Influence Of Different Ankle Positions On Tibial Nerve Conduction Velocity Study

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Abstract

Background: Changes in joint positions have been reported to affect nerve mobility and adaptability.**Purpose**: To investigate the influence of different ankle positions on tibial nerve conduction velocity. **Methods:**This study was conducted on sixty healthy participants from both sexes (age30.35±6.1years, weight58.28±9.93kg, height1.67±0.11m and BMI 20.82±1.46 kg/m^2). Tibial nerve motor distal latencies were recorded using Neuropack S1MEB-9004 Nihon Koden Japan from different ankle positions (neutral, 20º ankle dorsiflexion and 40º ankle plantarflexion) **Results**: showed a significant effect for ankle positions in motor distal latency of both lateral and medial branches of tibial nerve in favor of neutral ankle position compared with other positions Plantarflexionand dorsiflexion**,** the mean values of motor distal latency of both lateral and medial branhes for neutral ankle position were(4.62±0.87**,**4.57±0.89)respectively**,**plantarflexion were(5.06±0.81**,**5.24±0.83)respectively, and dorsiflexion were(5.64±0.92**,**6.03±0.93) **Conclusion:** Ankle neutral position is the most convenient position for assessing tibial nerve conduction velocity and it is the most appropriate position for reduce tibial nerve entrapment ,while prolonged ankle dorsiflexion positionshoud be avoided to redue risk of tibial nerve entrapment .

Keywords: Ankle positions, Nerve conduction velocity,Tibial nerve

Introduction

Tibial nerve is one of the two terminal branches of the sciatic nerve. It passes through the popliteal fossa to gastrocnemius and soleus muscles, then continues deep to the flexor retinaculum**[1].** Itis divided into medial and lateral plantar nerves, both planter nerves pass through the tarsal tunnel(TT)**[2].**

The tibial can adapt itself to positional change,repeative force and tensile stress imposed by joint motions**,** as it has a mechanical properties which enable it to the peripheral nerves to maintain ideal neural function**[3].**

But this mechanical properities of the peripheral nerves may be affected by compression**,**is which may cause disruption of the ability of the nerve to stretch , slide , reduce the blood supply to the nerve leading to ischemia, decreasing axonal flow and prolonged distal latancy(DL) soaffect the nerve function**[4].** Also**,**prolonged tension on nerve creates a sequel of intraneural events that may ultimately lead to impaired nerve sliding. **[5].**

Tension on the tibial nerve and its branches have been suggested to explain the pathogenesis of some cases of tarsal tunnel syndrome **[6],[7],**so assessment of tibial nerve at the ankle joint is one of the most challenging area in electrodiagnosis**[8]**. Nerve conduction and tissue pressure in fibro_Osseous tunnels are position sensitive**[9]**,it has been reported by trepman et al**.,**1999**,**that changes in ankle positions lead to increase the pressure on the tibial nerve in the TT. This increased pressure may affect nerve conduction and contribute to neural dysfunction**[10]**.

However the reported sensitivity of nerve condution velocity to changes of jiot positions on upper extremity **[11],[12].**up till now measurement of the effet of ankle joint positions on tibial nerve conduction velocity has not been previously reported .So this study was conducted to investigate to how extent the different ankle positions can affect on DL of the tibial nerve at the TT.

The intent of this research was to establish a valid and applicable foundation of scientific evidence that can be used to make good decision about the diagnosis and evaluate tibial nerve DL inside TT. In view of clinical perceptions, our goals for this study were to measure the impacts of different ankle positions on the tibial nerve DL anddetect the ideal position of ankle splint for patient suffering from tibial nerve entrapment .to derease the symptoms as pain and numbness.

Methods

Study Design:*One shot case* study.

Participants:Sixty healthy subjects Aged from 20 and 40 years of both sexes were participated on the study . This study was conducted at OutpatientPhysical TherapyClinic of October 6 University hospital between March 2018 to October 2018. The subjects with BMI between 18.5 and 24.9kg/m^{2}were eligible to participate in this study. Exclusion criteria included smokers, hypertension patients,obease subjects,pregnant women, cardiovascular patients, patients with osteoarthritis, patients with lumber disc prolapse, patients with previous leg fracture or any problems in ankle joint, patients with S1 Radiclopathy,patients with Tarsal tunnel syndrome and flat foot patient.

Measurement procedures:Neuropack S1 MEB-9004 Nihon Koden, Japan have been utilized to obtain an objective evaluation of the Tibial nerve distal latencies (Lateral and Medial plantar branches). in 3 different ankle positions: neutral, 20° dorsiflexion and 40° planterflexion.Weight and height of each participant was measured prior to nerve conduction study in order to exclude any obese participants, then a brief explanation about the EMG machine and the protocol of the tibial nerve motor conduction velocity measurement was presented to each participant who approved and signed a consent form before the beginning of the nerve conduction velocity measurement. Skin of the subjects at the areas of recording electrodes were firstly scratched by a disposable razor (vertical position) and secondly cleaned by alcohol, while the areas of stimulation were only cleaned using alcohol.

During measurement the subjects were seated in along sitting position , then ankle positions: neutral, 20° dorsiflexion, 40° planterflexionhave been detected by using manual goniometerand these positions were supported during the whole procedure by static splint.

Placement of electrodes for the medial plantar branch were as follows: The ground electrode was placed around the ankle area, between the stimulating and recording electrodes. The recording (negative) electrode was placed over the main bulk of the abductor hallucis muscle located in the medial aspect of the sole of the foot between heel and base of the first metatarsal bone). The reference (positive) electrode was placed distally over the ball of the big toe.

Placement of electrodes for the lateral plantar branch were as follows: The ground electrode was placed around the ankle area, between the stimulating and recording electrodes.The recording (negative) electrode was placed over the main bulk of the adductor hallucis muscle (located below the head of the third metatarsal bone). The reference (positive) electrode was placed distally over the tip of the third toe.Stimulating electrodeswere placed behind and above the medial malleolus.

Data anaylsis:Statistical analysis was conducted using SPSS for windows, version 23 (SPSS, Inc., Chicago, IL). The current test involved one independent variable was the (ankle positions); within subject factor which had three levels (neutral ankle, ankle dorsiflexion and ankle plantarflexion). In addition, this test involved two tested dependent variables (distal latency of medial and lateral tibial nerve). Accordingly, repeated measure MANOVA was used to compare the tested variables of interest at different tested conditions. Repeated measure MANOVA was performed on the examined sample with the alpha level 0.05.Prior to final analysis, data were screened for normality assumption, and presence of extreme scores. This exploration was done as a pre-requisite for parametric calculations of the analysis of difference. Descriptive analysis using histograms with the normal distribution curve showed that the data were normally distributed and not violates the parametric assumption for each of the measured dependent variables. The box and whiskers plots of each of the tested variables were done. All these findings allowed the researchers to conduct parametric analysis.

Results

The results of this study suggest that changing ankle positions have a significant effect on tibial nerve DL.

As presented in table (1) the mean ± SD values of DL of lateral tibial nerve at different ankle positions "Neutral ankle", "ankle plantarflexion " and "ankle dorsiflexion "" were 4.62±0.87, 5.06±0.81 and 5.64±0.92 respectively. The univariate tests of repeated measure MANOVA revealed that there were significant differences in the mean values of DL of lateral tibial nerveamong different ankle positions(F=117.020, P=0.0000*).As well as, multiple pairwise comparison tests (Post hoc tests) revealed that there were significant differences between (neural ankle Vs. ankle dorsiflexion), (neural ankle Vs. ankle plantarflexion) and (ankle dorsiflexion Vs. ankle plantarflexion) with (p=0.0001*, p=0.0001* and p=0.0001*) respectively. This significant reduction in favor to "ankle neural position" and "ankle plantarflexion position" compared to ankle dorsiflexion.

Also as presented in table (1), the mean ± SD values of DL of medial tibial nerveat different ankle positions "Neutral , ankle plantarflexion and ankle dorsiflexion " were 4.57±0.89, 5.24±0.83and 6.03±0.93 respectively. The univariate tests of repeated measure

MANOVA revealed that there were significant differences in the mean values of DL of medial tibial nerve among different ankle positions (F=94.7, P=0.0000*).As well as, multiple pairwise comparison tests (Post hoc tests) revealed that there were significant differences between (neural ankle Vs. ankle dorsiflexion), (neural ankle Vs. ankle plantarflexion) and (ankle dorsiflexion Vs. ankle plantarflexion) with (p=0.0001*, p=0.0001* and p=0.0001*) respectively. This significant reduction in favor to "ankle neural position" and "ankle plantarflexion position" in compared to ankle dorsiflexion.

Table (1): Descriptive statistics and repeated measureMANOVA for the DL of lateral tibial nerve and medial tibial nerve at different ankle positions:

<table>
<tr><th>Mean ±SD</th><th>Ankle neutral</th><th>Ankle plantarflexion</th><th>Ankle dorsiflexion</th></tr>
<tr><td>Distal latency of lateral tibial nerve</td><td>4.62±0.87</td><td>5.06±0.81</td><td>5.64±0.92</td></tr>
<tr><td>Distal latency of medial tibial nerve</td><td>4.57±0.89</td><td>5.24±0.83</td><td>6.03±0.93</td></tr>
<tr><td colspan="4">The univariate tests for the mean of Distal latency of lateral tibial nerve and medial tibial nerve among different ankle positions</td></tr>
<tr><td></td><td colspan="2">F-value</td><td>P-value</td></tr>
<tr><td>Distal latency of lateral tibial nerve</td><td colspan="2">117.020</td><td>0.0000*</td></tr>
<tr><td>Distal latency of medial tibial nerve</td><td colspan="2">94.7</td><td>0.0000*</td></tr>
<tr><td colspan="4">Multiple pairwise comparison tests (Post hoc tests) for the DL of lateral tibial nerve and medial tibial nerve among different ankle positions</td></tr>
<tr><td></td><td>Neutral Vs. dorsiflexion</td><td>Neutral Vs. plantarflexion</td><td>dorsiflexion Vs. plantarflexion</td></tr>
<tr><td>Distal latency of lateral tibial nerve</td><td>0.0001*</td><td>0.0001*</td><td>0.0001*</td></tr>
<tr><td>Distal latency of medial tibial nerve</td><td>0.0001*</td><td>0.0001*</td><td>0.0001*</td></tr>
</table>

***Significant at alpha level <0.05**

Discussion

In this study, tibial nerve DLwas measured from 3 different ankle positions to analyze tibial nerve DL responses to change in ankle positioning. Our results revealed that ankle neutral position was the most convenient position for reducing distal latency of both lateral and medial plantar branches when compared with 40° ankle plantarflexion and 20° ankledorsiflexion.

During the normal activity of daily living activities such as walking, the lower extremity motions such as dorsiflexion or plantarflexion of the ankle joint require the tibial nerve to adjust its position within the nerve bed according to load imposed by joint movements. The capacity of peripheral nerves to extend and slide is improtant to preserve perfect neural function.**[13]**

Tibial nerve has a mechanical mechanism to allow nerve to accommodate various stresses : paraneurium above the epineurium allows the nerve to slide , the endoneurial tissue accommodates to compression and the arrangement of the nerve fiber straighten with lengthening , however Prolonged compression have a dramatic effects on tibial nerve conduction **[14]**

Improvement in tibial nerve motor DL value with ankle neutral position can be explained by increasing inthe space inside the TT , increasing in cross sectional area of the tissue compartment thus improving tibial nerve conduction velocity**[15]**.

Also, the present study showed that ankle dorsiflexionmay add adverse effects on tibial nerve DL. This finding can be explained by increased tension on the tibial nerve as it lies on the convex side of ankle joint **[16]**.The nerve elongates about 6% that decrease the amplitude of the action potential , 8%nerve strain produce a reduction of flow in venules,15% strain produces intraneural vascular occlcslon, so prolonged elongation lead to decreasing in microvascular permeability , delaying in conduction time and decreased in blood flow in the nerve and increasing intrafascicular pressure**[17]**.

(Daniel et al., 1998) who reported thatpatients with tarsal tunnel syndrome using night splint or cast revealed a reduction of pain and parathesia when the ankle was placed in neutral position, while moving the ankle joint in dorsiflexion with full eversion or inversion ankle position increased intraneural pressure adding load on the flexor retinaculum and fibrous origin of abductor hallucis muscle leading to the nerve demyelination. **[6]**

The findings of the current study come in agreement with the results reported by **Trapman et al., 1999** who revealed that, tarsal tunnel pressure in normal cadaver specimens was minimal when the foot is in the neutral position which similar to our results which the pressure significantly increased from 20mmHg to 30 mmHg in both 20º plantarflexion with full inverted ankle position or 20º plantar flexion with full everted ankle position, which cause a delay in conduction time **[9].**

Our result was also supported by**(Kushkmar et al., 1988)**who conducted a study to evaluate various fibro-osseous tunnel pressures in normal subjects and they found that**,** the lowest tarsal tunnel pressure (4 to 6 mm Hg) when the ankle joint in the neutral which increased to 10 to 15 mm Hg during plantar flexion and 10 to 20 mm Hg during dorsiflexion of the ankle joint .**[18].**

However, the findings of the present study did not supported by the previous research study conducted by **(Allison et al .,2007)**to investigate pressure changes in medial and lateral planter nerves related to ankle positions on cadever **,** and they found that the combination of planterflexion and pronation led to higher pressure than neutral and dorsiflexionThis doesn’t correlate with our findings as ankle plantarflexion proved to be superior to dorsiflexion in reducing tibial nerve DL, this difference can be explained by 2 factors: the first factor is the difference between physiological properties of normal subjects and cadavers, the second factor is the combination between planterflexion with eversion increase sensitizing factor that may affect tibial nerve DL**[19]**.

The generalisability of these results is subject to certain limitations. For instance, the examiner who recorded all action potential data was not blinded to the subjects' ankle positions and I also found a limitation in this study was small sample size.

It was concluded that**,** neutral ankle position is the most convenient position for tibial nerve assessmentthus motor conduction velocity is advisable to be measured in a neutral ankle position, while prolonged 20° ankle may increase the risk of tarsal tunnel syndrome and patient suffering from pain or parathesia on the foot should avoid this position.

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