pain	9	75.0
Tingling & numbness	10	83.3
Muscle weakness	2	16.7
<i>Signs:</i>		
Phalen's sign	12	100.0
Tinel's sign	12	100.0
Thenar atrophy	2	16.7
Two-point discrimination	Average of 10.25mm (range, 7-15mm)	
Nerve conduction studies	Abnormal velocities in all cases	

All patients had smooth intraoperative course with mean operative time of 64.5 ± 4.3 minutes; range 54-87 minutes. Intraoperative blood loss was minimal during both neurolysis and harvesting of venous graft.

During the early postoperative period, no patient complained of night awakening or pain. No case developed haematoma or seroma. One case (8.3%) had superficial wound infection and managed by antibiotic and daily dressing. With respect to the donor area, 2 (16.7%) patients developed mild edema in the leg that resolved within the first week after the procedure.

All patients completed the study and follow-up with no missing cases. The mean follow-up period was 19.4 ± 7.1 ; range 8-36 months. During the follow-up period, no patient complained of pain at the first 2- and 4-weeks visits, whereas at 3-month visit only 1 patient had mild pain and was maintained on non-steroidal anti-inflammatory analgesics and physiotherapy, next visit at 6-month, there was no pain. No patient complained of nocturnal pain during the follow-up period. There was a significant improvement ($p < 0.001$) in both pain and nocturnal pain throughout the study period. Tingling and numbness were completely alleviated in 4 of 10 patients after 3 months and in 9 patients after 6 months with significant improvement ($p < 0.001$) throughout the study period, only 1 patient had residual tingling and numbness (score=2). Muscle weakness was non-significantly improved ($p > 0.05$) from moderate to mild in 1 of 2 patients at 9-months visit. Eleven (91.6%) patients were satisfied with management by this technique.

Pathognomonic irritation signs (Phalen and Tinel's signs) were still present in 3 (33.3%) of 12 patients at 3-months visit. These signs were disappeared at 6-months visit. Two-point discrimination

improved from an average of 10.25mm (range, 7-15mm) before surgery to 6.5mm (range, 4-10mm) at final follow-up visit.

The sensory nerve conduction velocity improved from an average of 36.m/s (range, 31-42m/s) before surgery to 40.1m/s (range, 36-46m/s) after surgery. The motor nerve conduction velocity improved from an average of 40m/s (range, 35-43m/s) before surgery to 44m/s (range, 35-48m/s) after surgery. For the 2 patients with thenar atrophy, one patient improved at 9-months visit, whereas the other patient did not improve.

DISCUSSION

Despite the high success rates reported in the literature by most investigators releasing the transverse carpal ligament at the wrist for carpal tunnel syndrome, the compression can recur [5,19,20]. The main reason for failure is the scar tissue that develops at the site of decompression surrounding the nerve. The risk factors for development of fibrous proliferation following carpal tunnel release remain unknown, but poor haemostasis and hematoma formation, prolonged postoperative immobilization, inadequate range-of motion exercises and therapy have been implicated. In these circumstances, the surgical outcome of revision carpal tunnel release followed by internal neurolysis remains unsatisfactory with poor results, even more scar tissue formation with the development of segmental devascularisation may occur [5,21-23]. Moreover, repeated mechanical stress on the nerve with movement of the joint may lead to the development of edema or demyelination [24].

The control of postsurgical scar formation has been the goal of nerve surgeons and researchers for many decades. In carpal tunnel syndrome there is a following problem: Into which bed the nerve should be placed only in case of reoperation [7,25,26]. For this reason several interposition materials had been tested to prevent postoperative adhesions between nerves and surrounding tissue in various clinical settings [27-30].

The hypotenar fat pad flap can produce good results and is uncomplicated in most cases [2,31], however this technique has come under criticism for its inability to be wrapped circumferentially and its limited extent of proximal and distal coverage [32]. Pedicle or free flaps, including the groin flap, lateral arm flap, and posterior interosseous flap, provide excellent protection of the nerve, but the technique is complex and the result is not always satisfying [31,33]. Median nerve wrapping

by omentum taken from the abdominal cavity was also described with poor results [34]. Small local flaps, such as the abductor digiti minimi, the palmaris brevis, and the pronator quadratus, also have been used. The dissection of these flaps, however, is not always easy, nerve coverage is sometimes inadequate, and skin closure problems may occur [35,36]. Moreover Kanta et al., [23] in an experiment on rat model, investigated peripheral nerve microstructure after its embedding into new environs. They noticed significant histological changes with perineural fibrosis after its wrapping into the fat lobe, and the extent of perineural fibrosis was five times higher, with seriously affected nerve gliding, in case when muscle was used.

The use of implanted peripheral nerve stimulators has been suggested to relieve pain resulting from compressed or injured peripheral nerves [37,38], but failures have been reported in many cases because of complications such as nerve injuries, skin problems and early formation of scar tissue due to silicone [32]. Preliminary studies also appreciate the bio-absorbable gel which was used in the study of reoperations of peripheral nerve entrapment syndromes [39].

In recent years, the autogenous vein graft has earned an ample popularity between the peripheral nerve surgeons. The technique of vein wrapping was first described by Masear and Colgin [40]. Since then, several studies have been reported regarding the use of the technique in order to prevent scar formation around nerves, both in experimental models and clinical settings, using autologous and allograft materials [15,16,41-44].

The safety of an autogenous vein graft wrapped around a nerve, as a potential wrapping material, has been proved in previous studies [15,16,40,41, 43,44,46].

The ideal wrapping material would be able to protect the nerve from compression by surrounding scarring, inhibit the formation of adherent scar to surrounding tissue, improve or protect the gliding function of a nerve during extremity motion. It should also resist degradation, minimize any inflammatory and immunologic reactions, and not be responsible for long-term compression of the nerve. The characteristic features of vein grafts that meet these criteria have been well documented previously [15].

Masear and Colgin [40] have described 2 methods of vein wrapping: A spiral and a sleeve pattern wrapping. We have preferred to use the former method which is much easier to apply. Further, it

is also easier to control the tightness of the vein graft around the nerve via this technique.

In our study, all patients reported significant pain relief and improvement in their sensory disturbances. Two-point discrimination and the findings of nerve conduction studies also improved. These results go in hand with that reported by other studies [17,42,43,47]. With respect to the functional recovery, one patient improved at 9-months visit, whereas the other patient did not improved with non-significant difference. This observation goes in hand with Fussetti et al., [2] who reported that the clinical results in terms of median nerve functional recovery cannot be predicted and using flaps to protect a damaged median nerve cannot guarantee a favourable result in terms of recovery of both sensory and motor deficits.

In this study minimal complications were noted in the donor area, 2 (16.7%) patients developed mild edema in the leg that resolved within the first week after the procedure. These figures go in hand with that reported by other studies [17,42,43,47].

Our patients were accepted and satisfied with management by this technique (91.6%). This is better than 71.4% reported after free and pedicled flaps coverage of median nerve reported by Dahlin et al. [14].

Our results were comparable with others studies in the sense that the autogenous vein wrapping technique are effective in the treatment of a compression neuropathy secondary to scar. This could be attributed to that the protection provided by the graft may result not only from its barrier effect which prevent the adhesion of the nerve to the surrounding tissue, but also from a favourable internal interface between the vein with its smooth endothelial surface and the nerve [15,16]. This interface may play an important role in enhancing the gliding between the nerve and the vein during motion of the wrist joint; it may also decrease the edema formation thus improving the blood flow to the nerve. This observation goes in hand with other authors who found a quantitative relation between increased endoneural fluid pressure and decreased nerve blood flow; increased endoneural fluid pressure should exacerbate the neuropathy by diminishing the local blood flow [24,48-50].

With respect to the role of the vein graft to prevent scar tissue formation, the exact mechanism of this effect remains uncertain [44]. In this aspect, in an experimental study; Xu et al. [41] used the femoral vein to wrap the sciatic nerve of rats, histological examination revealed absence of scar

tissue formation between the epineurium of the wrapped nerve and the intimal surface of the vein in nerves with vein wrapping versus nerves without vein wrapping. Moreover Vardakas et al. [16] reported a case which provides clinical intraoperative evidence in human of the lack of scar tissue between the intimal surface of the vein and the epineurium of ulnar nerve wrapped two years before, for recalcitrant cubital tunnel syndrome.

It could be concluded that this technique offers an effective and elegant alternative to the classic operations for recurrent carpal tunnel syndrome as the procedure is simple; the donor vein is readily available; harvesting is easy; minimal complications were noted in the donor area, and the graft tissue has good compatibility with adequate length for scarred nerve wrapping. It prevents median nerve readherence and produces excellent results. This technique can also be applied for chronic compression of any peripheral nerve.

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