Original Article

Physiotherapy and Occupational Therapy Journal
Volume 5 Number 3, July - Sept 2012

A Comparative Study between Elders with and without Knee Osteoarthritis on Quadriceps Strength, Prporioceptive Acuity and Balance

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Abstract

Objective: The study was done to assess the balance function in elderly with knee osteoarthritis along with quadriceps strength and prprioceptive acuity (joint position sense).

Methods: The study was observational type with 30 subjects in group 1 with osteoarthritis knee and 30 subjects in group 2 without any known history of osteoarthritis of knee joint. The subjects were measured for quadriceps strength, prprioceptive acuity, static balance using mCTSIB and functional balance using timed Up and Go test. The test scores were compared using student's t test.

Results: The study showed a statistically significant difference for all the variables studied such as quadriceps strength, prpioceptive acuity (joint position sense), modified CTSIB score and TUG scores between the groups.

Conclusion: The elderly adults with knee osteoarthritis have deterioration in quadriceps strength, proprioceptive acuity, static balance and functional mobility.

Key Words: Osteoarthritis; Postural control; Ageing and functional mobility.

Introduction

Balance is a complex biologic function dependent upon sensory inputs through visual, tactile-proprioceptive, and vestibular system. Sensory input is processed within the nervous system eliciting a restorative response coordinated among extremity and axial muscles.[1]An inevitable accompaniment of the aging process for many adults is the restriction in their ability to move independently within the context of constantly changing task demands and environmental context.[2] Greater postural sway and an increased incidence of falls observed in elderly suggest that older individuals may be slower in detecting and correcting postural disturbances.[3]

Persons with knee osteoarthritis (OA) have been found more likely to report difficulty with physical functioning than persons without knee OA.[4] As the prevalence of OA increases with age and aging is associated with decreasing physiological functions, the combination has a major health implication.[5] It has been suggested that proprioception declines with age and is further impaired in elderly with knee OA. Poor proprioception may contribute to functional impairment in knee OA.[6] Those with OA and older adults with lower limb arthritis are at an increased risk of falling due to deficits in neuromuscular system.[7] This is particularly apparent at the knee joint, one of the most commonest sites to be affected.[5]

Pain had been documented to affect quadriceps function. Nociceptors and other receptors in and around the joint can have flexor excitatory and extensor inhibitory

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(Received on 20.04.2012, accepted on 24.06.2012)

actions. At knee, these receptors are likely to excite hamstrings and inhibit quadriceps.[8] O' Reilly et al, demonstrated low quadriceps strength in individuals with knee pain than those without pain; and also reported decreased muscle activation.[5] Limited researches have evaluated the impact of knee osteoarthritis on balance in elderly. Few studies, all utilizing force platforms to measure postural sway have been undertaken in patient population, revealed deficits in postural control compared to asymptomatic subjects.[9, 10, 11]

So it is necessary to study the changes in muscle strength, proprioceptive function and balance performance in elderly with knee osteoarthritis as these changes may contribute to decline in function as well as other complications such as falls. In this study it was hypothesized that the elderly with knee osteoarthritis will display deterioration in quadriceps strength, proprioceptive acuity, static balance and functional mobility.

Methods

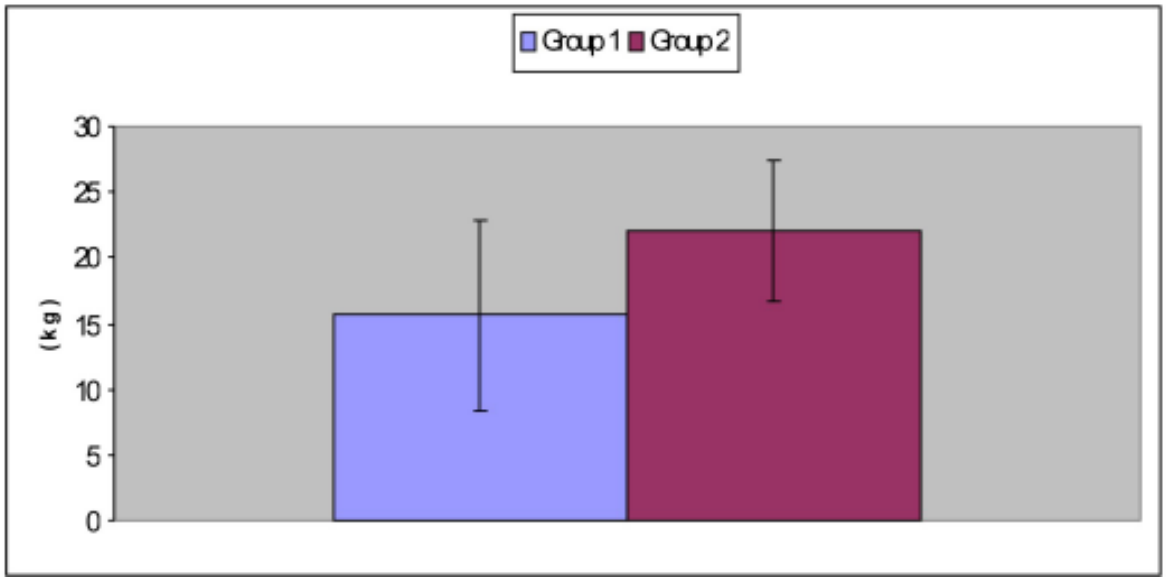
A sample of convenience of 60 community dwelling older adults, 60 to 70 years of age took part in the study. The sudy consisted of

Table 1: Comaprison of quadriceps strength, joint position sense, mCTSIB and TUG between group 1 and 2.

Variables	Group 1 (n=30)	Group 2 (n=30)	t-value	p-value
	Mean+ S.D	Mean+ S.D		
Quadriceps Strenght(kg)	15.64+ 7.22	22.05+ 5.31	3.91	0.05
JPS1(25^0)(Absolute error)	7.61+ 0.55	2.95+ 0.22	7.71	0.01
JPS2(45^0)(Absolute error)	8.05± 3.20	2.86± 1.02	8.45	0.01
JPS 3(60^0) (Absolute error)	8.90+ 3.05	3.10 + 1.39	9.45	0.01
mCTSIB(seconds)	114.67+5.73	117.43 =3.22	2.29	0.05
TUG(seconds)	11.25+1.29	9.90+0.74	4.93	0.01

mCTSIB-Modified test for sensory integration of balance.
TUG-Timed Up and Go Test

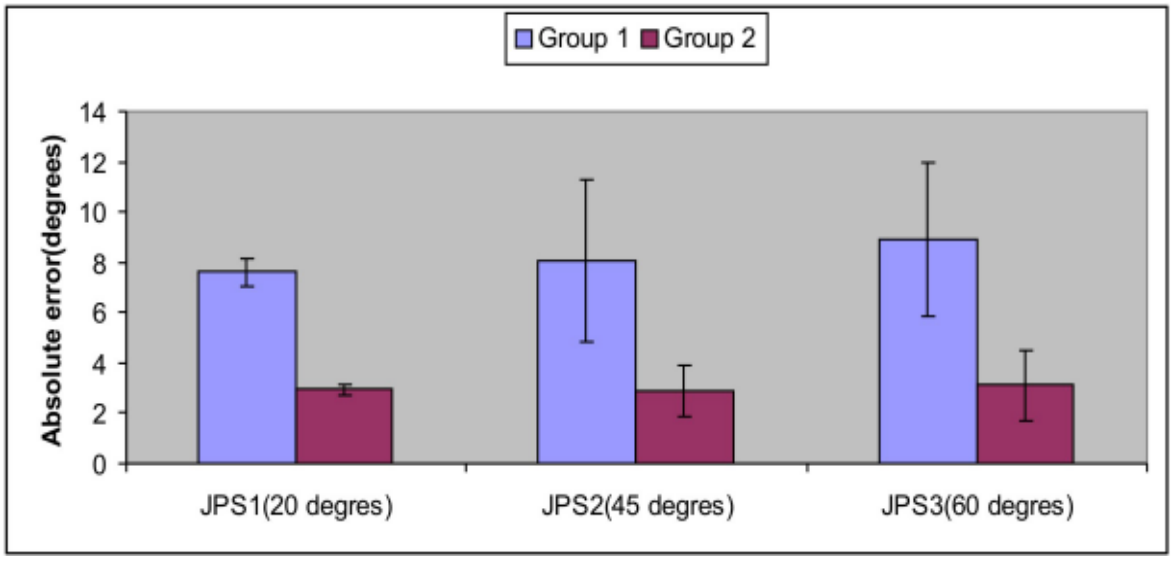
Figure 1: Comaprison of quadriceps strength between group 1 and group 2



two groups , group 1 consisted of 30 elderly with OA of knee and group 2 consisted of 30 elderly without known history of OA of knee. The study design was observational type. The study was approved by research and ethical committee of ISIC Institute of Rehabilitation Sciences, New Delhi.

The subjects were recruited from OPD of Indian Spinal Injuries Centre,New Delhi and from the free geriatric health check-up camp organized at the ISIC Institute of Rehabilitation Sciences, New Delhi.Subjects were recruited on the following criteria ,age 60 years and above, able to follow commands, study after signing an informed consent. The study was explained in detail to the participants. Following this, the subjects were assessed on the first day of their visit, for the isometric strength of quadriceps, followed by proprioceptive acuity assessment of knee joint. The subjects were assessed for static balance and functional mobility on the second non-consecutive day to eliminate the confounding effects of fatigue. Data for the isometric quadriceps strength and proprioceptive acuity was obtained in the group 1 (OA group) from the arthritic limb and in the group 2 (control group) from the randomly chosen limb (by lottery method).Equipment used were,

Figure 2: Comaprison of joint position sense between group 1 and 2



diagnosed with unilateral osteoarthritis of knee joint using clinical and radiological (ACR) criteria for diagnosis of knee osteoarthritis,[12]ndependent in ADL's and for group 2 subjects were without history of OA of knee. Subjects with intraarticular steroid injections, severe medical condition precluding safe testing, coexisting lower limb joint pathology, head trauma, neurological disease,visual impairment, limb or spinal fractures, persistent symptoms of vertigo, light headedness and unsteadiness, total knee arthroplasty, diaetes mellitus and history of falls were excluded.

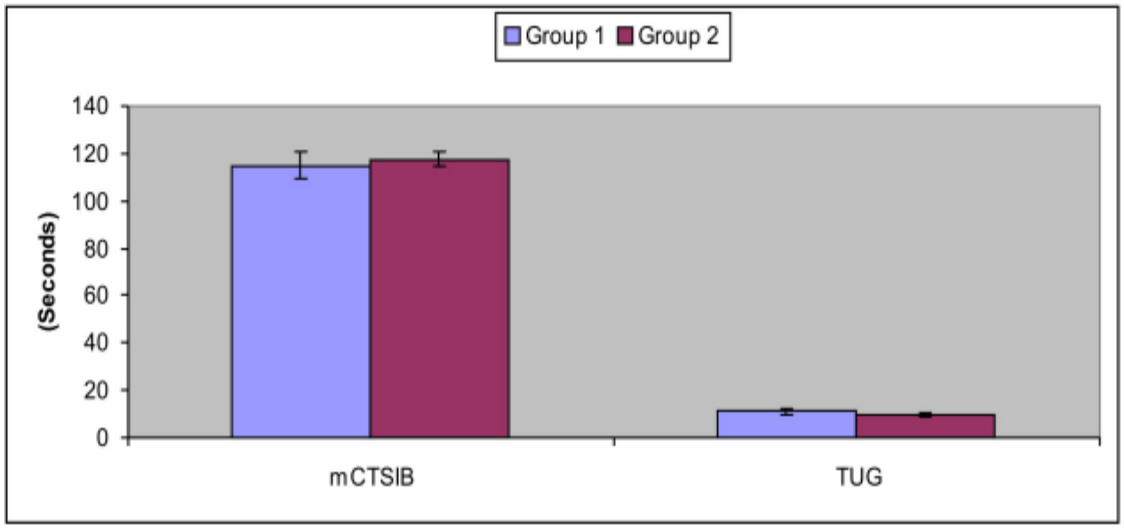
Demographic data was collected from the subjects who met the inclusion criteria of the quadriceps table, strain guage, continuous passive motion (CPM) device, air splints for ankle and thigh, medium density polyfoam (52.5 cm x 52.5 cm x 10.6 cm)stop watch and goniometer (360°).

The method used in present study to measure muscle strength was proven for its reliability and validity by Edwards et al.[13] For isometric quadriceps strength measurement, the subject sat on the quadriceps chair, with hips and knees flexed to 90°.One end of the strain gauge was connected just above the ankle pad over the lever of quadriceps table and the other end of the strain guage was attached to the back unit of the chair giving a horizontal link of pull. Each subject was asked

to push as hard as possible against the ankle pad by the chosen limb to try to straighten the leg.Restaring straps were used at thigh,hip and trunk. Subjects were allowed to practice maximum contraction and were given sufficient rest before the actual strength testing trial.Three strength testing trials were administered for each patient, with 1 minute rest between them. During the rest intervals, subjects were instructed to breathe out to prevent Valsalva maneuver effects. The maximum voluntary contraction (MVC) was taken as the highest value of three trials.[14]In the present study, the measurement of proprioceptive acuity, has been determined by passive-passive method,[15] which is considered to be a pre-requisite for measuring joint position sense clinically.[16] Tsang et al have reported that passive knee repositioning test produces highly repeatable data, with ICC=0.90.[17] Proprioceptive acuity measurements were done with subjects in shorts , they were made to lie supine with the chosen limb on the CPM device.To neutralize the cutaneous sensations air splints were used in thigh and foot, and subjects were blind folded to prevent any visual input. After fixing straps, the CPM device was adjusted so that the axis of the device was in line with the subject's knee joint. The knee joint was passively moved from its starting position (0 degree of knee flexion) to one of the predetermined angles (JPS1-25°, JPS2-45°, JPS3-60°) at a speed of 2 degree per second. The knee joint was rested at the target angle for 10 seconds (same duration for all the trails) by the investigator, and the subjects was instructed to remember the position of the knee joint. This was considered to be the first practice trial. The knee was then brought back to different randomly assigned angle between 10°-15° from the original starting position and rested for 10 seconds. This was followed by bringing the knee again to the target angle (as in practice trial 1) and rested for 10 seconds. The subject was again asked to remember the knee position. This was considered to be the second practice trial.[18] Total 2 practice trials were given to the subjects prior to final assessment. After the completion of the practice trials, the knee was again flexed with subject instructed to stop the machine with hand held remote to identify the target angle. The absolute difference between the presented angle and the perceived angle was recorded as the absolute error for the predetermined angle. Three readings were taken, and absolute error was calculated for each trial, and then the average absolute error was computed for each predetermined angle for the subject's knee.[19]

On the second test session, the subjects were first assessed for static balance using modified CTSIB balance test. All subjects were tested for each of the four conditions in modified

Figure 3: Comparison of mCTSIB and TUG score between group 1 and 2



CTSIB balance test. All the tests were done barefoot. The trials were timed using a stopwatch. Time was stopped during a trial and recorded if: (a) subject deviated from the initial crossed arm position, (b) subject opened eyes during 'eye closed' trial condition, or (c) subject moved feet (took a step) or required manual assistance to prevent loss of balance. A trial was considered successful if the subject was able to maintain the starting position independently for a period of 30 seconds in each condition. A maximum of three trials were permitted for each condition, each lasting for 30 seconds. Trials were performed until the subjects either: (a) successfully maintained the starting position for an entire 30 seconds, or (b) completed three, 30 second trials to the best of their ability. The score was averaged for each condition for the number of trials performed; which gave the condition score, and the average of all the conditions was summated to obtain the total score for the test. Prior to testing in each condition, a demonstration was provided to the subjects. The test was administered with the conditions in same order each time. Subjects were told that each trial would last for 30 seconds.[20]After completion of the static balance assessment, the subjects were provided a period of 5 minutes of rest (if required). The subjects were assessed for functional mobility using 'timed up and go'(TUG) test which ia basic test for functional mobility test for elderly with an inter-rater reliability of ICC=0.99. The subjects were instructed to move from a seated position in a chair to a standing position, walk 3 meters (10ft) at a normal and safe pace, turn around, walk back to the chair, and sit down. The timed up and go test was measured with a stop watch. The subjects were given a practice trial, followed by 2 timed trials. The test began with each subject sitting, back against the chair, arms resting on the lap, and feet just behind the distance marker on the floor. Subjects were instructed as follows "on the word 'go' stand up, walk comfortably and safely upto the cone on the floor, walk around the cone, come back and sit all the way back into your chair". They were informed that the trial would be timed. Timing began on the word 'go' and ended when subject's back rested against the chair upon returning. A practice trial was performed, followed by 2 recorded trials. Data obtained during the 2 recorded trials were averaged for use in data analysis.[14]

All four tests took approximately 40 minutes time to administer. The quadriceps strength testing took 4 to 5 minutes, proprioceptive acuity testing took 20 minutes, static balance assessment took 5-6 minutes and timed up and go took 4 to 5 minutes for completion.Data analysis were performed using SPSS software. A student's t-test was used to compare isometric quadriceps strength, proprioceptive acuity, static balance and functional mobility between group 1 and group 2.The significance level was set at p d" 0.05.

Results

The mean+ s.d of age of group 1 was 64.20+ 2.71 years and for group 2 was 64.43+2.97 years. There was a statistically significant difference for all the variables studied such as quadriceps strength, prpioceptive acuity (joint position sense), modified CTSIB score and TUG scores between the groups(table 1). The mean+ s.d of quadriceps strength of group 1 was 15.64+7.22 kg and for group 2 was 22.05+5.31kg(table 1 and figure 1). The mean+ s.d f of JPS1-25^0,absolute error was 7.61+ 0.55^0, JPS2-45^0,absolute error was 8.05+ 3.20^0 JPS3-60^{0,} absolute error was 8.90+ 3.05^0 in group 1 and in group 2 the mean+ s.d of JPS1-25^0,absolute error was 2.95+ 0.22^0, JPS2-45^0-,absolute error was 2.86+ 1.02^0, JPS3-60^0,absolute error was 3.10 + 1.392^0(table 1 and figure 2). The mean+ s.d of mCTSIB in group 1 was 114.67+5.73 seconds and in group 2 it was 117.43 +3.22 seconds and the mean+ s.d of TUG for group 1 was 11.25+1.29 seconds and for group 2 was 9.90+0.74 seconds.(table 1 and figure 3)

Discussion

In this study, the group of elderly with knee OA has displayed decreased quadriceps strength, compared to the age matched controls this finding is in accordance with reporting from Hurley et al.[22] The possible factors contributing to the deficit could be inadequate activation of muscles, joint pain and effusion.It has been reported that the articular damage may stimulate articular mechanoreceptors, evoking abnormal sensory information, which decreases voluntary activation.[22] Pain is also known to affect quadriceps function.[5] According to the pain adaptation model, the activity of the agonist muscle has been found to be decreased by pain, even when it does not arise from the muscle itself; also there has been found to be a small increase in the level of activity of antagonist. As a consequence of these changes force production, the range and velocity of the movement of the affected part are often decreased.[23] Nociceptors and other receptors in and around the joint can have flexor facilitatory and extensor inhibitory actions. Thus at the knee, these receptors are likely to excite hamstrings and inhibit quadriceps muscle.[24] Quadriceps function is also believed to be affected by coexisting effusion. Knee effusion has been found to stretch the joint capsule[25], and increase the intrarticular volume.[26] Because of this increased volume, there is an increase in pressure, accompanied by distension of capsular structures. Type 1 mechanoreceptors are believed to be activated by such change in the joint and are considered to mediate inhibition by reflexively inhibiting lower motor-neurons supplying quadriceps muscle.[27]

This study compared the proprioceptive acuity between arthritic and control groups, and found significant difference between the groups. The arthritic group has shown larger errors when compared to normal healthy controls. Proprioceptive acuity has been found to be affected at all predetermind angles, chosen for the study. Some previous studies have given similar results.[22,28] The possible explanation for such results can be loss of mechanoreceptors around the joint.[29] Larger errors were however shown at 60^{o} angle of knee flexion. Eventhough there have been studies suggesting critical role of joint receptors in proprioception and motor control.[30, 31]

Age has been shown to affect the balance physiology.[32,33] On comparing the static balance scores, the arthritic group was found more unstable, which has been confirmed by previous studiy.[22]The study used mCTSIB for evaluating static balance because elderly have been demonstrated to have difficulty balancing, when sensory inputs contributing to balance are reduced, so that they have less redundancy of sensory information.[34] The challenging stance conditions offered by the test placed greater reliance on peripheral proprioceptors,[35] and since arthritic individuals have larger poprioceptive deficits as compared to the normal elderly controls,[22,36] they were found more unstable, while performing the test. On comparing the functional mobility in both the groups, the arthritic group demonstrated altered functional mobility, that is- they took significantly longer time to accomplish the task.Aging has been shown to affect quadriceps strength,[35,37] so does arthritis.[38,39] The altered function by the arthritic group could be because of the combined effects of aging and the pathology.

The study suggests screening for balance deficits in elderly with OA and providing balance re-education. Future studies are recommended, which include a bigger sample group,studies on genders separately, studying effect of balance training protocols on functional performance of subjects with OA knee.

Conclusion

The data obtained from this study shows that the elderly with knee osteoarthritis have decreased quadriceps strength, proprioceptive acuity, static balance and functional mobility,

when compared to healthy elderly controls. Hence the hypothesis that "elderly with knee osteoarthritis will display deterioration in quadriceps strength, proprioceptive acuity, static balance and functional mobility" holds true.

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