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Comparison of Knee Joint Position Sense, Balance and Physical Function in Patients with Knee Osteoarthritis and Age-Sex Matched Normals

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Abstract: ***Objective: To understand about knee joint position sense, balance and physical function in patients with knee Osteoarthritis. Methods: 25 subjects with grade II osteoarthritis and 25 age- sex matched normals participated. Joint position sense was assessed with inclinotrac digital sensors at 30 and 45 degrees of knee flexion, balance withCTSIB using a Balance Master; Physical Function by WOMAC scale.Results:Knee joint repositioning error was (39.48 ± 6.80) and (32.47 ± 1.78) and (52.80 ± 7.29) and (46.73 ± 2.39) at 30 and 45 degrees of knee flexion, Sway velocity difference of (1.53) and (1.04) and WOMAC score for Osteoarthritis patients and matched normals respectively were statistically significant with p value (<0.005). Conclusion: Joint position sense, balance and physical function were affected severely in the osteoarthritis group.***

Keywords: Osteoarthritis, Knee, joint position sense, balance, physical function

1. Introduction

Osteoarthritis (OA) is one of the most prevalent musculoskeletal conditions of aged population and is one of the leading cause of and disability in this demographic worldwide.[1]Osteoarthritis, also known as Degenerative Arthritis, degenerative joint disease, is a degenerative musculoskeletal disorder caused by inflammation, breakdown, and the eventual loss of articular cartilage in the joints.[2]

This disease most commonly affects the middle-aged and elderly, although younger people may be affected because of injury or overuse.[3] Incidence of knee osteoarthritis is rising by increasing average age of general population. It has been found that about 13% of women and 10% of men aged 60 years and older have symptomatic knee osteoarthritis.[4]The prevalence of OA increases with age and generally affects women more frequently than men.[5]Age, weight, trauma to joint due to repeating movements in particular squatting and kneeling have been found to be common risk factors for knee osteoarthritis.[6] Many countries in Asia are ageing rapidly.[7] It has been estimated that the percentage of people aged 65 years and over in Asia will more than double in the next two decades, from 6.8% in 2008 to 16.2% in 2040.[8]

It has been observed that most of the OA disability burden is attributable to the hips and knees.[9]The knee is the most frequently affected joint of the lower limb.[3] The affection is mostly bilateral but in some cases, may be unilateral.[3] Being a weight bearing joint, the affection of the knee joint seriously affects mobility and hence the functional capabilities of the patient. In fact, OA is a precipitating diagnosis for more than 90% of the increasing number of total hip or knee joint replacement operations being undertaken worldwide.[9]Patients with knee osteoarthritis report pain and difficulty with functional activities such as prolonged sitting, ascending and descending stairs, walking, squatting, kneeling, rising from a chair and getting in and out of a car, leading to a loss of functional independence and reduced quality of life. Physical function depends upon many physiological parameters including muscle strength, sensory input from proprioception, visual and vestibular systems, intact balance mechanisms, range of motion and higher cortical function. Impairments in these parameters are likely contributors to disability.[10]

Knee osteoarthritis (OA) causes changes not only in the tissues within the articular cavity, but also the ligaments, tendons, and peri-articular tissues including the muscles.[11, 12]Also, the number of mechanical sensory receptors around the ligaments of knee joints with OA have been reported to be reduced when inspected histologically. Many aspects of the human body, such as the vestibular system, sight, proprioception, muscular strength, and cognition are related to the balance control, which is an important ability in everyday life.[13]Furthermore, it has been observed that falls and loss of balance most commonly occur during dynamic tasks such as walking, therefore, making it important that evaluation of balance incorporates testing procedures that reflect the dynamic nature of locomotor tasks.[14, 15]

Contradicting studies have been found in relation of proprioception deficit with knee pain. Also, some studies have demonstrated no association of osteoarthritis of knees and proprioception deficit. Thus, one of the objective of this study was to understand about proprioception in patients with knee osteoarthritis and then compare it with age-sex matched normals. To the authors best knowledge, there have been no studies comparing the joint position sense, balance and physical function in patients with grade 2 knee osteoarthritis and age-sex matched normals.

2. Aim and Objectives

The aim was to study joint position sense, balance and physical function among patients with Knee Osteoarthritis. Objectives of the study were to assess and compare

proprioception, balance and physical function among knee osteoarthritis patients and age – sex matched normals.

3. Materials & Methods

The study was conducted in Navi Mumbai, India.The study methodology was approved by the ethics committee at D.Y.Patil School of Physiotherapy, D.Y Patil University and was carried out at D.Y.Patil Hospital and Research Centre. The subjects were explained about the procedure and consent was taken for the same. The instrument used for assessing Joint Position Sense was inclinotrac digital sensors while for balance, Clinical test of Sensory Integration on Balance (CTSIB) using a Balance Master was used. The Physical Function of both the groups was assessed by the WOMAC scale.The study was conducted for a period of 4 months. 50 subjects between the age group of 45 - 60 were selected by the method of convenient sampling with 25 knee osteoarthritis patients and 25 age – sex matched normals. Inclusion criteria for the subjects were that they were diagnosed case of grade 2 osteoarthritis with no recent lower extremity fracture or injuries and no neurological deficit. On completion of data collection, the data was analyzed.

4. Results

It was found that the women with knee osteoarthritis showed a higher repositioning error than their age – sex matched normals. The difference in the joint repositioning error, balance as well as function between the two groups was found to be statistically significant. (Table 1)

Table 1

Joint Position Sense (JPS)			
	Mean ± S.D (deg)	P Value	Significance
EXPERIMENTAL			
Active 30	39.48 ± 6.80	<0.0001	Extremely Significant
Passive 30	30.48 ± 0.17		
Active 45	52.80 ± 7.29	<0.0001	Extremely Significant
Passive 45	45.41 ± 0.17		
CONTROL			
Active 30	32.47 ± 1.78	<0.0001	Extremely Significant
Passive 30	30.47 ± 0.14		
Active 45	46.73 ± 2.39	<0.0001	Extremely Significant
Passive 45	45.50 ± 0.15		
EXPERIMENTAL v/s CONTROL (30 deg)	**Mean ± S.D (deg)**	P Value	Significance
Active – Experimental	39.78 ± 6.8	<0.0001	Extremely significant
Active – Control	32.47 ± 1.78		
EXPERIMENTAL v/s CONTROL (45 deg)	**Mean ± S.D (deg)**	P Value	Significance
Active – Experimental	52.80 ± 7.29	0.0006	Extremely significant
Active – Control	46.73 ± 2.39		
BALANCE			
	Mean	P Value	Significance
FIRM SURFACE			
Eyes Open: Experimental	0.34	0.4091	Non-Significant
Eyes Open: Control	0.32		
Eyes Closed: Experimental	0.4	0.5137	Non-Significant
Eyes Closed: Control	0.37		
FOAM SURFACE			
Eyes Open: Experimental	0.69	0.3143	Non-Significant
Eyes Open: Control	0.64		
Eyes Closed: Experimental	1.53	<0.0001	Extremely Significant
Eyes Closed: Control	1.04		
WOMAC SCORE			
	Mean (%)	P Value	Significance
Experimental Group	40.71	<0.0001	Extremely Significant
Control Group	9.91		

5. Discussion

The study was designed to compare the Knee joint position sense (JPS), Balance and Physical Function in patients with knee osteoarthritis and matched normals. A total of 50 subjects were taken, 25 each in Experimental and Control groups. The mean age of the subjects in the study was 58.5 years. Out of which 22 were females and 28 were males. On statistical analysis, active JPS when compared to passive JPS, a difference / deviation of 9.78 degree at 30 degree and

7.39 degree in at 45 degree was seen in the experimental group as compared to no deviation by the control group. This shows that active JPS in Experimental group had a repositioning error when compared control group.

JOINT POSITION SENSE: Proprioception is defined as the afferent information arising from the internal peripheral areas of the body that contribute to posture control, joint stability, and several conscious sensations.[23] Proprioception information from afferent sensory organs (mechanoreceptors) reaches the central nervous system (CNS), where it is processed and integrated with other signals to regulate neuromuscular control and properly maintain joint stability.[24] Proprioception plays a vital role in maintenance of joint stability of the knee via the sensorimotor system.

Role of proprioception in sensorimotor system: Numerous types of afferent sensory organs (mechanoreceptors) found in various knee joint structures: Ruffini endings, Pacinian corpuscles, Golgi tendon organ (GTO) like endings, free nerve endings, muscle spindles and GTOs. The signals from the Ruffini endings may contain information about static joint position, intra-articular pressure, and the amplitude and the velocity of joint rotations[25] while Pacinian corpuscles function as pure dynamic mechanoreceptors.[26] Towards the end range of joint motion, the GTO like endings become active [27] and free nerve endings become active when the articular tissue is subjected to damaging mechanical deformations, [28] Muscle spindles are oriented in parallel with the skeletal muscle fibers encoding the event of muscle stretch and the rate of passive elongation.[29] In contrast, GTOs are aligned in series within the musculotendinous junctions encoding the stretch on the tendon generated by the total force of a given muscle during contraction.[24]Thus muscle spindles and GTOs help in regulating muscle tone and joint stiffness, especially during dynamic tasks.[30]

Several (knee OA related) factors have been hypothesized for their possible casual role in impaired proprioceptive accuracy in knee OA patients, in particular muscle weakness and impaired mechanoreceptors. It has been hypothesized that dysfunctional articular mechanoreceptors, which are prevalent in severe osteoarthritic knees, [31, 32] may lead to impaired proprioceptive accuracy. Also, atrophy muscle weakness may decrease muscle spindles sensitivity, thereby possibly impairing proprioceptive accuracy.[33, 34, 35]

In a previous study on Joint Proprioception on Osteoarthritic knees, it showed that patients with osteoarthritis had poorer joint position sense. It was thought that some loss of proprioception may be expected as a result of laxity of the capsule and ligaments caused by bone height and loss of cartilage. Also, possible release of lytic enzymes around the joint may cause damage to the receptor end-organs within the capsule. Though loss of joint position sense may be a consequence of the process of osteoarthritis, it might equally be a primarily factor in the initiation of joint damage.[36]Regardless of the severity of OA or amount of muscle atrophy, quadriceps weakness is common among individuals with OA , suggesting that this muscle weakness is due to the failure of the nervous system to fully activate available muscle fibers.[37] The proprioception deficits were not related to the severity of OA, and decrease proprioception was present in the contralateral limb of individuals with OA, suggesting a deterioration of the sensorimotor system.[38, 39] Recent evidence support that the loss of muscle strength and development of OA are the results of muscle dysfunction due to long-term reduction of physical activity and loss of mechanoreceptors rather than the 'wear and tear' of the articular cartilage as, age-matched individuals with regular exercise demonstrate better strength, function, balance and proprioception.[40]

Clinical testing of Sensory Integration on Balance (CTSIB) was done using a balance master to assess the sway velocity of the Experimental and Control group with eyes open and eyes closed on a firm and a foam surface.

On statistical analysis, the sway velocity was higher in the Experimental group than the control group in all the four components (Firm surface – eyes open & closed; Foam surface – eyes open & closed) showing that Balance was affected more in the Experimental group with the difference being statistically significant on foam surface with eyes closed.

BALANCE: Balance is a complex function involving numerous neuromuscular processes.[41, 42, 43]Balance impairments are associated with an increased risk of falls and poorer mobility measures.[44] Balance control is dependent upon sensory input from the vestibular, visual and somatosensory systems.

Knee osteoarthritis is a common chronic degenerative disorder, affecting 30-40% of the population by the age of 65years.[46] It has been found to be a major cause of locomotor disability and has been implicated as a risk factor for falls in older adults.[47, 48] The presence of knee OA may accelerate the deterioration of balance control systems or compound the effects of aging. However, studies that evaluated balance in people with knee OA were found to be limited.[50, 51, 52] Hassan et al.[51] and Wegener et al.[52] demonstrated increased postural sway in subjects with knee OA when standing on a firm surface in both AP and lateral directions.

The potential mechanisms that may be responsible for the balance deficit observed within the OA group could be deficit in lower limb proprioception and muscle strength that are associated with knee OA[53, 54, 55] and thus may be postulated as a cause of impaired balance. Pain associated with the osteoarthritic knee may also play a role in balance impairments.[56] The presence of pain may reflexively inhibit the muscles around the knee, which could compromise effective and timely motor responses in postural control. Moreover, pain may result in reduce loading of the affected joint[57], potentially jeopardizing an individual's ability to maintain their center of mass within the base of supports. Hassan and colleagues[58] found pain to be remarkable predictor of sway in their osteoarthritic sample. As we know, pain is one of the most common symptoms seen in knee osteoarthritis patients, thus, pain could be a contributing factor to an increased sway velocity of the sample. Knee flexion contractures, reduction in quadriceps activation and strength[53, 54, 59, 60] joint oedema, usually related

with OA could also be recognized as possible causes for the balance deficit as it shifts the individual center of mass.

The decreasing activity level associated with knee OA also has been also shown to be partially responsible for the balance impairment.[65] These deficits, with the ageing process, may culminate in greater impairments in balance in the patient population, compared with their age-matched and healthy counterparts. Control of balance is important in all postures and situations, both static and dynamic. Postural sway is often used as a measure of static standing balance.[66, 67, 68] Thus this can explain the increase in the sway velocity of the patients with osteoarthritis on a foam surface compared to a firm surface as higher demands are placed on all the above factors to maintain balance on a dynamic surface. On statistical analysis, experimental group showed a higher physical function affection of 40.71 % as compared to the control group with 9.91 %.

6. Physical Function

Some studies have explained poorer proprioception in those with greater disability as assessed by the WOMAC physical function score.[69] As the quadriceps strength is important for functional knee stability, [70] impairment of quadriceps sensorimotor function will make the patient feel weak, unstable, and lower their confidence. As a consequence, mobility impairment and performance of ADL will lead to decrease functional independence.[71] A previous longitudinal finding explained that people with greater proprioceptive deficits were at increased risk of deteriorating physical function and more severe pain.[72] People may accommodate for (sub) conscious proprioceptive decline by adapting their behavior. Hence, impaired proprioception may also explain why people with symptomatic OA walk more slowly and with longer double limb stance to avoid risk of joint injury and prevent worsening of the disease.[73, 74]Also, in osteoarthritis, weakness of the quadriceps femoris muscle is known to cause knee pain and significant functional disability. This further leads to a decrease in their Quality of Life.[75] Earlier studies suggest that fear of falling in people with knee instability is a common consequences of knee OA and may contribute to poor functional outcomes of the disease. Increased fear of falling and poor balance is associated with decrease physical function.[76] This was confirmed with our study findings.

7. Conclusion

Joint position sense, Balance and Physical Function were affected severely in the osteoarthritis group as compared to their age-sex matched normals.

8. Acknowledgment

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9. Conflict of Interest

None

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