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Circumferential Vein Wrapping Versus Vein Sheath to Improve the Outcome of Peripheral Nerve Repair

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ABSTRACT

Background: Trauma to peripheral nerves is relatively common which can be caused by blunt trauma or penetrating injuries. An important quality of the peripheral nervous system, as compared with the central nervous system, is its remarkable ability to recover after an injury. To improve the outcome in post-traumatic peripheral nerve injury beside precise suturing and orientation of the nerve stumps is to protect the anastomosis from the surrounding environment; this barrier should be biologically inert, biodegradable and non-compressive. Vein wrapping to the site of anastomosis was described to protect the neuro-anastomosis and to improve nerve conduction and prevent neuroma formation.

Methods: This randomized controlled study was conducted on 60 patients presenting with either median or ulnar nerve injuries in the forearm, they were divided into 3 groups were group (A) The neuro-anastomosis was covered with a vein segment passed through one segment and after the neurorrhaphy the vein is stretched to cover the suture line, In Group (B) The neuro-anastomosis was covered with a vein segment who was circumferentially wrapped, In Group (C) the neuro anastomosis was not covered with a vein wrap.

Results: After 12 months follow-up were: Functional recovery of motor nerves, sensitivity and the presence of neuroma at the site of nerve both group A and B showed a more rapid motor and sensory recovery and a reduction of the painful symptoms compared to the control group (C).

Conclusion: Both Vein wrapping techniques provides a valid solution to avoid the dispersion of the nerve fibers, adherent scars and painful neuromas formation.

Key Words: *Peripheral nerve injury – Neuro-anastomosis – Vein Wrapping – Neuroma.*

INTRODUCTION

Injuries to peripheral nerves are very common in traumas of the upper extremities and can cause massive disabilities and dysfunction that eventually interfere with their professional and normal daily activities of the patients. It is therefore adequate treatment of peripheral nerve injuries is so crucial to prevent dramatic impact of the specific person's capacity to function adequately **[1]**. The peripheral nervous system has a great advantage which its remarkable ability to recover after an injury as compared with the central nervous system **[2]**.

There is no single classification that can describe the variable types of peripheral nerve injuries; most classification systems try to correlate the degree of injury with clinical symptoms, pathology and prognosis. Seddon classified nerve injuries to three types which are neuropraxia, axonotmesis and neurotmesis according to the disruption of the internal structure and consequently a worsening prognosis **[3]**. Sunderland expanded the classification to five degrees of peripheral nerve injury, the first three degrees are as Seddon described, the fourth-degree injury, only the epineurium remains intact and the fifth-degree lesion is a complete transection of the nerve **[4,5]**.

All patients with a potential nerve injury should be judged individually and the general condition of the patient is extremely important in the decision-making of if and when a procedure on the peripheral nerve should be done, the history of the patient and evaluation of the mechanism of the injury must be evaluated by the surgeon. Sensory and motor functions should be carefully examined, where the motor evaluation includes pinch and grip strength as well as evaluation of the function and the strength of individual muscles that are innervated by the specific involved nerves. Sensory function can be evaluated by examination of light touch, but in patients with an acute injury it may be easier to assess the patient's ability to feel pain Two-point discrimination and the patient's ability to separate sharp and blunt objects can be used, but the former may be less specific in the acutely injured patient. Sudomotor function can be checked even in children with a suspected nerve injury. A positive

Tinel's sign may also be present over the proximal nerve end of the injured nerve **[6]**.

Primary immediate repair should always be the choice of management for peripheral nerve injuries and it is technically easier to perform than a delayed nerve repair **[7]**. The best treatment of peripheral nerve repair is primary early end-to-end precise suturing of the nerve stumps **[8]**. To improve the outcome in post-traumatic peripheral nerve injury beside precise suturing & orientation of the nerve stumps is to protect the anastomosis from the surrounding environment; this barrier should be biologically inert, biodegradable and non–compressive. Vein wrapping to the site of anastomosis was described to protect the neuro-anastomosis and to improve nerve conduction and prevent neuroma formation **[9]**.

PATIENTS AND METHODS

This randomized controlled study was conducted on 60 patients presenting with either median or ulnar nerve injuries in the forearm, they were divided into 3 groups were group (A) the neuro-anastomosis was covered with a vein segment passed through one segment and after the neurorrhaphy the vein was stretched to cover the suture line, In Group (B) the neuro-anastomosis was covered with a vein segment which was circumferentially wrapped, In Group (C) the neuro anastomosis was not covered with a vein wrap.

This study was conducted on single nerve injuries where 34 patients suffered from ulnar nerve injury and 26 patients suffered from Median nerve injury.

Group (A) included 20 patients where 12 patients presented with ulnar nerve injury and 8 patients presented with median nerve injury, Group (B) included 20 patients where 11 patients presented with ulnar nerve injury and 9 patients presented with median nerve injury, Group (C) included 20 patients where 12 patients presented with ulnar nerve injury and 8 patients presented with median nerve injury.

The nerve repair was standardized by all the surgeons in the study to perform an epinurial repair to the injured nerves using 7/0 prolene sutures.

The veins used in both Group A and B were harvested from the same surgical bed to avoid any donor site morbidities. Group C was used as a control group.

In Group A (n=20); the neuro-anastomosis was covered with a vein segment passed through one segment and after the neurorrhaphy the vein is stretched to cover the suture line. To accommodate the nerve diameter, the vein can be stretched and dilated by injecting saline from one end under pressure.

In Group B (n=20); the neuro-anastomosis was covered with a vein segment that is circumferentially wrapped round the neuro-anastomosis. The Vein was incised longitudinally and then wrapped around the nerve where the intimal surface towards the verve.

All patients were followed for 1 year after the repair, the follow-up included sensory and motor improvement using clinical evaluation, the presence of neuroma using the Tinel's test along the course of the nerve repaired, EMG testing after 3 months and 12 month post-operative.

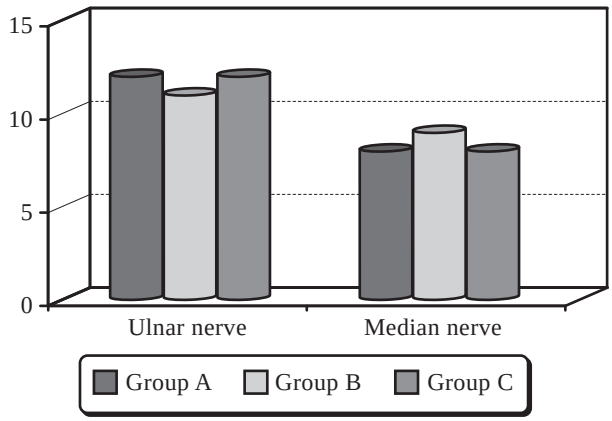

Fig. (1): Type and number of nerve injuries in each group of the study.

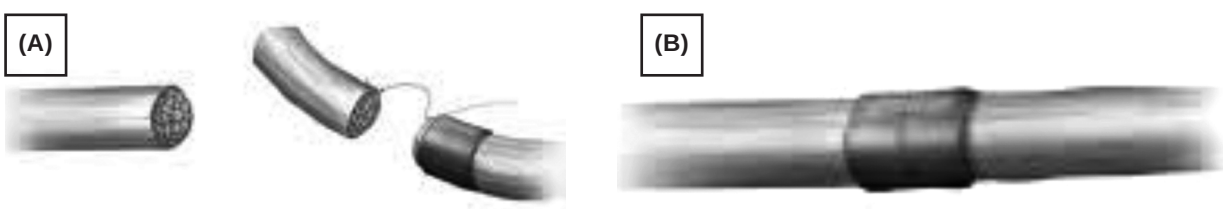

Fig. (2): Showing a vein segment passed through one segment (A) and after the neurorrhaphy the vein is stretched to cover the suture line (B).

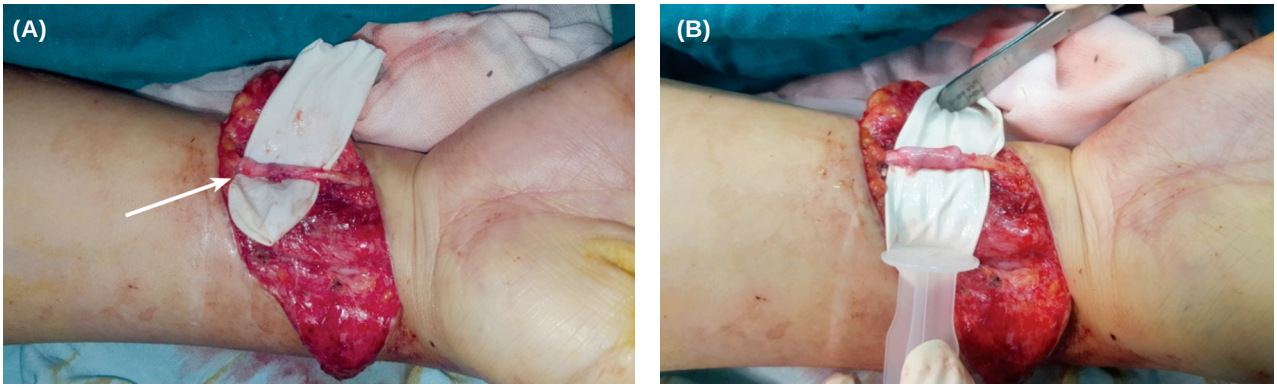

Fig. (3): Showing a patient presenting with ulnar nerve injury where vein segment was passed in the proximal end of the nerve showed by the arrow (A), the after the neurorraphy the vein segment was stretched to cover the nero-anastomosis (B).

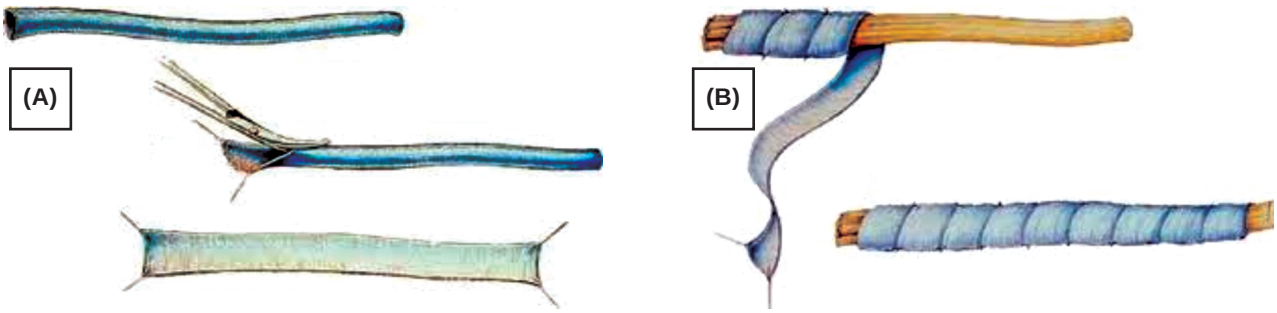

Fig. (4): A diagram showing the steps of vein wrapping around the neuro-anastomosis **[25]** (A) the vein is incised longitudinally where the intimal surface is the one facing the nuero-anastomosis, (B) the process of spiral wrapping.

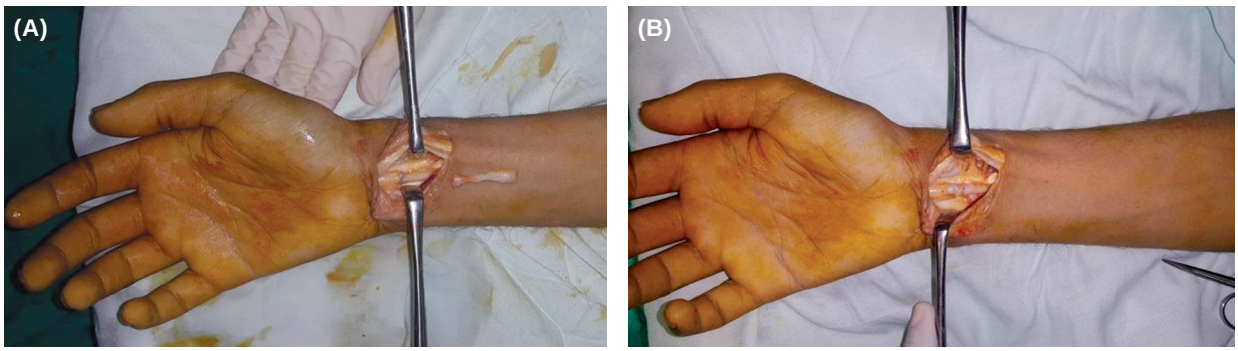

Fig. (5): Showing a patient presenting with median nerve injury (A) after the neurorraphy and preparation of the vein segment which was incised longitudinally (showed by the arrow) and (B) after the circumferential spiral wrapping of the neuro-anastomosis with vein segment.

Results

According to the presence of Neuromas (Detected clinically be Tinel's Test after 3-6 months), In Group (A): Neuromas were detected in 1 patient (5%) who was previously presented with ulnar nerve injury, In Group (B): Neuromas were detected in 1 patient (5%) who was also previously presented with ulnar nerve injury, In Group (C): Neuromas were detected in 4 patients (20%) 3 patients were presented with ulnar nerve injuries and 1 patients presented with median nerve injuries.

According to the functional recovery which was detected clinically by both sensory and motor recovery and confirmed with the degree of regeneration by EMG, In Group (A) moderate to complete recovery was found in 14 patients (70%) and mild to moderate recovery was found in 6 patients (30%), In Group (B) moderate to complete recovery in 15 patients (75%) and mild to moderate recovery in 5 patients (25%), In Group (C) moderate to complete recovery was found in 9 patients (45%) and mild to moderate recovery was found in 11 patients (55%).

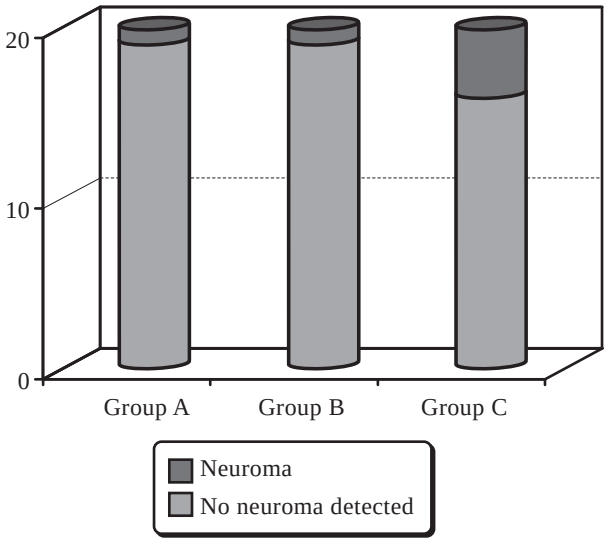

Fig. (6): The number of neuromas appeared in each group during follow-up.

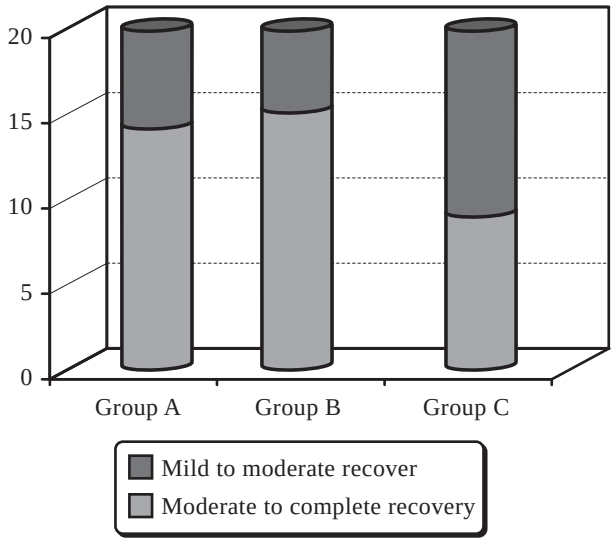

Fig. (7): The functional recovery in all study groups.

DISCUSSION

Injuries of the peripheral nerves are a very common association to all upper limb trauma causing significant disabilities and dysfunction to the patients as they interfere with their normal daily activities and occupational capabilities causing massive impact not only the patients but also to the community **[10]**. And thus improving the skills and techniques for adequate and precise repair for those injuries is of extreme importance.

The gold standard of peripheral nerve repair is immediate primary end-to-end coaptation of the nerves **[11]**. The aim of adequate nerve repair is the precise apposition of the two stumps of injured nerve using a minimum number of sutures with minimal tension **[12]**.

The prognosis of this repair depends on the timing the repair, the patient's age, type of nerve affected, level of injury, trauma mechanism and also the development of scar fibrosis **[13]**. In fact fibrosis obstructs the growth of axons from the proximal to the distal stump, and can also cause irritation pain syndromes and functional limitations. This phenomenon triggers the inflammatory cascade mediated by macrophages, lymphocytes, mast cells, in addition Schwann cells release neuronal adhesion factors and cytokines leading to the formation of neuroma **[14]**, therefore minimizing fibrosis will definitely improve the outcome and prognosis of peripheral nerve repair **[15]**.

The incidence of post-traumatic peripheral nerve neuroma formation after repair is not clear but the incidence of asymptomatic end-neuromas after peripheral nerve injury is 3-7% and the incidence of symptomatic end-neuromas after amputation is 13-32% while 63-79% of patients with neuroma pain complained of working and functional disabilities **[16]**.

To improve the outcome in post-traumatic peripheral nerve injury beside precise suturing & orientation of the nerve stumps is to protect the anastomosis from the surrounding environment; this barrier should be biologically inert, biodegradable and non-compressive **[17]**. Multiple biomaterials had been previously used for this purpose as Vozzi et al. **[18]** who used tubes of polycaprolactone, Carlucci and Delaviz **[19,20]** assessed the effect on nerve regeneration of polyurethane so that the tube acts as a veritable chamber for nerve regeneration. Vein grafts are among the first non-neural biological conduits used for peripheral nerve repairs, they can be used as a conduit if there is a defect of 1-3cm between the two stumps of the nerve or can be used as a barrier between the neurorraphy and the surrounding environment **[21,22]**.

The question about the survival of these vein grafts and if there is any absorption or degradation for these grafts causing more scarring on the repaired nerves has been answered in the experimental histological study by Maboub et al., in 2017 showing excellent results of the survival and efficiency of the vein wrapping in shielding of the repaired peripheral nerve from invasion by the surrounding scar tissue **[23]**.

The techniques for wrapping the vein around the nerves varied from either vein segment passed through one stump of the transected nerve and after the neurorrhaphy the vein is stretched to cover the suture line **[9]** or the spiral circumferential wrapping of the vein segment which was more commonly used after neurolysis of chronically compressed nerves **[24,25,26].**

In this study both Group (A) were the neuro-anastomosis was covered with a vein sheath and in Group (B) were the neuro-anastomosis was covered with a circumferential vein wrap", the vein wrap decreased the incidence of neuroma formation and helped to improve the functional recovery of the repaired nerves in comparison to Group (C) were the neuro-anastomosis was not covered with any vein wrap, this is may be due to not only the vein wrap acted as a mechanical isolation chamber to prevent spouting of nerve fibers and thus preventing neuromas, but also the vein wrap act as a conduit that facilitated nerve regeneration. The use of vein wrapping has more advantages over other synthetic materials used for the same purpose (as silicone and collagen) as they are less antigenic and with No cost. Harvesting the veins from the same operative bed gives the advantage of avoiding any donor site morbidities. Sometimes veins are too small and narrow especially is females to be used as a vein sheath and this gives more advantage to circumferential wrapping that can be done with any size of veins.

There was No significant deference in the results either in the presence of neuroma or in the functional recovery between both techniques of vein wrapping (either vein sheath or circumferential wrapping).

Conclusion:

Vein wrapping techniques is an easy, available and useful tool that helps in the improvement of peripheral nerve repair results, Both techniques of vein wrapping have the same results although circumferential wrapping technically speaking has the advantage of being used in any size of veins available in the same surgical field.

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