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Original Research Article

CORRELATION OF STATIC AND DYNAMIC BALANCE WITH KNEE PROPRIOCEPTION IN NORMALS

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ABSTRACT

Background: Human balance depends on coordinated integration of sensory input from somatosensory, vestibular and visual systems. Proprioception includes 3 components: sense of position, sense of movement and sense of force. Most of the injuries have the potential to decrease proprioception and subsequently balance. It is important to understand the relation between proprioception and balance in young adults. Thus this study aimed at co-relating static and dynamic balance with knee proprioception in Normals.

Purpose of the study: To understand the correlation of balance with knee proprioception.

Materials and Methods: Young asymptomatic adults (N=50),equal males (n=25) and females (n=25) between the age group of 18-30 years (mean age=21.2) were assessed for knee joint proprioception at 60^0 using universal goniometer, static balance using Balance Error Scoring System(BESS) and dynamic balance using Star excursion balance test (SEBT).

Result: There is a weak negative correlation [r = -0.3161(rt) and r = -0.1599(lt)] of knee joint proprioception error with dynamic balance and a weak positive correlation [r = 0.3358(rt) and r = 0.2912(lt)] of knee joint proprioception error with static balance error.

Conclusion: The study concludes that lesser the knee joint proprioception error better is the dynamic balance. And lesser the knee joint proprioception error lesser is the static balance error.

KEY WORDS: Static balance, dynamic balance, knee proprioception error, star excursion balance test, balance error scoring system.

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BACKGROUND

Balance is defined as the ability to maintain a posture for performing activities and counteract with conflicts and in other words maintaining body mass center in the domain of base of support. The presence and maintenance of normal balance of the body in many daily activities and during exercise is of great importance.

The sensory receptors that are found in joints, muscles, tendons provide input to the central nervous system (CNS) regarding tissue deformation and force.

The incoming information from the sensory receptors of body joints needs to be coordinated in the CNS in order to identify the body's position in space [1]. Proprioception can be described as sense of position, which is awareness of position of one's own limbs and the orientation of their body parts with respect to one another; sense of movement which is the ability to perceive both direction and velocity of movement and sense of force which is the ability to estimate the amount of muscular force that must be exerted to make movement or to maintain the position of joint against a resistance [2]. One of the preventing factors of joint injuries is the optimum relationship with surrounding environment, spatial perception and individual's awareness of his/her joint.

Static balance is the ability to maintain the centre of gravity within the base of support and keep the centre of pressure of the body as immobile as possible within the base of support.

Dynamic balance refers to a person's ability to move the centre of pressure in a given direction within the limits of stability [1].

Most of the injuries have the potential to decrease proprioception and subsequently balance. Hence it is important to understand the relation between proprioception and balance in young adults.

Thus the purpose of this study was to understand the relation between static and dynamic balance and knee proprioception.

MATERIALS AND METHODS

Approval for the study was taken from the institutional ethics committee and a written informed consent was taken from all the subjects. The study was a correlation study which was conducted at research laboratory of K. J. Somaiya college of Physiotherapy. 50 young asymptomatic adults (N=50), equal males (n=25) and females (n=25), within the age group of 18-30 years were enrolled. Subjects with any musculoskeletal disorders of the lower limbs, recent injury or trauma to the lower limbs, neurological conditions, foot abnormalities, vestibular disorders and subjects not willing to participate in the study were excluded. Each subject was assessed for knee joint proprioception error at 60p using goniometer, static balance using balance error scoring system (BESS) and dynamic balance using star excursion balance test (SEBT).

Assessment of knee joint proprioception: It was assessed in standing position. A goniometer with the fulcrum was placed over the lateral aspect of knee joint and tied with Velcro straps. The subject was asked to squat till his/her knee attained an angle of 60^0 and then asked to maintain it for 15 seconds. Subject was blindfolded to block visual input (fig.1, 2). After maintaining for 15 seconds, the leg was returned to 0^0 knee extension. The subject was then asked to return to the position perceived as the target and report. Each subject was made to perform 3 trials in order to obtain a realistic value of joint position sense accuracy and reliability. The absolute angle error of 3 trials was noted. Average of the 3 readings was noted [2].

Assessment of static balance: Static balance was assessed by Balance error scoring system (BESS) [3,4,6]. It is portable, cost effective and objective method. It includes 6 components each tested barefoot, eyes closed for 20 seconds each:

Double leg stance (feet together)

Single leg stance (non dominant foot)

Tandem stance (non dominant foot back)

Each was tested on firm as well as foam surface (fig.3,4). Total score of 0-60(lower scores indicate better balance and less errors).

Errors which were considered during BESS are as follows:

· Moving the hands off the hips.

· Opening the eyes.

· Step, stumble or fall.

· Abduction or flexion of the hip beyond 300.

· Lifting the forefoot or heel off the testing surface.

· Remaining out of proper testing position for greater than 5 seconds.

Assessment of dynamic balance: It was assessed by Star excursion balance test (SEBT) which is carried out on a grid of 8 lines [5]. The foot of the test limb was positioned in the center of grid. The subjects were told to reach as far as possible along the 8 lines in clockwise direction, lightly touch the line on the ground with the most distal part of reaching foot and return the reaching leg back to double leg stance, while maintaining single leg stance with other

Fig. 1: Starting position for assessment of knee joint proprioception.

Fig. 2: Assessment of knee joint proprioception at 60^0.

Fig.5: Star excursion balance test (SEBT) grid.

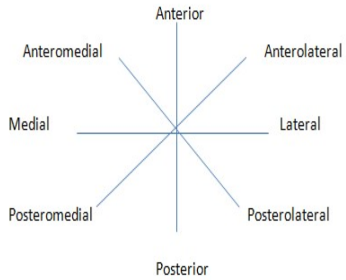


Fig. 3: BESS on firm surface.

Fig.4: BESS on foam surface.

Fig.6: SEBT- Starting position.

Fig.7: SEBT- Anterolateral direction.

Fig.8: SEBT- Posteromedial direction.

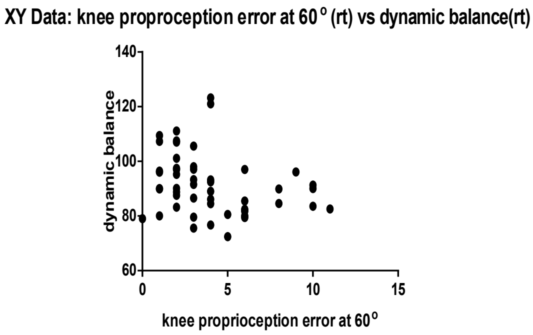
Fig.9: Anteromedial direction.

leg in center of grid. Subjects were instructed to keep their hands on their iliac crests and to keep the heel of the stance leg on the ground at all times. (fig.5,6,7,8,9) Average of three reaches in each direction was taken and normalized by dividing by the leg length [1]. Leg length was measured from anterior superior iliac crest to the medial malleolus of tibia[7].

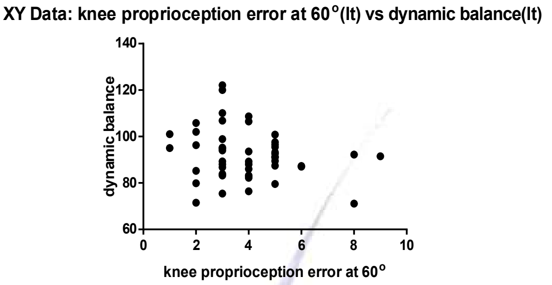
RESULT

The data thus collected was statistically analysed using Graph Pad Prism version 7. Since the data was not normally distributed, Spearman's rank coefficient was used. Also, Scatter diagram was plotted to explain the correlation (Graphs 1,2,3,4). Significance level was set at 95% confidence level for all statistical tests. Spearman's rank coefficient for correlation of knee proprioception error with dynamic balance was -0.3161(Rt) and -0.1599(Lt). Spearman's rank coefficient for correlation of knee proprioception error with static balance was 0.3358(Rt) and 0.2912(Lt).

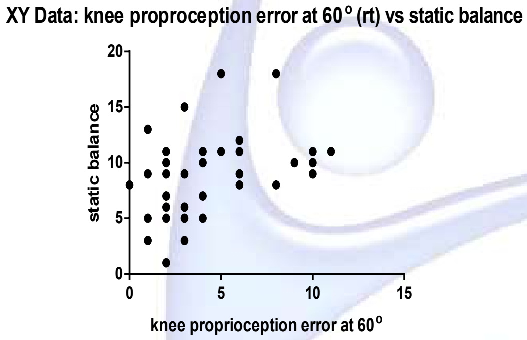
Graph 1: Correlation of knee joint proprioception error at 60^0 (rt) with dynamic balance (rt).



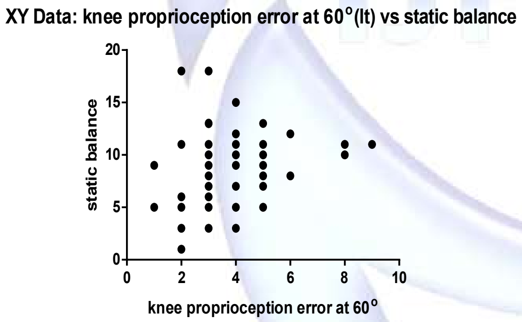
Graph 2: Correlation of knee joint proprioception error at 60^0 (lt) with dynamic balance (lt).



Graph 3: Correlation of knee joint proprioception error at 60^0 (rt) with static balance error.



Graph 4: Correlation of knee joint proprioception error at 60^0 (lt) with static balance error.



DISCUSSION

The aim of this study was to correlate static and dynamic balance with knee proprioception in normals. Static balance, dynamic balance and knee proprioception at 60^0 were assessed.

Data analysis showed a negative correlation between knee joint proprioception error and dynamic balance while a weak positive correlation between knee joint proprioception error and static balance error.

Since the study showed a negative correlation between proprioception error and dynamic balance it suggests that lesser the proprioception error better the dynamic balance.

According to R. Bhaktiari et al (2012), balance control is an interaction of various inputs from visual, somatosensory and vestibular systems. Each sensory system provides the CNS with specific information about position and motion of the body; thus each of them is important for balance control. The visual system provides a sense of verticality and also the motion of the head. The somatosensory system provides the CNS with the position and motion information about the body's position in space with reference to the supporting surfaces. The vestibular system provides the CNS with information about the position and movement of head with respect to gravity and inertial forces. Thus, proprioception is not the only factor essential for balance control; there are other factors too which play a role. This explains the weak positive correlation between proprioception error and static balance error [1].

According to B.Riemann et al (2002), for effective motor control accurate sensory information regarding both the external and internal environmental conditions of the body is essential. During any activity, provisions must be made to adapt the motor program to changes occurring in the external environment and internal environment. These provisions are stimulated by sensory triggers occurring in both feedback and feed forward manners [8].

However, in environments in which a sense does not provide optimal information regarding the body's position, the CNS is able to modify how it uses the sensory information for balance. This is called sensory reweighting. It occurs when reliance on one sensory system for balance control increases while, at the same time, reliance on another sensory system decreases [9].

Various studies examining the effect of vision on static balance have examined the amplitude of sway with eyes open versus eyes closed, and have found that there is a significant increase in sway in normal subjects with eyes closed. Thus, it has been proposed that while vision is not absolutely necessary for normal stance, it does actively contribute to static balance control [9].

According to Eva Hansson et al, vision seems to affect static balance the most, then proprioception and lastly vestibular system [10]. While in case of dynamic balance, adults tend to rely more on somatosensory inputs depending on the contact surface (Shumway Cook et al).

In support to the discussion of the study, it concludes that proprioception error and static balance error have a weak positive correlation and proprioception error and dynamic balance have a negative correlation with each other.

CONCLUSION

There is a negative correlation of knee joint proprioception error with dynamic balance. Also, there is a weak positive correlation of knee joint proprioception error with static balance error.

Clinical Implication: Balance control does not depend on a single sensory input from the CNS but is a result of interaction of inputs from various systems. Hence balance assessment and rehabilitation must include clinical strategies for assessing both the integrity of individual sensory systems and the ability to organize these sensory inputs for balance control.

Limitation: An inclinometer could have been used instead of a goniometer to reduce the tactile feedback for measuring proprioception error.

Conflicts of interest: None

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