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COMPARISON OF POSTURAL BALANCE BETWEEN THE OLDER ADULTS WITH NORMAL (EUTHYROID) VERSUS HYPOTHYROID STATUS- A PROSPECTIVE COHORT STUDY

Physiotherapy

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ABSTRACT

BACKGROUND: The risk of impaired postural balance and falls with potentially life threatening injuries (e.g. brain injury, hip fractures) is high in the older adults. Hypothyroidism is associated with impaired neuromuscular function.
OBJECTIVE: To assess the effects of hypothyroidism on postural balance in the older adults.
METHODS: Older adults (≥65 years) participants with either normal (Euthyroid) or hypothyroid status were enrolled in a prospective observational study. The BRIEF BESTest (BBT) was used for assessing balance. The primary outcome was the total BBT scores between the two groups of participants.
RESULTS: 66 participants (33 per group) were recruited over 12 months. The mean (±SD) age, weight and height of hypothyroid vs euthyroid group participants was 76.39 (±6.48) vs 76.18 (±7.94) years, 67.33 (±6.49) vs 64.15 (±5.14) kg and 170.53 (±10.00) vs 166.83 (±13.86) cm respectively. The mean (±SD) total BBT scores were significantly lower [10.818(±2.66) vs 12.515 (±3.52), p=0.039] in the hypothyroid vs euthyroid group participants respectively. Of the individual BBT components, anticipatory postural adjustment (left side), reactive postural response (both sides), and sensory orientation scores were significantly less in hypothyroid participants.
CONCLUSION: Hypothyroidism was associated with adverse effect on balance in the older adults.

KEYWORDS

Balance, Brief Bestest, Older Adults, Falls, Hypothyroidism, Posture

INTRODUCTION

Postural balance is the ability to keep the body in equilibrium and to regain balance after the shift of body segments[1]. Postural balance is a fundamental motor skill learned at an early age and represents an essential basic for daily routine tasks and athletic activities[2]. There is no universally accepted definition of human balance. However, postural control is usually defined as the act of maintaining, achieving or restoring a state of balance during any posture or activity[3]. Postural control strategies may be either predictive or reactive, and may involve either a fixed-support or a change-in-support response[3].

Impairment of balance is common in the older adults with an estimated incidence of 20% to 60%[4,5,6]. Balance impairment is said to occur when the centre of mass (COM) falls out of alignment with the base of support (BOS). Furthermore, in a unilateral stance, the BOS is reported to be halved which compromises stability[4] . When the line of gravity (LOG) passing through COM falls outside the BOS, human beings are capable of taking necessary actions/preventive measures to achieve realignment[4,7] .

With increasing age there is gradual decrease in postural balance with an increased risk of falls, soft tissue injuries, and even death. Every year almost 33% of all older adult people over the age of 65 years fall[8,9]. Furthermore, more than half of them fall more than once. Approximately 10–25 % of falls lead to serious consequences such as traumatic brain injury[10] and around 6% sustain fractures[7]. It has been estimated that inadvertent injuries are the fifth most common cause of death in the older adults[10].

The relation between muscle strength and the risk of falls with increasing age is important. Muscle strength is at its peak into the 5th or 6th decade of life. Thereafter, it declines rapidly by 15% strength loss per decade[11]. As much as 50% of the muscle strength is lost by 80 years of age. Lower extremity muscle weakness is highly correlated with fall risk in the older adults[4] . The risk of falls can be increased by hypothyroidism, a condition known to affect muscle strength, particularly, that of the proximal muscles, and also associated with mononeuropathy and sensorimotor polyneuropathy[12,13,14,15,16,17] .

Thyroid hormones play an important role in regulation of metabolism in most tissues including the musculoskeletal and neurological systems, whose combined functioning is important for maintaining postural balance[15,18] . Results of previous studies have suggested that thyroid dysfunction in hypothyroidism may play an important role in postural balance impairment[17,19]. Hypothyroid myopathy is a common clinical feature in hypothyroidism affecting about 79% of patients[15] . It is seen in both congenital and acquired hypothyroidism, and characterized by generalized myalgia and muscle weakness. Patients with severe or untreated hypothyroidism can develop significant muscle disease leading to severe functional limitations[12,15] .

To our knowledge, the link between thyroid dysfunction and postural balance in the older adults has remained unexplored. Given the significance of the underlying issues in the context of the risks associated with falls in the older adults, we aimed to assess the effects of hypothyroidism on postural balance in the older adults. Our hypothesis was that presence of hypothyroidism as a concurrent illness will be associated with adverse effect on balance in the older adults.

MATERIALS AND METHODS

DESIGN AND SETTING:

This prospective observational study was conducted over a period of 12 months (Jan 2018 to Dec 2018). This study involved a single assessment of balance (The BRIEF BESTest) that was conducted in various geriatric homes, residential places and endocrinology clinics in Pune.

ETHICAL APPROVAL:

Permission was received from review board of Sancheti Institute College of Physiotherapy Pune, Maharashtra. Helsinki guidelines were followed for the design and conduct of this study.

INCLUSION CRITERIA:

Age ≥ 65 years with either hypothyroidism or normal thyroid function (Euthyroid).

EXCLUSION CRITERIA:

Recent trauma or injury, neuromuscular disorder or dysfunction that would affect balance or gait

THE BRIEF BEST (BALANCE EVALUATION SYSTEMS TEST):

Enrolled participants were administered the BRIEF BESTest (BBT) by investigator. The BBT is a clinical tool for assessment of balance impairment predominantly in those >65 years' of age. The BBT is a 4 point (0-3) scoring test with a total score of 24 points. Higher scores indicate better balance performance. Based on the 6 items of the BESTest, one from each section, with two items (single-leg stance and functional forward reach) scored bilaterally, the BBT becomes an 8-item test[20,21] . The 6 sections of BBT include (1) Biomechanical

constraints: Hip strength, (2) Stability limit: Reach forward, (3) Anticipatory-postural adjustment: Bilateral, (4) Reactive postural response: Bilateral, (5) Sensory orientation, and (6) Stability in gait. The BBT thus represents all theoretically based sections of the original BESTest for assessing balance impairment[20].

The reliability of BBT has been shown to be comparable with the BESTest and Mini-BESTest among individuals with Parkinson's disease[22] , multiple sclerosis[20] , total knee arthroplasty[23] and chronic stroke[24] .

Its administration time of less than 10 minutes makes BBT more feasible in daily clinical practice[20] for predicting falls, particularly when time and equipment constraints are of concern[25] .

OUTCOMES:
The total BBT score and the individual scores for the 6 components of the BBT were the primary and the secondary outcomes respectively.

COMPARISONS:
(1) Primary: The total scores of the BBT were compared between participants with hypothyroidism and those with normal thyroid status. (2) Secondary: The scores of the 6 individual components were also compared between these two groups.

SAMPLING TECHNIQUE:
This involved convenience sampling from randomly selected geriatric homes, residential places and endocrinology clinics in Pune.

SAMPLE SIZE ESTIMATION:
In a pilot study enrolling 10 older adults participants in each arm, we found that mean (+/-SD) total BBT scores of 11.4 (+/-2.14) in hypothyroid and 13.3 (+/-3.04) in the euthyroid (control) group respectively. A sample size of 23 in each arm was estimated to be adequate for finding a significant difference between the two groups with 80% power and significance (ά error) at 0.05.

STATISTICAL ANALYSIS AND SOFTWARE:
The Mann Whitney U test was used for statistical analysis. The software used for analysis was SPSS version 21.

RESULTS
A total of 66 participants (Hypothyroid: 33 vs Normal/Euthyroid: 33) were recruited in the study over a period of 12 months (Table 1). The demographic characteristics were comparable between both study groups. The total number of male and female participants in the hypothyroid vs euthyroid group was A and B vs C and D respectively. The mean (±SD) age, weight and height of hypothyroid vs euthyroid group participants was 76.39 (±6.48) vs 76.18 (±7.94) years, 67.33 (±6.49) vs 64.15 (±5.14) kg and 170.53 (±10.00) vs 166.83 (±13.86) cm respectively.

PRIMARY OUTCOME:
(1) Comparison of the total BBT scores: The mean (±SD) total BBT scores were significantly lower [10.818 (±2.66) vs 12.515 (±3.52), p=0.039] in the hypothyroid vs euthyroid group participants respectively.

SECONDARY OUTCOME:
Comparison of individual components of BBT (Table 2) showed results as follows: (1) Biomechanical constraints score: No significant decrease in hypothyroid vs euthyroid participants. (2) Stability limit score: No significant decrease in hypothyroid vs euthyroid participants. (3) Anticipatory postural adjustment (Left side) scores: Significant decrease in hypothyroid vs euthyroid participants. (4) Anticipatory postural adjustment (Right side) scores: No significant decrease in hypothyroid vs euthyroid participants. (5) Reactive postural response (Left side) scores: Significant decrease in hypothyroid vs euthyroid participants. (6) Reactive postural response (Right side) scores: Significant decrease in hypothyroid vs euthyroid participants. (7) Sensory orientation scores: Significant decrease in hypothyroid vs euthyroid participants. (8) Stability in gait: No significant decrease in hypothyroid vs euthyroid participants.

SAFETY:
There were no adverse events related to the BBT assessments during the study

DISCUSSION
Our results showed that the total BBT scores (Primary outcome) were significantly lower in hypothyroid compared with euthyroid participants suggest that hypothyroidism may have an influence on postural balance in the older adults with age ≥65 years. As for the secondary outcomes, the scores for some of the individual components of the BBT, namely anticipatory postural adjustment (left side), reactive postural response on right as well as the left side, and sensory orientation, were significantly lower in hypothyroid compared with the euthyroid participants. These findings may relate to the neuropathy and muscle changes in hypothyroidism. With regards to anticipatory postural adjustment, the lower scores only on the left side may be explained by higher frequency of right handedness in the general population.

The findings of our study indicate the importance of assessing thyroid function in the older adults given their risk of impaired balance and falls. The hormones produced by the thyroid gland [Triiodothyronine (T3), Thyroxine (T4) and reverse Triiodothyronine (rT3)] are essential for regulation of metabolic activity and have effect on various organ systems of the body. They are controlled by thyroid stimulating hormone (TSH) secreted from the anterior pituitary gland[26].

The effect of hypothyroidism on muscles is well known. Hypothyroid is commonly associated with myopathy resulting in nonspecific symptoms such as myalgias, muscle cramps, fatigue, and muscle weakness[27] . Proximal muscle weakness occurs especially in the shoulder and pelvic girdle, causing difficulty in climbing stairs, getting up from squatting position, and combing hair[15] . Electromyography (EMG) demonstrates low/small amplitude potentials. There is selective atrophy of type 2 muscle fibers (fast-twitching type) which are dependent on glycolysis for energy[12,28] . This results in slowing of muscle contraction, poor contractility of actin-myosin units and low myosin ATPase activity[28,29] . Although many patients also have raised serum levels of creatinine kinase, it is not specific to myopathy[15,27] . Animal studies have shown involvement of thyroid hormone in regulating gene expression of skeletal muscle proteins such as gene coding for Type 1 myosin heavy-chain (MHC), actin and the sarcoplasmic retinaculum, ATPase pump[30] .

Furthermore, neurological dysfunction is an important consequence of hypothyroidism with manifestations including somnolence, lethargy, impaired memory and concentration, depression and entrapment neuropathy. Rare but reversible neurological manifestations include cerebellar ataxia, psychosis, dementia, and myxedema coma[31] . Various investigators have reported findings such as significantly prolonged distal motor latencies, reduced compound muscle action potential (CMAP) amplitudes and slowed motor nerve conduction velocity in the peripheral nerves[32] , mild neuropathy of sensory type[14] , small fibre neuropathy[33] , multifocal motor neuropathy[34] , peripheral neuropathy[35] , and gait disorder including ataxia[19] in hypothyroidism[36] studied functional changes in the nervous system in 23 patients with hypothyroidism and 200 normal participants matched for age and sex. The hypothyroid patients were 17-64 years old (Mean age: 38.2 year) with thyroxine <4 microgram/dl and thyrotropin >4.5mU/ml. Detailed central (CNS) and peripheral (PNS) nervous system assessments included electromyography, motor conduction velocity, visual-evoked potentials, brainstem auditory-evoked potentials and electroencep halography (EEG). The PNS was involved in 52% of the patients; entra pment neuropathy was the commonest pathology (35%). Axonal neuropathy was noted in 9%, and myopathy was noted in another 9% of patients. The CNS was affected in 78% of the cases, and eight patients had EEG changes. Importantly, no significant correlation was observed between hormonal levels and the different electroph ys iological parameters[36] . Overall, these data show the significance of neuromuscular pathology of hypothyroidism in the context of falls in the older adults.

The limitations of our study need to be acknowledged. The observational nature of our study makes it difficult rule out bias due to known and importantly, unknown confounding factors. For example selection bias could confound our results as the participants were recruited from various geriatric homes, residential places and endocrinology clinics, and not from general home based population. Small studies, such as ours, are also prone to give unreliable (often false or too positive) results. Confirmation of our results with large, adequately powered well-designed studies to detect small but clinically significant effect size is thus necessary. Despite these

limitations we believe that our study has generated novel data that is useful for designing such studies. The importance of further research in this field cannot be over emphasised considering the health burden related to falls in the older adults and the fact that hypothyroidism is an easily detectible and treatable condition.

In summary, the results our prospective observational cohort study indicate that presence of hypothyroidism as a concurrent illness was associated with adverse effect on balance in the older adults. Large studies are needed to confirm our findings. Preventive measures are important considering the risk of serious injuries due to falls in the older adults.

DECLARATION OF INTEREST STATEMENT:
The authors declare no conflict of interest of any kind in relation to this study. No funding was required.

Table 1: Participant demographic characteristics*

Characteristic	Hypothyroid	Euthyroid
Age (Years)	76.39(±6.4)	76.18(±7.9)
Weight (Kg)	67.33(±6.5)	64.15(±5.1)
Height	170.53(±10)	166.83(±13)
Male gender	23(69.7)	20(60.6)

*Data expressed as mean (±Standard deviation) and n(%)

Table 2: Outcomes as scores of the BRIEF Best test#

Outcome	Hypothyroid	Euthyroid	p values
Primary outcome: Total BBT* score	**10.8 (± 2.66)**	**12.5(± 3.52)**	**0.039**
Secondary outcome: BBT component scores			
(1) Biomechanical constraints: Hip strength	1.12(±.48)	1.30(± .52)	**0.146**
(2) Stability limit: Reach forward	1.72(±.57)	1.93(±.55)	**0.129**
(3) Anticipatory-postural adjustment: Right side	1.39(±.55)	1.61(±.60)	**0.135**
(4) Anticipatory-postural adjustment: Left side	1.36(±.54)	1.73(±.45)	**0.006**
(5) Reactive postural response: Right side	1.21(±.41)	1.48(±.56)	**0.034**
(6) Reactive postural response: Left side	1.21(±.41)	1.55(±.56)	**0.010**
(7) Sensory orientation	1.06(±.24)	1.39(±.55)	**0.003**
(8) Stability in gait.	1.72(±.62)	1.51(±.87)	**0.417**

#Data expressed as mean (±Standard deviation)
*BBT: Brief BEST Test

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