Intraoperative Evaluation of Median Nerve Excursion in Carpal Tunnel Surgery

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Introduction: Patients complaining of pain and or parasthesia along the arm, forearm and hand with or without abnormal functions in the small muscles of the hand present with a condition that must be anatomically localized, mechanically understood and pathologically classified. Numerous causes can produce neuropathy including non-surgical causes that must be excluded. This may cause difficulty in the diagnosis even after clinical and radiological evaluation, so we resort to electrophysiological examination to confirm the diagnosis.

Methods: The study was carried out on twenty patients, admitted to Benghazi Medical Centre during the period of one year. All patients had a detailed history taken, and a complete physical examination with neurological evaluation. The diagnosis was confirmed by electrophysiological studies. Subsequently, the appropriate surgical procedure was performed. All the cases were followed up clinically and electrophysiologically.

Results: The mean age of the patients was (41.55± 10.44) with a high frequency of 30 to 40 years, 80 % of cases were females and 20% were males, 75% of cases were workers, 55% of the patients presented with their right hand and 45% with their left hand, The duration of symptoms prior to operation ranged from 2 to 30 months with a mean of (10.1±7.38). The latter difference had a statistically significant effect on the results. Clinical analysis showed that pain and numbness in the distribution of the median nerve were the most common complaints. The most common physical finding was a positive Phalen's test (85%). Preoperatively 35% of cases were graded mild, 25% were graded moderate and 40% were graded severe. After 6 months of regular follow up we found that 75% of our patients showed good improvement as regarded the nerve conduction study result.90% improvement of pain, 77% in lessening of numbness, 66% in lessening of weakness and 50% in lessening of wasting of thenar eminence. A statistically significant difference was found between the preoperative and postoperative nerve conduction studies (motor and sensory). Intraoperatively, there was an increase in the significant excursion of the median nerve in association with the three wrist positions (neutral, flexion, extension) after release of the transverse carpal ligament. Only 10% of our patients developed post-operative complications (wound infection and scar tenderness) which were dealt with appropriately. The overall result was good in 75% of cases, fair in 15% of cases and poor in 10 % of cases.

Conclusion: The finding of this study showed that the position and movement of wrist had a profound effect on an excursion of the median nerve, and may aid in the understanding of the pathophysiology of the carpal tunnel syndrome. Moreover, we should be considering the limitation of median nerve excursion as one of the causes of carpal tunnel syndrome. Also the longer the duration of preoperative symptoms the worse is the result, so early surgery in moderate and or severe grades is recommended.

Keywords: Carpal tunnel, median nerve, excursion

Introduction

Carpal tunnel syndrome is the most common peripheral entrapment neuropathy, in which The carpal tunnel is the semi-rigid conduit that contains the median nerve and the nine flexor tendons.(1,2,3,4,5) It represents a confined area with little free space, hence any process that increases the volume of its content or reduces its capacity leads to compression of the median nerve with distortion or ischemia ". Even a slight swelling of the synovial sheaths of the flexor tendons". Phalen wrote, "may be sufficient to force the median nerve up against the firm inelastic transverse carpal ligament, causing motor or sensory changes"(6,7).

Patients complaining of pain and or paresthesia along the arm, forearm, and hand with or without abnormal function of the small muscles of the hand, present with a condition that must be anatomically localized, mechanically understood and pathologically classified (6,7,8). Numerous cases can produce neuropathy including non-surgical causes that must be excluded (9,10,11). This may cause difficulty in the diagnosis even after clinical and radiological evaluation, so we resort to electrophysiological studies to confirm the final diagnosis (12,13,14,15,16,17).

Acute carpal tunnel syndrome occurs when there is a

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rapid and sustained increase in the pressure inside the carpal tunnel as in fracture of the distal radius or other causes such as hemorrhage or burns. (4,18).

More frequently encountered is the chronic carpal tunnel syndrome in which symptoms are present over months to years, in most patients the cause is idiopathic, with more specific tenosynovitis leading to median nerve compression. (2,3,4).

Methods

The study was carried out on twenty patients, admitted to Benghazi Medical Centre during the period of one year. All patients subjected preoperatively to detailed history taking and complete physical examination with neurological evaluation. The diagnosis was confirmed by electrophysiological studies.

Patients were operated according to the following steps:

1-Lazy S skin incision.

2-Exposure and marking of the median nerve proximal to the transverse carpal ligament.

3-Measurement of the distance between the marker and an imaginary line crossing transversely at the lower end of the radius bone by a direct radiographic technique in three wrist positions: neutral, full flexion, and full extension.

4- Incision of the transverse carpal ligament.

5-Repetition of the measurement after release in the same wrist positions: neutral, full flexion, and full extension.

Figures 1-5: show intraoperative carpal tunnel release and x-ray of the wrist in three positions(neutral, flexion and extention).

Results

The mean age was (41.55+_ 10.44), eighty% were females, seventy five % of cases were workers, fifty five % had involvement of the right hand and forty five % the left hand, the duration of symptoms prior to operation ranged from two to thirty months with a mean of (10.1+_ 7.38). The difference had a statistically significant effect on the results. Clinical analysis showed pain and numbness in median nerve distribution were the most common complaints, the most common physical finding was a positive Phalen's test (eighty five %). Preoperative nerve conduction study revealed thirty five % of cases were graded mild, twenty five % were graded moderate and forty% were graded severe. After six months of regular follow up, we found that seventy five % of our patients had good improvement as regarded the nerve conduction study result, ninety% improvement as regarded pain, seventy-seven % as regarded numbness, sixty six % as regarded motor function and fifty% as regarded less wasting of the thenar eminence. Statistically, a significant difference was found between the preoperative and postoperative nerve conduction studies (motor and sensory). Intra operatively, there was an increase in significant excursion of the median nerve in association with the three wrist positions (neutral, flexion, extension) after the release of the transverse carpal ligament. Only ten% of our patients developed postoperative complications (wound infection and scar tenderness) which were dealt with appropriately. The overall results were good in seventy five % of cases, fair in fifteen% of cases and poor in ten% of cases.

Discussion

The diagnosis of carpal tunnel syndrome continues to be made with increasing frequency because of the availability of more sophisticated diagnostic investigations and public awareness.

Recognition that occupational factors contribute to cumulative trauma disorders involving the hands is not a new discovery, it has been somewhat controversial, it was approved by Osler and Hunt, but not totally agreed with by Phalen.(19,20) Individuals who experience symptoms during the course of repetitive manual labor represent seventy five % of the patients.

Classically patients present with nocturnal pain or numbness of the lateral three and a half fingers radiating up to the forearm, arm, and sometimes even reaching the ear. (6,21,3,4).

Many conditions are associated with carpal tunnel syndrome, which may be the reason why no single test can be used as a golden standard. (22)

Although there are conflicts about provocative tests, yet they are still used widely among clinicians because electro diagnosis still lacks the sensitivity and specificity to detect all cases of carpal tunnel syndrome. (23)

Bedside tests include Phalen's test (6,24) which was positive in seventeen of our cases showing a sensitivity of eighty five % while Ahn (25) showed a sixty seven point five% sensitivity. Tetro (26) et al gave a sensitivity of sixty one%.

Tinel's sign was positive in fourteen cases showing a sensitivity of seventy% compared to sixty seven point five % in Ahn's (27) study, seventy four % in Tetro's et al study(26) and thirty three % in Del Pino's et al study (28).

These variations concur with what was previously mentioned that there is no single test that can be used as a golden standard. The degree and duration of nerve entrapment can also play a role, as well as the patient's intellectual level.

The hand elevation test which is a new provocative test was positive in 15 cases giving a sensitivity of seventy five % compared to the seventy five point five found in Ahn's study. (27)

There were ten patients with a sensory deficit in the territory of the median nerve distribution of the hand. Sixty five % of our patients had no motor deficits; fifteen% presented with weakness of the thenar muscles, twenty% had wasting of the thenar muscles.

In our study, a mean value of (10.81±5.82 m/sec) for motor latency ranged from (4.46 to 19), and a mean value

(12.06±9.93 m/sec) for sensory latency ranged from 2 to 29). In our patients thirty five % were classified s mild cases, twenty-five % as moderate cases, and enty% as severe cases according to the Greenberg et al) grading system.

ormal nerve excursion in response to the joint motion made possible by the median nerve's inherent elastic- y and its ability to glide smoothly through its bed and edistribute focal stresses throughout the entire nerve. 9,30,31,32) The normal nerve is surrounded with tis- ue that allows for gliding, this layer permits the easy issection and mobilization of the nerve. If the normal xcursion is restricted, a neurodesis effect and in- reased strain occur across the portion of the tethered erve. It may cause temporary or permanent disruption f action potential propagation, resulting in impairment f sensory and motor function. Any increase in base- ine pressure of the carpal tunnel would be expected o increase the friction forces between adjacent sliding tructures (nerve, tendons, and retinaculum). Therefore, ome authors hypothesized that altered kinetics may be pathogenetic element in nerve entrapment syndromes uch as carpal tunnel syndrome, and speculated that ncreased pressure in the carpal tunnel might amplify he relative role of shear forces in median nerve motion. Because carpal tunnel syndrome develops slowly over a long period of time, slowly increasing ambient pressure makes the passage of the nerve within the carpal tun- nel increasingly difficult, and the trunk of the median nerve may become fixed in the carpal tunnel. (33)

In our study there was a statistically significant differ- ence of the median nerve movement in the three posi- tions of the wrist: neutral ($p = 0.031$), flexion ($p = 0.041$) and extension ($p = 0.031$), in the comparison between before and after the open release of the transverse car- pal ligament. Tuzuner et al, 2004 (34) reported that the difference in the median nerve movement between be- fore and after the endoscopic release of the transverse carpal ligament in the three wrist positions was statis- tically insignificant.

All of our patients were followed at regular intervals. Two patients developed complications. One was in the form of wound infection discovered at the tenth post- operative day and represented five% of our cases, and the other complication was scar tenderness discovered after one month and also represented five%. Abdullah et al, 1995 (35) reported twenty four % of their cases had complications, and reported that persistent severe pain and tenderness at the operative site were gener- ally interrelated, most likely they resulted from the su- perficial position of the nerve, with only a thin layer of fascia under the skin and sometimes from the anterior displacement of the median nerve, with possible entrap- ment between the edges of the ligament.

Finally, all of the complications were treated by conser- vative methods with a total resolution of wound infec- tion in two weeks and scar tenderness in eight weeks.

It was shown that the mean time for our patients to re- gain normal daily activity was (3.9±1.37) weeks, ranging from two to six weeks, forty five % of our cases returned to their usual activities in four to five weeks. Nathan et al, 1993 (36) reported ninety five % of their cases took four to six weeks before returning to their usual activi- ties. This difference may be due to the difference in the nature of the patient's work.

In the third and sixth months of postoperative follow up with nerve conduction studies there was a significant decrease in the motor and sensory delay in comparison with the preoperative nerve conduction studies. Accord- ingly, seventy five % of our patients had significantly good improvement and fifteen% had only fair improve- ment, while only two of the patients had a poor result. The duration of preoperative symptoms significantly ($p = 0.012$) affected the result. The longer the duration of preoperative symptoms the worse result. That is be- cause long-standing compression of the median nerve by the transverse carpal ligament, may affect both my- elinated and unmyelinated nerve fibers and leads to axonal degeneration which worsens the result postop- eratively(37,38).

There was a significant relationship between the degree of entrapment and the improvement. Seven patients with a mild degree of entrapment had good resulting improvement (46.7%) after the release of the transverse carpal ligament. It is to be noted that longstanding compression of the transverse carpal ligament on the median nerve that restricts its normal excursion and increases the strain across the portion of the tethered nerve, may cause disruption of action potential propa- gation, resulting in impairment of sensory and motor function of the nerve. Therefore, the more the severity of nerve entrapment preoperatively, the lesser the im- provement postoperatively.

Conclusions

Patients with carpal tunnel syndrome must be com- pletely evaluated to exclude non-surgical conditions. Several bedside examinations are performed. The most sensitive is Phalen's test. Early neurophysiological as- sessment is a valuable tool in confirming the clinical di- agnosis and helping to evaluate the benefits of surgery. The finding of this study showed that the position and movement of the wrist had a profound effect on the ex- cursion of the median nerve, and may aid in the un- derstanding of the pathophysiology of carpal tunnel syndrome. Moreover, it is worth considering the limita- tion of median nerve excursion as one of the causes of carpal tunnel syndrome. The longer the duration of preoperative symptoms, the worse is the result follow- ing delayed surgery, so early surgery in moderate and severe grades is recommended.

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Conflicts of interest

There are no conflicts of interest.

Figure.1 : The transverse carpal ligament is incised.

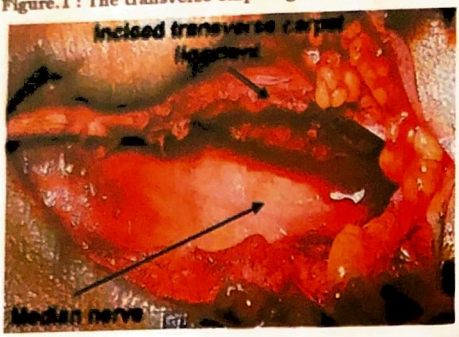


Figure.2 : Exposure and marking of median nerve proximal to the transverse carpal ligament..

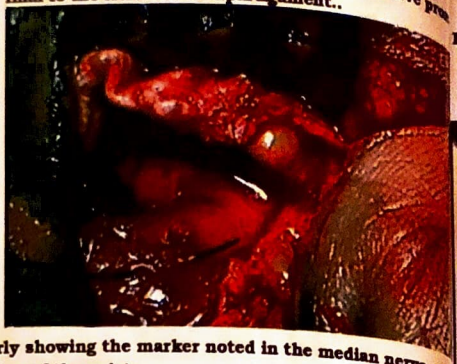
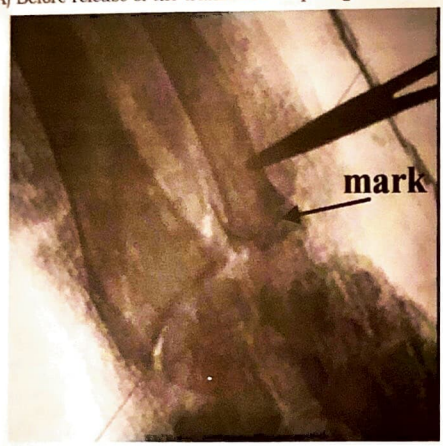


Figure.3 : Plain x-ray of the wrist joint anteroposteriorly showing the marker noted in the median nerve at the neutral position of the wrist:

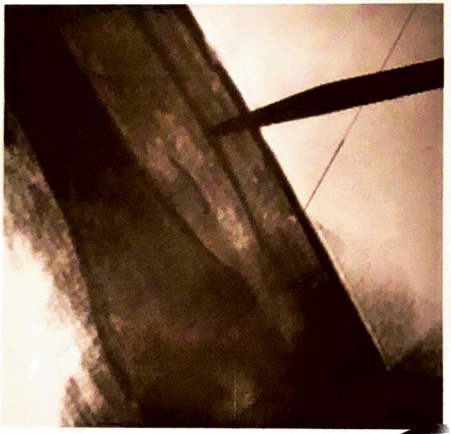
A) Before release of the transverse carpal ligament.



B) After release of the transverse carpal ligament.

Figure 4 : Plain x-ray of the wrist joint anteroposteriorly showing the marker noted in the median nerve at the flexion position of the wrist:

A) Before release of the transverse carpal ligament.



B) After release of the transverse carpal ligament.

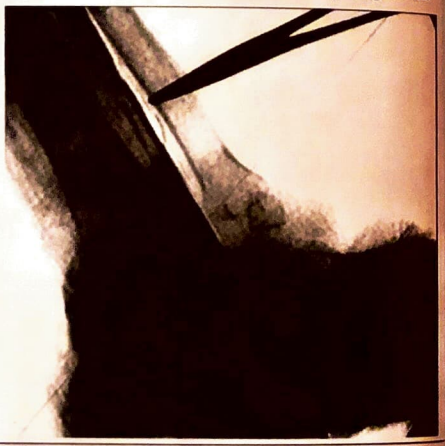


Figure 5 : Plain x-ray of the wrist joint anteroposteriorly showing the marker noted in the median nerve at the extension position of the wrist:

A) Before release of the transverse carpal ligament.

B) After release of the transverse carpal ligament.

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