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Original Article

Relationship between nerve conduction studies and risk of fall in elderly

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ABSTRACT

Introduction

Redundancy in sensory input is common in the elderly either because of aging alone or because of sub clinical disease processes and results in impairments in distal proprioception and strength that hinder balance and predispose them to falls. Aim of study is to identify the risk of falling in elderly persons and determine the relationship between the risks of fall to the changes of NCS.

Methods

Using purposive sampling 18 elderly subjects reported healthy were selected and underwent BBS, TUS& TUG. MNCS, SNCS and Late responses were performed using standard techniques. Descriptive statistics (Mean, SD and SE) were done and t test to compare mean value of variable between two groups. To check association between two attributes chi-square test was used and Fisher's Exact test for more precise "p" value (for only 2 by 2 table).To know the correlation among variables Pearson's correlation co-efficient(r) was used.

Results

Study sample was 18 subjects inclusive of 14 Males and 4 Females BBS mean value was 52.22 ± 3.70. TUS mean value was 21.33ms In TUG test the mean value was 12.30 ± 3.2. In the age group comparisons there was minimal reduction in amplitudes and minimally prolonged conduction velocities were noted but no significant changes in latencies.

Conclusion

On Berg Balance Scale all subjects were in the non – faller category. TUS and TUG were significantly altered in all subjects. NCS changes that have been observed were age related. TUS had strong association with Posterior Tibial Nerve Amplitude and with Sural Nerve Amplitude.

INTRODUCTION

Aging –"an inevitable consequence of time". Aging may be defined as a progressive deterioration of physiological function, an intrinsic age-related process of loss of viability and increase in vulnerability to diseases[1]. Each system of our body is affected by aging including nervous system. In Peripheral Nervous System, the average motor neuron loss from the second to tenth decade is approximately 25%. The decrease in motor unit number is accompanied by an increase in size or innervations ratio. There is an age-related preferential large fiber reduction than small fibers and this loss is estimated to be approximately 5%. Axonal nerve conduction velocities of all motor nerve fibers are uniformly slowed with aging. This suggests that with aging, the alterations in conduction velocities could reflect a variety of changes in the nerve fibers, such as a dropout of the largest fibers, a segmental demyelination, and a reduced intermodal length.

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Increase in the risk of fall is a potential problem in elderly. A number of researchers have defined a fall as 'an involuntary displacement of the body resulting in the subject finding himself on the ground'[2]. This covers the two essential elements in injurious fall: (1) an involuntary motion by the individual; and (2) the consequences of hitting the floor, or other object, unintentionally as a result

A fall is usually caused by a complex interaction among intrinsic factors, extrinsic factors and situational factors. In Intrinsic factors, Somato-sensation is an important input for balance control. Deterioration in the function of the somatosensory and motor systems occurs with ageing, and has been found to be related to poorer static standing balance [3–5]. Activities involving functional balance control, such as bending or lifting, have been found to have no or only poor association with vibration sense [6]. The performance of the above tasks was also not related to the strength of the leg muscles [6], but walking speed, chair rising and stair climbing were[7, 8].

In addition to maintaining balance while performing daily activities, the ability to counteract unexpected externally induced imbalancing forces, i.e. reactive postural control, is also essential for independent living. This aspect of balance control can be tested by inducing body sway in standing subjects by sudden support surface translation [9, 10]. Changes in postural responses following support surface translation were found to occur with ageing and could possibly lead to delayed, insufficient or inappropriate attempts at balance recovery [11–15]. However, in addition to older adults, altered reactive postural responses have also been observed in healthy young adults who were experimentally deprived of normal somatosensory function, and in patients with vestibular dysfunction or peripheral neuropathy [13, 14, 16, 17]. Limited contraction capacity in the gastrocnemius, and smaller muscle response amplitudes to support surface perturbations, have also been observed in functionally unstable older adults compared with stable older adults [13]. Thus, the control of reactive balance is also under the influence of the function of the sensorimotor systems.

In the absence of diagnosable disease, visual, vibratory and proprioceptive in put are commonly diminished in the older adult [18]. Peripheral neuropathy is common in elderly and results in impairments in distal proprioception and strength that hinder balance and predispose them to falls.[19]. Redundancy in sensory input may be compromised either as a result of aging alone or as a result of sub clinical disease processes to which elderly people are particularly prone.

Aims and Objectives

To identify the risk of falling in elderly persons

To determine the relationship between the risks of fall to the changes of Nerve Conduction Studies (NCS).

To find the associated factors or co-morbidities related to the risk of falls in elderly persons

METHODOLOGY

This was hospital based cross sectional study and human research ethical committee approval was obtained. Subjects were patients or relatives who did not have complain in the lower limbs as well as in balance.

Table 1 Inclusion & Exclusion criteria

Inclusion Criteria
Adults of both genders, 60 or more than 60 years of age,
Exclusion Criteria
<60 years Cognitive impairment Any Musculo-skeletal problem that affects balance Loss of vision or Uncorrected Reduced Visual Acuity Diseases/Conditions which predispose falls Use of 4 or more medications Using Medications that hamper balance

Purposive Sampling technique was used and the subjects who were willing to participate were interviewed for medical history inclusive of medications, if any and underwent a routine clinical examination. Eighteen (18) subjects were selected for the study in accordance to the following inclusion and exclusion criteria (table no. I) and written informed consent was obtained after explaining the details of NCS and about physical functioning tests.

After collecting demographic data of every participant, height and weight of the subjects were measured and their Body Mass Index (BMI) was calculated (table II). All participants were enquired about the history of fall that they encountered in the last 12 months. The subjects underwent Berg Balance scale (BBS), Timed Get up and go test (TUG) and Timed Unipedal Stance (TUS) as prescribed in their original forms. Subjects were allowed to perform these tests with or without their footwear on as per their convenience. Subjects were asked to rest as needed between the different functional tests and between trials of the same test. All the tests were performed under the supervision and thus the subjects' safety was strictly ensured.

Table 2 Descriptive Statistics

	Mean ± SD
Age	69.06 ± 6.50
BMI	24.31
BBS	52.22 ± 3.70
TUS	21.33±18.47
TUG	12.30 ± 3.2
Total Subjects (n) – 18, Male – 14, Female – 4	

After finishing the physical function tasks NCS were done by using RMS-II of Recorders and Medicare Systems Inc, Chandigarh, India. Subjects were positioned in Lying or Half Lying with Knees supported and ankles kept in neutral for MNCS. The position was altered as per requirement of studies (prone in H reflex studies, side lying in sural nerve studies). Skin was prepared before placing the recording electrodes and all universal aseptic precautions were taken while performing the NCS. All the NCS and Late responses were done using standard stimulation and recording parameters of the concerned tests.

Motor Nerve Conduction Studies (MNCS)

Each motor nerve was stimulated at least at two points along its course and compound muscle action potential (CMAP) was recorded. Using a standard measuring tape the distance between the distal and proximal stimulation points (cathode to cathode) were recorded. Latency, amplitude and conduction velocity was calculated using the equipment software. Latency was measured at initial negative deflection and amplitude was measured from peak to peak amplitudes.

MNCS was done for bilateral Peroneal and Posterior Tibial nerves

1. Peroneal Nerve, which was stimulated at Ankle and at neck of Fibula, and CMAP was recorded from Extensor Digitorum Brevis

2. Posterior Tibial, which was stimulated at Medial Malleolus and Popliteal fossa and CMAP was recorded from Abductor Hallucis

Sensory Nerve Conduction studies (SNCS)

SNCS was done antidromically for Sural nerves bilaterally with the use of surface electrodes. Cathode was placed near to the lateral malleolus and anode of recording electrode was placed at a minimum of 4 cm distance along the course of the nerve. Latency was measured at initial negative deflection and amplitude was measured from peak to peak amplitudes.

F waves

F waves were recorded from distal muscles by stimulating the appropriate nerve. Recording electrode is placed in a belly tendon montage similar to MNCS.

H reflex studies

The active surface electrode is placed at the distal edge of calf muscle and the reference electrode on Achilles tendon. Cathode is kept proximal to anode to avoid anodal block. Latency was measured at initial negative deflection and amplitude was measured from peak to peak amplitudes.

Data Analysis

The data were fed into computer in Microsoft Excel Sheet. For statistical analysis SPSS (Statistical Package of Social Science) package version 12 was used. Descriptive statistics of Mean, Standard Deviation (SD), and Standard Error (SE)) was done. t test was used to compare mean value of variable between two groups. To check the association between two attributes, chi-square test was used and Fisher's Exact test is taken for more precise "p" value (for only 2 by 2 table).To know the correlation among variables Pearson's correlation co-efficient(r) was taken.

RESULTS

In this Cross sectional hospital based study the total study sample was 18 subjects which was inclusive of 14 Males and 4 Females (78% and 22% respectively). Demographic data was described in Table – II.

None of the subjects reported any fall in the last 12 months but 3 of them reported to have a fear of falling. For statistical calculation purpose, the subjects were divided in to two groups by age, i.e. less than 70 and 70 and above. Less than 70 age group comprised 11 subjects and 70 and above group comprised 7 subjects.

BBS mean value was 52.22 ± 3.70. Even the scores for every subject was above 45 which makes all of them into non faller category. When calculated for subjects who are less than 70 the score was 53.73 ± 3.25 and the same was 49.86±3.23 for the age group of 70 and above which showed there is a reduction in balance in the 70 and above age group and p value of correlation was .026, which was of statistically significant.

TUS mean value was 21.33 with standard deviation of 18.47. However 8 subjects were able to stand for less than 10 seconds which makes them to be grouped under faller category. Age group comparison showed reduction in the duration (24.91 ± 16.05 for less than 70 and 15.71± 21.846 for 70 and above) but was statistically insignificant (p value - 0.318)

In TUG test the mean value was 12.30 ± 3.2. Only 4 subjects were able to finish test within the prescribed time for their age group. During age group comparison the mean value for less than 70 was 11.36 ± 3.0 and the same was 14 ± 3 for the 70 and above age group. The p value or age group correlation was 0.090, which was statistically insignificant.

Nerve Conduction Studies

NCS values are as in Table – III and Late response Table - IV.

Table 3 Nerve conduction study

	Latency	**Amplitude**	**Conduction velocity**
Peroneal	4.44 ± 0.76	7.75 ± 2.30	43.78 ± 5.60
Posterior Tibial	6.09 ± 1.20	9.00 ± 3.62	42.6 ± 4.32
Sural	1.85 ± 0.86	8.20 ± 8.0	36.77 ± 4.27
Total Subjects (n) – 18, Male – 14, Female – 4			

Table 4 Late Responses

	Mean±SD
F Waves	
Peroneal	47.60 ± 9.65
Posterior Tibial	52.17 ± 8.66
H Reflex	32.65 ± 6.6

In the age group comparisons, there was minimal reduction in amplitudes and minimally prolonged conduction velocities were noted however, latencies did not change significantly. All the above changes were statistically insignificant between the age groups. Posterior tibial nerve the persistency of F waves were around 9 / 10 but in Peroneal nerves the F waves were either inconsistent or reduced in persistency.

The nerve conduction parameters, i.e., latency, amplitude and conduction velocity were correlated with the timed unipdeal stance test and TUG test. Statistical analysis showed that TUS had a significant correlation with the Posterior Tibial nerve amplitude (p value 0.019) and also with the Sural Nerve amplitude (p value 0.015). In addition, Sural nerve latency had a moderate correlation with TUS (p value 0.060) – Table 4. None of the other nerve parameters showed any statistical significant correlation with those three tests.

Table 5 Cross table of Timed Unipedal Stance with Sural Nerve

			Sural					
			Latency		Amplitude		Conduction Velocity	
		No. of Subjets	Normal	Abnormal	Normal	Abnormal	Normal	Abnormal
Timed Unipedal Stance	Normal	10	9	1	7	3	5	5
	Abnormal	8	4	4	1	7	3	5
p value			**.060**		**.015**		.596	

Table 6 Cross table of Timed Unipedal Stance and Posterior Tibial Nerve

			Posterior Tibial					
			Latency		Amplitude		Conduction Velocity	
		No. of Subjets	Normal	Abnormal	Normal	Abnormal	Normal	Abnormal
Timed Unipedal Stance	Normal	10	*	10	5	5	5	5
	Abnormal	8	*	8	0	8	4	4
p value			.(a)		**.019**		1.000	

While correlating both Peroneal and Posterior tibial nerves F wave minimum latencies and H reflex minimum latency with the timed unipdeal stance test and TUG test it was found that a highly significant correlation at the 0.01 level between the H reflex minimum latency and TUG test (p -.662).

DISCUSSION

One of the leading risk factor associated with the elderly is risk of falls and the number of researchers has studied various factors responsible for this increased risk. The present study aimed to find out the association of changes in nerve conduction as related to the risk of falls.

The mean value of BMI for our population was 24.31. The World Health Organization (WHO) expert consultation, 2004 states that the appropriate BMI for Indian population is 23 to 25 Kg/m^2[(20)]. With an increase in age, the body fat mass also increases due to the accumulation of more internalized fat deposits and decrease in lean body mass[21]. A recent study on Obesity among elderly in Chandigarh by H. M. Swami et al., also concluded that prevalence of overweight (BMI >25) exists in about one third elderly population, with higher prevalence in female[22]. In our study also, the BMI values were minimally increased and our study population falls in the upper normal limits.

It has been reported that a single or multiple fall increase the risk of fall. All subjects reported that they did not have a single fall in the last 12 months. Cummings SR et al., have concluded that elderly subjects often do not recall falls that occurred during specific periods of time over the preceding 3 to 12 months[23]. But in another study it has been noted that no such difference occurs, and the elderly subjects with normal cognitive function, can recall falls.

A study reported that a single fall often results in a fear of falling, which leads to a loss of confidence in one's ability to perform routine tasks, restriction of activities, social isolation, and increased dependence on others[24]. In our study, out of 18 subjects 3 subjects reported about the fear of fall.

In the study about the Incidence and Risk Factors for Developing Fear of Falling in Older Adults, the prevalence of fear of falling increases with age and having two or more falls, feeling unsteady, and reporting fair or poor health status were independent risk factors for developing fear of falling[25]. Out of 3 subjects who reported fear of fall, 2 subjects were 80 years of age and above.

During the performance of physical functional tests, there was no strict consideration about the footwear. It was left to choice of the subject as it is. In a recent study, it was reported that there was no difference existing between scores on the balance tests with shoes on versus off [26].

The mean value for BBS and TUS were within normal limits for all subjects but mean values TUG was lower. Study also showed correlation of BBS to age. Subjects, on the BBS was well within age matched norms[27, 28]. Thus, subjects did not come under the category of risk of fall based on this test. However, age related decline was evident on comparison between the groups and statistically significant for BBS.

Most of subjects on TUG test and TUS showed definite changes. Only 4 subjects could finish TUG test within the prescribed age matched time limits. We used the Meta analysis values estimated by Bohannon for this purpose [29].

The cut of value in the elderly population for TUS was put to be at 10 ms as per Richardson JK et al[30] and only 10 subjects were able to complete the test as per this value. Further, between the group there was statistically significant reduction in TUS as age increases.

For all subjects, the mean value of NCS for both motor and sensory nerves the latencies were prolonged, amplitudes were reduced and conduction velocities were slowing as compared to the Indian adult values[31]. The above findings are suggestive of age related changes. It has been reported that the conduction velocity begins to decline after 30 – 40 ears of age but the values normally change by less than 10 m/s at the 6th or even in the eight decade [32,33,34]. In the absence, symptoms of neuropathy in subjects, with the decline of values, can assume that redundancy in peripheral nerve function could be the reason.

Out of 18 subjects, for 5 subjects we could not elicit the SNAP for the Sural nerve. In those 5 subjects, for 2 subjects who were 80 and above years of age we could not elicit the SNAP bilaterally, thus in total, SNAP could not be elicited for 7 limbs.

Mean value of F waves for Peroneal and Posterior tibial nerves were minimally prolonged and the H reflex latency was prolonged.

In present study, the TUS and the TUG tests identify whether the subjects were at the risk of fall or no. So we tried to find the relationship between NCS and TUS and TUG tests. TUS had a significant association with the amplitude of Posterior tibial nerve (p value 0.019). TUS also had a significant association with the Sural nerve amplitude (p value 0.015) and a moderate association with the latency of Sural nerve (p value 0.060).

Since this kind of study, i.e. finding the relationship with the risk of fall and NCS, is relatively unexplored largely, we found some association between the NCS with the functional tests that assess the risk of fall. In the absence of any significant symptoms in the elderly, we can assume that there may be relationship between the abnormal values of NCS with the risk of fall identified in some physical functional tests. Therefore, we conclude that the abnormal values NCS may help in identifying the risk of fall and they may have a relationship with falls in elderly. There is apparently a very limited review on the subject of alteration in NCS with the risk of fall and or amongst the fallers.

CONCLUSIONS

- Average BMI of all our subjects was in the upper normal limits.
- On BBS all the subjects were in the non – faller category.
- The NCS changes that have been observed are age related.
- The Sensory Nerve Action Potential (SNAP) for Sural nerve could not be elicited in 5 subjects (7 limbs), out of 5 subjects SNAP was bilaterally absent in 2 subjects and both of them were more than 80 years of age.

In assessing the relationship of NCS to tests which categorize the subjects on faller and non faller,

- TUS had strong association with Posterior Tibial Nerve Amplitude
- TUS had strong association with Sural Nerve Amplitude and weak association with Sural Nerve Latency

Limitations of our study:

- Limited Sample Size.
- Having subjects with history of fall would have helped further.
- Fear of fall was assessed subjectively.

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