Original Research Article

The effect of external pressure on two point discrimination test and pain threshold in healthy individuals and clinically diagnosed patients of carpal tunnel syndrome

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Abstract

Background: Carpal Tunnel Syndrome is the commonest form of entrapment neuropathy which is the combination of symptoms and signs resulting from compression of the median nerve when it passes through the bony carpal tunnel, from forearm to palm. It is prevalent in 2.7 to 5.8 % of the general adult population. In this work we studied the difference in Pain Threshold and Two Point Discrimination test in CTS patients before and after application of pressure. **Methodology:** The study was conducted on sixty clinically diagnosed patients of Carpal Tunnel Syndrome. Two Point Discrimination Test was done on palmar aspect of tip of index finger of the right hand. It is studied before application of pressure, after 15 min of 150mm of Hg pressure application and after 15 min of rest on releasing the pressure. Pain threshold for electrical stimulation was also studied before and after applying pressure and after 15 min of rest. **Results:** The distance for two point discrimination was increased that is the ability to discriminate between 2 points is reduced and a highly significant difference was observed before and after application of pressure in both patients and in controls. There was a significant variation between the applications of pressure and after 15 minutes of rest on release of pressure in CTS patients compared to control and we observed that it was not coming back to normal in patients whereas it returned to normal in the subject. The pain threshold was decreased and highly significant difference was observed before and after application of pressure in both patients and in controls. It was also noted that the pain threshold was decreased and highly significant difference was observed before and after application of pressure in both patients and controls in similar manner but there was no significant difference in pain threshold on pressure application during and after 15 minutes of rest. **Conclusion:** Two point discrimination capacity is lowered and the pain threshold is reduced in the CTS patients. The median nerves of CTS patients are more susceptible to the hazardous and injurious effects of pneumatic tourniquet compression.

Key Words: Carpal tunnel Syndrome, Two Point Discrimination Test, Pain Threshold.

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INTRODUCTION

Carpal Tunnel Syndrome is the commonest form of entrapment neuropathy which is the combination of symptoms and signs resulting from compression of the median nerve when it passes through the bony carpal tunnel, from forearm to palm. Dull aching pain in hand especially after prolonged work and numbness in the median innervated parts of the hand are common symptoms of CTS patients. It is prevalent in 2.7 to 5.8 percentage of the general adult population[1]. The incidence rates of up to 276 cases per one lakh person per

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year have been reported, with a prevalence rate up to 9.2% in women and 6% in men. CTS is more common in females than in males, its occurrence is generally bilaterally with a peak age range of 40 to 60 years; although it occurs in all age groups[2].The Incidence of CTS is alarmingly increasing all over the world due to the increased use of computers and increased prevalence of obesity and diabetes mellitus[3,4].Many of the CTS cases finally ends up in Carpal tunnel releasing surgery, which is one of the most frequently done hand surgery. During the procedure, to achieve bloodless fields, pneumatic tourniquets are applied. Recommended safe limits of an upper arm tourniquet is 50-75mm of Hg above systolic pressure for 60 minutes[5-7]. In CTS patients the median nerves are already compressed because of which they are more vulnerable to the ischemic effects of tourniquet compression. In this work we studied the difference in Pain Threshold and Two Point Discrimination test in CTS patients before and after application of pressure and compared the changes with normal subjects.

MATERIALS AND METHODS

The study was conducted in the electrophysiology lab of the department of physiology, Krishna Institute of Medical Sciences, Karad, Satara, Maharashtra. The study was conducted on sixty clinically diagnosed patients of Carpal Tunnel Syndrome who were referred to the department for nerve conduction and on sixty age and sex matched healthy individuals who were selected from students and staff of this institution.This study was approved by the Ethics committee of Krishna Institute of Medical Sciences, Karad and the patients and subjects were informed the detailed procedure and written consent was taken.

Inclusion Criteria: Sixty Patients clinically diagnosed based on the symptoms and signs suggestive of Carpal Tunnel Syndrome are selected for the study. Sixty apparently healthy age and sex matched Students/staff of Krishna Institute of Medical Sciences, Karad, without any other illness and neurological abnormality are selected as subjects.

Exclusion Criteria: Patients with hypertension, h/o fractures, skin graft, skin diseases, cardio-vascular diseases, sickle cell anaemia, pregnancy, peripheral artery diseases, diabetes, CTS patients with symptoms of polyneuropathy or radiculopathy, any other marked systemic or local abnormality were excluded from the study.

Study procedure

- Two Point Discrimination Test was done on palmar aspect of tip of index finger of the Right hand of the subjects and the patients. It is studied before application of pressure, after 15 min of 150mm of Hg pressure application and after 15 min of rest on releasing the pressure.
- Pain threshold for electrical stimulation was also studied before and after applying pressure and after 15 min of rest.
- The stimulation was given, with the ring electrodes used for sensory nerve conduction studies, on the ring finger on the area of median nerve stimulation.
- Stimulation is given from 0mA onwards; increasing 2mA each time till the patient perceives pain.
- For the studies, Recorder and Medicare System (RMS Mark II) machine from Chandigarh (India) was used.

Statistical Analysis: Statistical analysis was performed using the software origin-8 (Origin LAB, Origin Lab Corp., MA, USA).

RESULTS

Two Point Discrimination: It was noted that the distance for two point discrimination was increased that is the ability to discriminate between 2 points is reduced and a highly significant difference was observed before and after application of pressure in both patients and in controls. After 15 minutes of rest it was compared with the initial reading and observed that it was not coming back to normal in patients whereas it returned to normal in the subject. Thus there was significant variation between application of pressure (A) and after 15 minutes of rest on release of pressure (C) in patients and that of control was not significant (table 1).

Pain Threshold: It was noted that the pain threshold was decreased and highly significant difference was observed before and after application of pressure in both patients and in controls. After 15 minutes of rest it was compared with the initial reading and observed that it was not coming back to normal in patients whereas it returned to normal in the subject. Thus there was significant variation between application of pressure (A) and after 15 minutes of rest on release of pressure (C) in patients and that of control was not significant. There was no significant difference between patients and controls, before and after application of pressure. But a significant difference was observed between patients and controls after 15 min of rest since the values were coming back to normal in controls on rest where as it is not in patients (table 2).

Table 1: Two Point Discrimination in Controls Versus CTS Patients.

		A Vs B		*p* value	A Vs C		*p* value	B vs C		*p* value
2 point discrimination (mm)	Patients	5.13±2.8	18.38 ± 7.4	<0.001***	5.13 ± 2.8	10.5 ± 5.1	<0.001***	18.38 ± 7.4	10.5 ± 5.1	<0.01**
	Controls	2.77 ± 1.2	7.52 ± 4.6	<0.001***	2.77 ± 1.2	3.2 ± 2.2	> 0.05ns	7.52 ± 4.6	3.2 ± 2.2	<0.001***

Before application of pressure (A), Immediately after 15 minutes of 150mm of hg pressure (B) and After 15 minutes of Rest on release of pressure (C).*** Highly significant, **Verysignificant, *Significant,Ns: Non significant

Table 2: Pain Threshold Parameters in Controls Versus CTS Patients

		A Vs B		*p* value	A Vs C		*p* value	B vs C		*p* value
Pain threshold (mA)	Patients	13.38± 6.9	6.25 ± 2.8	<0.001***	13.38± 6.9	8.13 ± 5.3	> 0.05ns	6.25 ± 2.8	8.13 ± 5.3	> 0.05ns
	Controls	19.0 ± 6.5	10.0 ± 4.6	<0.001***	19.0 ± 6.5	18.7 ± 6.2	> 0.05ns	10.0 ± 4.6	18.7 ± 6.2	<0.001***

Before application of pressure (A), Immediately after 15 minutes of 150mm of hg pressure (B) and After 15 minutes of Rest on release of pressure (C).*** Highly significant, ** Verysignificant, *Significant,Ns: Non significant

DISCUSSION

We studied the changes happening in two point discrimination since it is a very reliable physical parameter which reflects any change in nerve conduction.It is defined as the minimum distance by which two stimuli can be separated to be perceived as twoseparate points. The size of the receptive field for light touch can be measured by this test. Its magnitude changes from place to place on the body and it is smallest where tactile receptors are abundant. Points on back for instants must be separated by 65mm or more before it can be distinguished as separate points, while on the fingertips twostimuli can be resolved if they are separated by as little as 3mm. Touch is carried by Aβ andAδ fibres diameter of which is 5-12 and 3-6µm and conduction velocity is 30-70 and 15-30 m/s. They are more susceptible to hypoxia and intermediately susceptible to pressure.In the present study, the difference between the values in controls and CTS patients before the application of pressure were highly significant (*p* value = <0.0001). This shows that the ability for two point discrimination was reduced in patients of CTS compared to the normal subjects.As the capillary circulation slows and the intrafunicular pressure rises, the incarcerated nerve fibres get compressed and their nutrition becomes impaired. In this respect the large myelinated fibres are known to be more susceptible and to suffer earlier than the thin finely myelinated or non-myelinated fibres. Repeated attacks of ischemia destroy the larger fibres in the nerve trunk leaving only the smaller fibres capable of conducting impulses. Fibres which carry the sensation of touch are larger fibres which are more susceptible to ischemia and pressure destruction of which causes decrease in the ability for 2 point discrimination[8,9].After 15min of 150mm of Hgthe values in controls was 7.52± 4.6 and that of CTS patients was 18.38±7.4, the difference between the two and the difference between before and after application of pressure were statistically highly significant (*p* value = <0.0001).This is because in controls the electrolyte and metabolic changes causes temporary stopping of few fibres and slowing of conduction. The primary factor accounting for observed functional abnormalities in human nerves compressed by the pneumatic tourniquet is ischaemia. The reduction in nerve conduction observed in the present study during 15 min of arterial occlusion may be predominately due to other factors besides oxygen lack, for the latter condition was reached early in the ischemic state. Moreover, it is difficult to conceive of the ATP store in large myelinated nerves, of the type studied in this investigation, being materially depleted during so short a period of hypoxia. A possible mechanism could have been an alteration in extracellular-intracellular electrolyte concentrations, such as a build-up of extracellular potassium, originating from the nerves themselves and from the surrounding muscles and other tissues. Such a situation would have led to a relative inactivation of sodium conductance, followed by a progressive reduction in nerve conduction velocity. Resulting changes in the concentration of metabolites in extracellular fluid (an increase in lactic acid and carbon dioxide, a decrease in pH, etc.) could also have contributed to the observed alterations[10-14]This in turn causes the increase in distance for two point discrimination i.e. decreased ability to discriminate between two points.In patients of CTS the application of external pressure aggravates the process of deterioration. Because of ischemia and venous congestion more and more fibres get affected which is reflected as decreased ability for two point discrimination[8]. After 15min of restthe difference between values in controls and CTS patients were statistically highly significant (*p* value = <0.0001). The difference before the application of pressure and after 15 min of rest on releasing pressure was significant in CTS patients and insignificant in normal subject which says that the reduced values were coming back to the normal stage in controls whereas the changes were still persisting in patients of CTS. This is because the changes in controls were transient and temporary which easily reverted back to near normal on releasing pressure. But in CTS patients due to persistence

of pathology even long after release of pressure the two point discrimination values were not coming back to normal. The venous congestion and intrafunicularedema takes more time to resolve in patients of CTS because of which two point discrimination values takes more time to revert back to normal pre-pressure levels.In the present study the pain threshold was significantly reduced in patients of CTS (p value = <0.05), which was further lowered after the application of pneumatic tourniquet and was not reverting back to normal after 15min of rest on releasing pressure.As the capillary circulation slows and the intrafunicular pressure rises, the incarcerated nerve fibres are compressed and their nutrition impaired to a point when, they become hyper excitable and start to discharge spontaneously. In this respect the large myelinated fibres are known to be more susceptible and to suffer earlier than the thin finely myelinated or non-myelinated fibres. Fibre dissociation and the imbalance in fibre activity originating in this way gives rise to pain[15-18]. Thus the occurrence of paraesthesia and pain mark the appearance of troublesome pathology, the essential lesion at this stage being caused by an impoverished intrafunicular blood supply and mild intrafunicular pressure both of which should be rapidly corrected when the circulation improves[8,9,16-18]. But this does not happens because as we apply tourniquet the venous congestion increases and intra funicular pressure also increases, this further increases the hyper excitability and releasing of inflammatory and pain mediators lower down the pain threshold more.Even after release of pressure the venous congestion is corrected very slowly and the intra funicular pathology remains. Because of decreased venous return the inflammatory mediators are not washed away properly. All these things results in lowered pain threshold which is not going back to the pre pressure values in CTS patients.

CONCLUSION

Our study suggest that two point discrimination capacity is lowered and the pain threshold is reduced in the median innervated portion of the palm in CTS patients.This could be one reason for dull aching pain in the median innervated portion of the palm in CTS patients. Our study also shows that the median nerves of CTS patients are more susceptible to the hazardous and injurious effects of pneumatic tourniquet compression which is evident by the significant difference in the physical parameters such as two point discrimination and pain threshold after application of pressure and not going back to normal after 15min of rest.So the upper limit of duration and pressure in pneumatic tourniquet application should be less than that of normal individuals.However large-scale study is required to establish new safe standards for pneumatic tourniquet application.

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