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Contribution of Corollary Discharge in Elderly People with Peripheral Proprioception Deficit

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ABSTRACT

Introduction: Corollary discharge which is otherwise known as sense of effort is assumed to be the internal signal that arises from centrifugal motor command and that influences perception of movement. This provides proprioceptive cues during muscular activity, apart from the peripheral proprioceptive inputs. With ageing the peripheral proprioception acuity decreases.

Aim: To examine the contribution of sense of effort to compensate the deficit in peripheral proprioception.

Materials and Methods: Proprioception acuity was tested using an electronic goniometer by doing passive and active reposition test in the knee joint. A total of 20 elderly subjects with normal passive proprioception angle error (control group) and 10 elderly subjects with abnormal passive proprioception angle error (study group) were studied. Paired and unpaired t-tests were used to analyse the results.

Results: Between the groups passive error angles were statistically different ($p<0.05$). Subjects who had abnormal passive proprioception error did not show abnormal active proprioception error.

Conclusion: Active proprioception error angles are smaller than passive angle errors. An active proprioception error angle is not affected even when passive proprioception angle error is affected. The results suggested that, the sense of effort does compensate in the elderly for loss of peripheral proprioception.

Keywords: Clinical tests, Kinaesthetic, Neurology, Rehabilitation

INTRODUCTION

Proprioception includes the sensibility of motion and tension in skin, muscles, tendons and joints. It provides the immediate experience of our body [1]. The primary receptors for proprioception or kinaesthesia are muscle spindles. Other organs are located in muscle, tendons, and joints particularly pacinian corpuscles. These respond to pressure, tension, stretching or contraction of muscle fibers. These receptors help in conscious and non conscious monitoring of movements in extremities and trunk. They also help in forming motor and sensory programs of automatic movements. The acuity of these receptors is tested as a part of motor system evaluation. The receptor function is tested for their ability to sense movement and specific joint position. These motion position sense are usually tested together by passively moving a part and noting the subjects ability to recognise direction and amount of movement, and position of joint in space. This method of assessment of proprioception is done based on knowledge of peripheral receptors only. Such evaluations only give a picture of the acuity of the peripheral receptors. Recent studies have found a contribution of the sense of effort in producing proprioceptive cues, required to hold the limb against the gravity [2-4]. Sense of effort is associated with central origin derived from the motor command.

Active position sense, passive position sense, passive motion detection threshold and passive motion direction detection are commonly used methods of assessing proprioception [5]. As mentioned earlier passive proprioception testing will be a reflection of peripheral proprioceptor function while active repositioning or proprioception test will have additional information on central motor programs or sense of effort. Passive movement testing preferred over active tests, though active tests are functionally relevant.

Decline in proprioception with increase in age is documented in various studies [6-10]. Generally, humans have ability to compensate deficit in one modality of sense with other available sensations. We assumed that, as proprioception does not arise solely from peripheral proprioceptors but also from centrally generated motor commands, individual should be able to compensate for peripheral proprioception acuity with the help of sense of effort. However, such contribution or compensation by sense of effort is not clear from the literature. Hence, the study was conducted with the aim to examine the contribution of corollary discharge (sense of effort) to proprioception in the elderly with peripheral proprioception deficit.

MATERIALS AND METHODS

An observational study with convenience sampling was conducted in an OPD of university teaching hospital between 2007-2008. The study was approved by the Ethics committee. Individuals in the age group of 55 years to 75 years were screened for inclusion criteria. Knee joint was used for proprioception assessment. As it is one of the complex joint with major ligamentous support with strong proprioceptive feedback mechanisms. It is one of the joint commonly referred in proprioception related studies [5,6,11-13]. Individuals with: 1) no history of knee pain; 2) no deformities in the knees, 3) no recent injuries/surgeries around the knee were considered for inclusion in the study. Individuals with history of diabetes, severe osteoarthrosis of the knee as graded by Kellgren-Lawrence grading system [14], and presence of neurological problems which can limit proprioception were excluded from study. Subjects were included by convenience sampling. Selected individuals were tested for their passive and active proprioception of the knee. Right leg was used irrespective of the dominant leg as limb dominance may not influence proprioception acuity [15,16]. Proprioception was tested using reposition test, in which the subject was asked to reposition the limb to the test position, without a visual clue. The angle error was reported as a measure of proprioception acuity [5,17,18]. Earlier literature reported a mean absolute angle error for knee in passive testing as 4° (SD 3.4°) [10,19]. Based on the 95% CI of this angle error, values above 5.5° were considered to represent passive proprioceptive deficit. Subjects were tested with passive proprioception testing followed active repositioning test.

An electronic goniometer with the Phenix USB, version 8, biofeedback was used to measure angle error. The goniometer, like any other standard goniometer, consisted of two arms. A potentiometer attached in the electrogoniometer's axis measured the degree of movement occurring at the knee joint. This angle was displayed in the monitor, connected to the electronic goniometer.

Passive joint angle reposition test was done with the subjects dressed appropriately, such that the lower limb of the subject is exposed from mid thigh level. The subject lay in left side lying with the right leg on top. The right lower limb was placed on the re-education board with a sheet under the leg and feet to reduce friction while the examiner moved the tested lower limb. The electronic goniometer was aligned at the knee, with the axis as the lateral mid tibiofemoral line.

Vision of the subject was occluded using opaque glasses in order to prevent them any visual feedback. Subject was asked to relax the leg while the examiner moved the leg passively. The examiner extended the knee from an angle of 90° of flexion. As acuity of joint proprioceptors, like the muscle spindle, depends on the degree of deformation, an angle below 60° was chosen and kept constant for all the subjects. The subject was given five seconds to feel the position of the knee. The leg is taken back to 90° of flexion and moved again into extension while the subject was instructed to say 'stop' when they feel the knee joint has reached the initially positioned angle. The difference between the examiner positioned angle (test angle) and the repositioned angle was used to calculate the degree deficit or the angle error. This procedure was repeated three times and the values across the three repetitions were averaged to obtain the angle error.

Active angle reposition test was done in high sitting without changing the goniometer alignment as placed in the earlier test. The subjects, with vision occluded with opaque glasses, were asked to raise the leg into extension from 90° flexed position till the examiner asks to stop at a particular angle (below 60° of excursion) and subjects were asked to remember that position. Then subjects were instructed to take the leg to the starting position, and raise the leg again to the point it was raised previously. This test was also repeated for three times. The angle error was calculated as a mean of the three angle errors from three repetitions of the test.

Thirty subjects were included in the study, in which 10 subjects (study group) had passive proprioception deficit and 20 (control group) had passive proprioception error within normal range. The mean angle error between passive and active proprioception was compared within and between the study and control group using t-tests with open stat program. Alpha for all the testing was fixed at 0.05.

RESULTS

The [Table/Fig-1] shows the profile of the participants in the study. The age group was not statistically different between the control group and study group. The [Table/Fig-2] shows the mean angle error for passive and active repositioning tests in the control and study group. The angle error in control group was not statistically different between active and passive testing. The difference between the angle errors in the study group was statistically different.

Variables	Control group	Study group
Age mean (years, SD)	59.15±3.32	58.3±3.71
Sex ratio, men:women	9:11	4:6

[Table/Fig-1]: Details of subjects.

Groups (n)	Control group (20)	Study group (10)	Between the group p-value[a]
Passive testing Mean error (SD)	3.31±1.31	7.82±1.69	0.001
Active testing Mean error (SD)	3.26±1.59	2.36±1.58	0.15
Within group p-value[b]	0.91	0.001	

[Table/Fig-2]: Comparison of passive testing error angle and active testing error angle between control and study group.
* p-value[a]-unpaired t-test; p-value[b]–paired t-test

DISCUSSION

The study supports the contribution of sense of effort to proprioceptive deficit in elderly. Earlier studies confirmed the contribution of sense of effort in joint position and movement sense [2,20,21]. Passive proprioception angle errors were different from active proprioception angle errors, as noted in several previous studies [19,20,22,23]. These findings reinforce the notion that both passive and active testing is necessary while testing proprioception.

Out of the 30 elderly subjects, only 10 subjects showed a decline in passive proprioception. In these subjects, no significant difference was observed in the active acuity. These results support our hypothesis that while there is a decrease in the peripheral proprioceptors acuity, the contribution from sense of effort does not decrease in the elderly people. Researchers have reported the importance of sense of effort in proprioception acuity; however, they have not commented on presence of normal active proprioception in those with passive proprioception deficit [6,24].

While testing proprioception a few subjects reported that it was easier to understand and perform in the passive testing than active testing. This was obvious when elderly subjects required more number of trails for understanding the active test, than passive reposition test. We observed few subjects demonstrating poorer acuity in active testing than passive testing, in first trial, which improved with the third trail of active reposition test. These findings indicate presence of a learning process improving joint position acuity when tested actively.

LIMITATION

One limitation of the study was that, all the subjects were not studied at the same point of time during the day so diurnal changes might have influenced our results. Another notable limitation was the smaller sample size. Active proprioception acuity also depends on muscle fatigue [25]. It was also noted that active proprioception acuity was poorer in those subjects who have travelled long unaccustomed distance prior to testing. Muscle fatigue could be a potential reason for the high standard deviation in the findings. Fatigue related injuries in sports was attributed to impaired proprioception leading to inappropriate placement of leg [26].

This study indicates the important contribution of sense of effort to proprioception. These findings may be significant to rehabilitation professionals. During assessment, a proprioception deficit, as might occur in an individual with sensory loss, can easily be masked by the subject if there is an active muscle work. The concept of sense of effort can be used to rehabilitate individuals with a proprioceptive loss.

CONCLUSION

Sense of effort contributes for peripheral proprioception and helps in compensation of the loss. Hence, mere absence of passive proprioception may not be relevant for clinical testing. Active proprioception should be tested to understand the compensation present in the patients with proprioception loss.

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