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Influence of generalized joint hypermobility on knee joint proprioception in asymptomatic healthy women

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Abstract
Knee joint proprioception is important to modulate the muscle activity, aid in neuromuscular control of knee joint position which eventually help in performance of activities of daily living. Hypermobility refers to joint range of motion that exceeds beyond the normal limits. Presence of hypermobility may have an effect on the knee joint which may in turn affect the alignment and stabilization function. The aim of this study was to determine the effect of generalized joint hypermobility on knee joint proprioception in asymptomatic healthy individuals. A cross-sectional study conducted in 60 participants. Of which, 30 asymptomatic healthy women with generalized joint hypermobility on the basis of Beighton score and 30 age matched healthy women in the age group of 18 to 25 years were selected. Knee joint proprioception was assessed in full weight bearing position using goniometer. Angle of error was calculated as the absolute difference between the target angle and the reproduced angle for target angle of 30 degrees knee flexion. The mean age of the participants in generalized joint hypermobility and control group was 21.47 ± 1.87 and 21.88 ± 1.9 years respectively. The comparison of mean values of angle of error between generalized joint hypermobility and normal subjects evaluated using unpaired t test was statistically significant (p = 0.000) with mean value of angle of error higher in generalized joint hypermobility group. Knee joint proprioception was impaired in generalized joint hypermobility women as compared to healthy women. Proprioceptive training should be incorporated in the individuals with generalized joint hypermobility to prevent any musculoskeletal injury.

Keywords: Proprioception, hypermobility, knee joint, proprioceptors, stabilization

Introduction
The knee joint, a complex multidirectional structure, withstand extreme weight bearing stresses during the performance of activities of daily living. In the normal healthy knee, static and dynamic stabilizers assist to oppose the high impact loads, maintain normal lower limb alignment and provide stability at the knee joint. The primary role of static stabilizers of knee that include ligaments, menisci and the joint capsule is mechanical in nature i.e. providing stabilization to the joint. These structures also play vital sensory role by detecting joint position and motion [1, 2]. Sensory afferent feedback from the receptors present in the capsuloligamentous structures projects directly into the cortex and help to mediate reactive muscle activity for dynamic restraint [3].

Proprioception is defined as 'the cumulative neural input to the central nervous system from mechanoreceptors in the joint capsule, ligaments, muscles, tendons and skin [3]. Proprioception comprises of mainly three components - sense of position, sense of movement and sense of force. Sense of position implies awareness of position of one's own limbs and the orientation of their body parts with respect to one another. Sense of movement is the ability to perceive both direction and velocity of movement and sense of force is the ability to estimate the amount of muscle work necessary for movement or to maintain the position of the joint against a resistance [4]. Stimulation of specialized nerve-endings or mechanoreceptors in the joint capsule and ligaments are responsible for these senses. [5]. Knee joint proprioception is important to modulate the muscle activity, aid in neuromuscular control of knee joint position which eventually help in performance of activities of daily living. Impairment in proprioception may lead to altered biomechanics and adoption of faulty joint positions. Performance of knee joint function in these altered position causes repeated microtrauma and further contribute to the development of degenerative joint diseases such as osteoarthritis [6].

Hypermobility refers to joint range of motion that exceeds beyond the normal limits [7]. It is defined as increased active or passive range of motion of a joint which exceeds that expected for an individual's age, gender and ethnicity [8]. Hypermobility may be localized to selective joints or can be present in multiple body areas (typically greater than five sites) and is called as generalized joint hypermobility (GJH). The presence of GJH may be asymptomatic or can also be associated with local or widespread musculoskeletal issues. These hypermobile joints may be prone to dislocations or soft tissue injuries resulting in acute pain and reduced physical function. Also, repetitive microtrauma may predispose to recurrent musculoskeletal pain and early joint degeneration [8, 9]. Presence of hypermobility may have an effect on the knee joint which may in turn affect the alignment and stabilization function. Hence, the aim of this study is to determine the effect of generalized joint hypermobility on knee joint proprioception in asymptomatic healthy individuals.

Materials and Methods

The study was conducted after obtaining approval from the Institutional Research Review Committee (IERC). It was a cross-sectional comparative study conducted in 60 participants. 30 asymptomatic healthy women with generalized joint hypermobility in the age group of 18 to 25 years were selected purposively and formed the experimental group. Subjects were categorized with generalized joint hypermobility on the basis of Beighton score. It is a nine – point scale and is based on the performance of five tests - bilateral and one active unilateral performance [10]. A minimum score of 4/9 has been considered as the cut off limit to diagnose person with GJH [11]. Subjects with history of any knee surgery, traumatic injury to knee or on steroidal injection were excluded from the study. 30 healthy women were age matched controls without generalized joint hypermobility and any history of pain, trauma or surgeries in both the lower extremities. Subjects were explained about the nature of the study in the language best understood by them. A duly signed written informed consent was taken from the subjects who were willing to participate in the study. Demographic data of the subject was noted.

Assessment of knee joint proprioception

Knee joint proprioception was assessed in full weight bearing position using goniometer. The test was performed in 30 degrees knee flexion. The fulcrum of the goniometer was placed at the lateral joint line of the knee joint of the dominant extremity with velcro straps. Then the contralateral limb was held approximately at 60 degrees of hip flexion with sufficient knee flexion for foot clearance. Participants were asked to fully extend the knee i.e. at 0 degrees at the starting position. They were asked to close eyes to prevent any visual cues. Then they were asked to bend the knee at their own pace to target angle of 30 degrees of knee flexion. Position was maintained for 5 second. They were then asked to return back to starting position. After a 5 second rest, they attempted to reproduce the previously attained target angle. Then, the target angle and angle reproduced was noted by the examiner. Angle of error was calculated as the absolute difference between the target angle and the reproduced angle for target angle of 30 degrees knee flexion. This position was held for 5 seconds. Three trials were reported and mean value was noted.

Statistical analysis

All statistical analysis was done using SPSS Statistics version 16.0. Descriptive statistics was used to calculate mean and standard deviation. Comparison of mean values of angle of error between generalized joint hypermobility and normal subjects was evaluated using unpaired t test. The level of significance was set at p value less than 0.05.

Results

In this study, there were total 60 subjects, of which 30 women were with generalized joint hypermobility and 30 were healthy females in the age group of 18 to 25 years. The mean age of the participants in generalized joint hypermobility and control group was 21.47 ± 1.87 and 21.88 ± 1.9 years respectively (Table 1). The comparison of mean values of angle of error between generalized joint hypermobility and normal subjects evaluated using unpaired t test was statistically significant (p = 0.000) with mean value of angle of error higher in Generalized joint hypermobility group. (Table 2).

Table 1: Demographic Data of the participants**.**

Variable	Generalized joint hypermobility group		Control group	
	N = 30		N = 30	
	Mean	Standard deviation	Mean	Standard deviation
Age (in years)	21.47	1.87	21.88	1.9

Table 2: Comparison of mean values of angle of error between generalized joint hypermobility and control group.

	Generalized joint hypermobility group	Control group	Significance
	Mean ± SD	Mean ± SD	p value
Angle of error (in degrees)	6.27 ± 1.03	2.14 ± 0.68	0.000

* p value is significant at < 0.05.

Discussion

Generalized joint hypermobility is characterized by hyper extensibility and increased laxity in multiple joints with or without any presence of chronic musculoskeletal problems. Proprioceptive mechanism at the knee joint plays a critical role in maintenance of joint stability, including sensation of both position and movements of joint, under dynamic conditions. Muscle and joint receptors are main primary sources for proprioception which are responsible for position and movement sense. Proprioceptive mechanisms effectively assist in coordination of complex movement patterns which are required for performance of activities of daily living. Proprioceptive function is very important to prevent any undesired movements like hyperextension and hyperflexion and hence plays a protective role in prevention of any musculoskeletal injuries.

In our study, it was observed that proprioception was impaired in women with generalized joint hypermobility as compared to healthy women. Our study was in consensus with study performed by Hall *et al.* in which they compared age

and gender matched 10 female cases with hypermobility syndrome and healthy individuals and reported that proprioception was impaired in cases with hypermobility [12]. This can be attributed to the hypermobility which is associated with laxity of ligaments and surrounding periarticular structures. In hypermobile subjects, the discharge of joint receptors which normally signals the amount of flexion or extension of the joint may be reduced. This results in these patients to perceive the joint to be more towards the mid position than it is objectively [13].

Impairment in proprioception may lead to abnormal stresses being placed on the joint which are repetitive in nature that can further cause joint receptor damage further affecting the proprioception. Hence, increased laxity at the knee joint contribute to diminished proprioception, renders the knee less sensitive to potentially damaging forces and at possible injury risk.

Conclusion

Knee joint proprioception was impaired in generalized joint hypermobility women as compared to healthy women. Proprioceptive training should be incorporated in the individuals with generalized joint hypermobility to prevent any musculoskeletal injury.

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