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Impact of Prolonged Standing in Static and Dynamic Balance and Propriocepion in Co-Relation with Q Angle Among Nursing Population: A Prevaleance Study

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Abstract
Aim: The aim of study is to investigate the effect of Q angle on static and dynamic balance in young and healthy adults in prolonged standing. **Relevance of study:** In long standing profesion there is increase in pressure or weight in lowerlimbs which lead to weakness in lowerlimb musculature. There is increase risk of injury in such individuals. So knowing about our balance and proprioception one can start working on it for strengthening the musculature. **Methodology:** In this study 80 individuals were selected on the basis of inclusion and exclusion Criteria. The two test were conducted for assessing balance and other one is for rule out proprioception.
Results: The study concluded that there is a positive correlation between Flamingo balance test and proprioception, YBT and proprioception, Q angle and flamingo balance test, Q angle and flamingo balance test. **Conclusion:** There is decrease in proprioception of knee joint in prolonged standing population which lead to decrease in static and dynamic balance. It lead to many injuries in lowerlimb and early OA.

Keywords: Balance, Flamingo balance test, YBT, Q angle, Proprioception, knee injuries

Introduction

Balance is the condition in which all the forces acting on the body are balanced such that center of mass (COM) is within the stability limits, the boundaries of the base of support (BOS) [1]. Body balance control is a complex body function that involve regulating posture and movement through cerebellum by processing sensory inputs from vestibular, visual and proprioceptive system in cerebral cortex [2]. It is important aspect in day-to-day life as it helps to maintain a stable posture for performing daily activities while neutralizing external or internal conflicts. There are two types of balance. Static balance is the ability to maintain postural stability and orientation with center of mass over the base of support and body at rest [1]. Dynamic balance is the ability to transfer the vertical projection of center of gravity around the supporting base of support [3].

Balance is sustained by several factors which include the vestibular system, visual-spatial perception, tactile input proprioception, musculoskeletal and neuromuscular system. Any insufficiency in these factors may result into postural imbalance and increase the risk of injury [4].

Q angle is defined as the angle formed between an imaginary line connecting the anterior superior iliac spine (ASIS) of the pelvis to the patella's midpoint and a proximal projection of line running from the tibial tubercle to the patella's center [5-6]. It has been suggested that Q angle represents the Frontal plane resultant force vector of quadriceps musculature and patella's tendons acting, respectively on the patella [7-8].

The Q angle is one of the most clinical used parameters in evaluating the quadriceps forces and factors acting on Patellofemoral joint. Static Q angle is defined as angle represent the frontal plane resultant force vector of quadriceps musculature and patella's

tendons acting on patella. Dynamic Q angle is angle through the knee joint flexion, with or without a dynamic activity [9].
In women the Q angle should be less than 22 degrees with in extension and less than 9 degrees with the knee in 90 degrees of flexion. In men the Q angle should be less than 18 degrees with knee in extension and less than 8 degrees with the knee in 90 degree of flexion. A typical Q angle is 12 degrees for men and 27 degrees for women [12].
A study has concluded that there is a decrease in knee joint proprioception can occur after prolonged standing due to generalized fatigue of joint. This phenomenon is attributed to the accommodation of exteroceptors. During prolonged standing, there is continuous transfer of impulse to the exteroceptors regarding the static and dynamic standing position of lower- limb. As a result of these continuous impulses, the nerve becomes accommodated, leading to altered readings when simultaneous checking of proprioception.
Following prolonged standing, there was a decrease in knee joint proprioception regardless of gender.
The clinical significance of static Q angle is currently under investigation as an increased Q angle is considered as a risk factor for various injuries and disorders such as Patellofemoral pain (PFP), Patellar subluxation and dislocation, chondromalacia patellae, knee osteoarthritis, Overuse injuries, acute cruciate ligament injury, patellar instability, disturbances on dynamic balance and ankle sprain. Decreased Q angle maybe associated with chondromalacia, Patella alta, patellar and (PFP).
The nursing population, which constitutes approximately 33% of hospital workforce accounts for 60% of the MSD.[10]
The most commonly reported biomechanical risk factors for MSD include excessive repetitions, awkward postures, heavy lifting and prolonged standing [11]. Knee pain is more prevalent among nursing personnel compared to other workers. In univariate modeling, knee pain is associated with both physical and psychosocial work exposure, including the complete physical exposure score, psychological job demands, and job strain [13]. The second most prevalent MSD amongst nurses is foot and ankle injuries, as nurses spend almost half of their time on their feet and walking between wards [15].
The assessment of static and dynamic balance was conducted using the Flamingo balance test and Y-Balance Test (YBT) respectively. The Flamingo balance test is a comprehensive test to evaluate total body static balance. It meets the requirements of simplicity, cost-effectiveness, and suitability for mass investigations [17]. This test assesses the strength of the leg, pelvic, and trunk muscle, as well as dynamic balance [17].
On the other hand the YBT is a three directional test that is used to assess lower extremity balance more efficiently. It evaluate an individual's ability to maintain equilibrium on single lower extremity while moving the contralateral extremity in desired directions. The YBT assess the dynamic balance by testing the limit of stability and asymmetrical balance in the anterior (A), posteromedial (PM) and posterolateral (PL) direction. It is a time efficient test that predicts musculoskeletal injuries or impairments in neuromuscular control [16]. The reliability of this test is indicated by an Intraclass Correlation Coefficient [ICC] of [1.0, 95% CI:1.0] [16].

Need of Study

A normal Q Angle value varies between genders, with a range of normal value from 8° to 17°, and women exhibiting a higher Q Angle than men. Deviations in Q angle can exert strain on structure of hip and knee joint, potentially leading to injury. Several significant studies have indicated that professionals who engage in prolonged standing may experience a decrease in proprioception in relation to their Q angle. Additionally, some research has suggested a moderately negative correlation between the Q angle and static and dynamic balance. Therefore, the primary focus of this study is to explore the relationship between proprioception, Q Angle and static and dynamic balance.

Material and Methodology

Material

- Wooden beam
- Stadiometer
- Weight machine
- Stopwatch
- Tape
- Goniometer

Methodology

1. **Study Design** – Prevalence
2. **Method of Sampling -** Purposive
3. **Sample Size** - 80
4. **Place of study** - Dr. Ulhas Patil Medical College Jalgaon
5. **Study Duration** - 6 months
6. **Selection Criteria-**

Inclusion Criteria

- Normal healthy individuals of both gender of age 22 - 35.
- Individuals working more than 6 hours.

Exclusion Criteria

a. Candidates were excluded if disease or functional impairments of the auditory, visual, vestibular and proprioceptive systems.
b. History of injury to or surgery on the lower limb structure, congenital deformities, current use of any medications that might alter postural balance, presence of neurological, cardiovascular, metabolic, rheumatic disease
c. Subjects complaint of instability of knee.
d. Participants who underwent any ankle, foot, knee and spine surgery.

Assessment

1. Q Angle

The static Q angle can be measured in an supine position with knees extended and quadricep relaxed. Place the centre of axis of long arm goniometer over the centre of patella. Next palpate the proximal tibia and align the lower goniometer arm along the patellar tendon to tibial tubercle.

Static Q Angle inter-rater reliability is [ICC; 0.989 and 0.94-0.989] respectively.

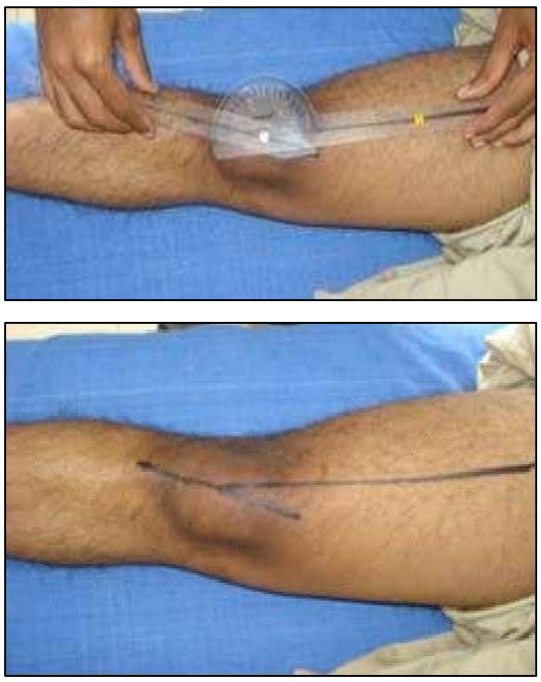

Fig 1: Q angle

Fig 2: Flamingo Test

Y Balance Test

In this test the participants were instructed to maintain single limb stance on the center foot palate with the foot behind the marked straight line. Next the participants used the foot of their non-stance leg to slide the reach indicator along the designated tubes as far as possible and then return their foot to starting position while maintaining the balance. The subject was asked to reach with the other leg in three direction i.e., anterior, posteromedial and posterolateral in relation to the stance foot by pushing the reach indicator box as far as possible.

The reliability of YBT is AN (ICC= 0.99 95% CI: 0.99-1.0) PN (ICC= 1.0, 95%, CI: 1.0) PL [ICC= 1.0, 95%, CI: 0.99-1.0) Composite score (1.0, 95% CI: 1.0) [16-19].

Fig 3: Y Balance Test

To Check Proprioception

Subjects were asked to sit on chair in high sitting position erect posture with hip flexed at 90 degree and knee flexed 90 degree. Then the patient were asked to close their eyes to exclude the visual stimulus, then the knee of subject extended 30 degree from initial 90 degree flexed position passively. The knee was kept at that position for 2 second for the subject to remember the position. Then the knee was passively brought back to the initial starting position. Then subject was then asked to actively extend the knee to the position achieved passively by the subject [18].

Fig 4: To Check Proprioception

Procedure

A Observation experimental study will be conducted among normal healthy individuals of either gender of age 22 - 35

years in Nursing Students in Jalgaon. To conduct the following study approval from ethical committee from Dr. Ulhas Patil College of Physiotherapy, Jalgaon will be taken. Participants be selected according to the inclusion criteria. They will be included by purposive sampling.

Participants will be evaluated according to the format. The study will be explained to the participants and written informed consent will be taken. All the participants performed test without wearing shoes.

The tests were stopped anytime during the procedure keeping in mind the termination criteria such as if patient gets tachycardic or blood pressure increases.

Q angle was measured in standing, (Fig.1) three landmarks were identified anterior superior iliac spine (ASIS), centre of the patella and tibial tuberosity. For marking patellar midpoint, the borders of patella were palpated and outline was drawn. The point joining the maximum vertical and transverse diameters of patella was marked as midpoint of patella. The point of maximum prominence at anterior upper end of tibia was noted as the tibial tuberosity. The fulcrum of goniometer was placed on centre of the patella; the moving arm was directed to the ASIS and the stationary arm to the tibial tuberosity. The angle created by the intersection of these 2 lines is the Q angle.

The tests were demonstrated to all participants and the students were allowed to practice three times to avoid all possible errors. Tests were practiced with eyes open without shoes for both the right and left leg. To assess static balance Flamingo test was performed and for dynamic balance YBT test was used.

To administer the flamingo test the subject was asked to stand on the wooden beam (50 cm long, 5 cm high, 3 cm wide) with shoes removed on the tested leg and bend the free leg at the knee, and the foot of this leg was held close to the buttocks with both hands on the iliac crests, standing like a Flamingo. Participants were instructed to maintain this position as long as they can. Stopwatch was used to note each time the person loses balance either by falling off the beam or letting go of the foot being held or hands removed off the body. Every participant was must perform three attempts and the mean was calculated for statistical analysis.

In YBT participants were made to stand on the dominant foot on the centre footplate, at the starting line and maintain the single leg stance. The subject was asked to reach with the other leg in three directions i.e., anterior, posteromedial, and posterolateral in relation to the stance foot by pushing the reach indicator box as far as possible. Participants were to complete 3 consecutive trials for each reach direction. All statistical analysis was done on the data collected and outcome.

In proprioception testing subjects were asked to sit on chair in the high sitting position erect posture with hip flexed at 90 degree and knee flexed at 90 degrees. Then the patients were asked to close their eyes to exclude the visual stimulus, then the knee of the subject was extended 30 degrees from the initial 90-degree flexed position passively. The knee was kept at that position for 2 seconds for the subject to remember the position. Then the knee was passively brought back to the initial starting position. The subject was then asked to actively extend the knee to the position achieved passively by the subject. Three trials were taken and the reading were recorded for each subject.

Statastical Analysis

Statistical method used

- The entire data of the study was entered and cleaned in ms excel before it was statistically analysed in “graphpad instant version 3.05”.
- All the results are shown in tubular as well as graphical format to visualize the statistically significant difference more clearly.
- The data on quantitative characteristics was presented as mean ± standard Deviation (SD) across study group.
- The Pearson co-relation-test was used for finding co-relation between Q Angle, static balance, dynamic balance and proprioception.
- The entire data was analysed statistically using “graphpad instat version 3.05” for ms windows.

Observation and Tables

Table 1: The age wise distribution of study subjects

Age in Years	No of Subjects
21-35	80

Table 2: Gender distribution of study subjects

Gender	Total subjects (n=80)
Female	42
Male	39

In the study we found more 52% females and 48% male

Table 3: Result of co-relation of flamingo balance test with proprioceptio

	Flamingo
r-value	0.136
P-value	<0.001 Considered extremely significant

Comment: There is an extremely significant co-relation between flamingo balance test and proprioception.

Table 4: Pearson co-relation test of Y balance

	Y-Balance Test
r-value	0.087
P-value	0.037 Considered significant

Comment: There is a significant co-relation between y balance test and proprioception.

Table 5: Descriptive data of flamingo balance test

	Q angle	Flamingo Test
Mean	17.325	12.452
SD	2.898	4.736

Table 6: Pearson co-relation test of Flamingo Balance

	Flamingo
r-value	0.167
P-value	<0.0001 Considered extremely

Comment: There is extremely significant co-relation between q angle and flamingo balance test

Table 7: Pearson co-relation test of Y Balance test

	Y Balance
r-value	-0.035
P-value	0.586 Considered not significant

Comment: There is no significant co-relation of Q angle with Y balance test

Table 8: Pearson co-relation test of proprioception

	Proprioception
r-value	0.086
P-value	0.019 considered significant

Comment: There is significant co-relation in between the Q angle with proprioception.

Result

Co-relation of flamingo balance test with proprioception test

The co-relation between flamingo balance test with proprioception were analyzed by using Pearson correlation test.

The result shows positive coo relation between flamingo balance test with proprioception as the value of r was 0.136 and value of p was p= < 0.001, considered extremely significant.

Co-relation between Y Balance with proprioception test

The co-relation between Y balance with proprioception were analyzed by using Pearson co-relation test.

The result shows positive co-relation between Y balance with proprioception test as the value of r was -0.087 and value of p was p=0.037, considered significant.

Co-relation between Q angle and static balance

The co-relation between Q angle and static balance were analyzed by using Pearson correlation test.

The result shows positive coo relation between Q angle and static balance test as the value of r was 0.167 and value of p was p= < 0.0001, considered extremely significant.

Co-relation between q angle and dynamic balance test

The co-relation between Q angle and dynamic balance were analyzed by using person co-relation test.

The result shows negative co-relation between Q angle and dynamic balance test as the value of r was -0.035 and value of p was p=0.586, considered not significant.

Co-relation between q angle and proprioception

The co-relation between Q angle and Proprioception were analyzed by using Pearson co-relation test.

The results shows positive co-relation between Q angle and proprioception test as the value of r was 0.086 and value of p was p = 0.0196, considered significant.

Discussion

The aim of the study is to observe the impact of prolonged standing in static and dynamic balance and knee joint proprioception in co-relation with Q angle among nursing population.

In our study we measured Q angle and static balance using flamingo balance test and we found strong co-relation between two variables. Individuals with higher Q angle held the flamingo balance test position for less time hence, having poor static balance. Russel A K *et al* have shown in their study that both muscle strength and balance effect the lower extremity alignment [20].

The study conducted by Dr. Khyati Patole and her co-worker in 2021 on The effect of Quadriceps Angle On Static and dynamic Balance In Young Adults concluded that there is a weak negative co-relation between Q angle and static balance. They used stork test for assessing static balance test. Another outcome of the study was co-relation of Q angle and dynamic balance which was measured using y balance test. We found that the two variable are negatively correlated. Proper co-contraction of lower limb muscle is necessary to maintain the balance and improve functional stability [21]. Multiple anatomical factors influence the magnitude of QA such as tibio femoral angle, hip internal rotation which impacts QA that is related to dynamic knee function JE Earl *et al* conducted a study to perceive which muscles are activated during each reach directions of the SEBT [22]. It was found that there was significantly higher activity of VMO and VL in anterior direction, higher activity of tibialis anterior (AT) in posteromedial direction and higher activity of biceps femoris (BF) and AT in posterolateral directions as compared to other muscles of the lower limb [16]. Which means these particular muscles play an important role in maintaining dynamic balance and their weakness will result in poor dynamic balance.

Weakness of the quadriceps muscle will cause a change in the force of muscle pull; the Q angle will change and any change in this angle other than normal will make an individual to have impaired balance.[13] Individuals with higher Q angle could not reach further in the YBT and thus had poor dynamic balance.

We have conducted a co-relation between q angle and proprioception and we found that the two variables are positively co-related. There was a significant decrease observed in the proprioceptive accuracy of the patient in this study we count fascinating that after prolonged standing there was decrease in knee joint proprioceptive accuracy irrespective of their gender.

This decrease in knee joint proprioception after prolonged standing can occurs due to generalized fatigue of the joint. This phenomena happens due to the accommodation of the exteroreceptors.

The study conducted by Ayush Anand and Yamini sharma *et al*. 2018 on effect of prolonged standing on knee joint proprioception concluded that there was a significant decrease in the proprioceptive accuracy of the patient. Based on the findings, it is clear that prolonged study adversely affects the knee joint health in the long run. The workers whose job profile consists of prolonged standing should take care of knee joint to prevent early degenerative changes in their joint.

The study concluded that there is decrease in static balance due to decrease in knee joint proprioception.

Conclusion

The study concluded that there is a positive correlation between flamingo balance test and proprioception. Additionally, it found a positive co-relation between Y balance with proprioception. The study found a positive co-relation between Q angle and flamingo balance test.

It also identified a negative co-relation between Q angle and Y Balance test. Furthermore, the study revealed a positive co-relation between Q angle and proprioception.

Limitations

- Due to physiological limitation Q angle is not assessed in standing position.
- There are only 3 trials in flamingo balance test which was not sufficient.
- This study does not take in account various other methods to assess the proprioception in the individuals.

Future scope of study

- Further studies can be done on co-relating various risk factors related to balance and prolonged standing.
- Also studies can be done in various long standing workers.

Clinical Implication

- Flamingo balance test instrument can be used to improve lower limb strength and balance training.
- Y Balance test instrument can also be used to agility training and improve balance.

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