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HEALTHY AGING RESEARCH

Does prophylactic ankle bracing improve proprioception in the elderly?

Terry J. Ellapen[1*], Samantha Ballington[1], Samantha Beukes[1], Christie Wolhuter[1], Johan H. Van Heerden[1]

1 Department of Biokinetics, Exercise and Leisure Sciences, School of Health Science University of Kwa Zulu Natal, South Africa

Abstract

Background: Falls are a common occurrence among the elderly, which result in many health care practitioners prescribing prophylactic ankle bracing (an assistive device) to improve proprioception and reduce the chance of falling. The aim of this study was to compare proprioception in a cohort of elderly individuals when prophylactically braced or unbraced on the Biodex System 3.

Methods: Data were collected from 173 elderly individuals who resided at seven of the old age retirement institutions in the Highway area of Durban, South Africa. Information was obtained with voluntary informed consent. The participants completed a Fall Risk Questionnaire that categorized them into two groups: increased risk or poor risk for falling. Subsequently, they completed a dynamic proprioceptive test both with and without an ankle brace. The significance level was set at $p \leq 0.05$.

Results: Forty-one elderly individuals were categorized as having an increased risk for falling (X^2 p-value: 2.65e -12). The proprioceptive unbraced performance of the increased fall risk (IRF: 2.9 ± 0.48) and poor fall risk (PRF: 2.97 ± 0.48) groups did not significantly differ ($p > 0.05$). The IRF group's unbraced (2.9 ± 0.48) and braced proprioceptive (2.8 ± 0.45) scores did not significantly differ ($p > 0.05$). Finally, the PRF group braced (2.99 ± 0.46) and unbraced proprioceptive (2.97 ± 0.48) scores did not significantly differ ($p > 0.005$). There was a weak correlation between the dynamic proprioception and Fall Risk Index ($r = 0.04$).

Conclusions*:* Ankle bracing did not enhance proprioception of the elderly.

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* Email: tellapen1@yahoo.com

Introduction

Falls are a common occurrence among the elderly, which can lead to hospitalization, immobility, disability, and premature death [1]. Individuals aged > 64 years have a 30% predisposing risk for falling [2]. Masud and Morris have reported that elderly individuals who do not undergo physical therapy after an initial fall have a 66.6% chance of a recurrent event. Indeed, the fall rate at old age retirement care institutions is approximately 50% [1,3].

In the elderly, predisposing risk factors for falls are categorized into intrinsic and extrinsic variables. Intrinsic factors comprise advanced age, previous falls, ambulation deficiencies, poor vision and hearing and fear of falling [4]. Extrinsic risk factors include lack of stair handrails, poor stair design, lack of bathroom grab bars, dim lighting or glare, obstacles and tripping hazards, slippery or uneven surfaces, psychoactive and anti-depressant medication (often

prescribed for mood disorders) and improper use of assistive devices [4,5].

In general, the appropriate interactions between proprioception, auditory stimulation and vision ensure proper balance; however inefficiency in any one of these factors can result in poor balance and accidental falling [7,8]. Anatomical sites susceptible to musculoskeletal injury from falling are the ankle, tibia, fibula, knee, femur, hip and shoulder; ankle instability is the primary facilitator of falls [9,10].

Ankle bracing is commonly used to improve the stability of sprained ankles in sports [10,11]. Anecdotal reports indicate that many health care practitioners (physiotherapists, podiatrists, and medical doctors) have also prescribed prophylactic ankle bracing (an assistive device) to the elderly after a falling episode to, improve their balance and reduce their chances of falling again. However, the actual improvements made by the prophylactic ankle brace have been called into question. In two different studies, Anderson et al. and Bot and Van Mechelen reported that ankle bracing reduced the functional proprioceptive ability of the sub-talar joint in the frontal and horizontal planes [12,13]. However, Gross et al. and Bocchinfuso et al. demonstrated that ankle bracing facilitated improved functional stability in the sagittal plane [14,15]. Finally, Glick et al. and Garrick and Requa reported that ankle bracing increased the likelihood of knee and other musculoskeletal injuries along the kinetic chain because of redistribution in the direction of the forces [16,17]. Therefore, the aim of this study was to compare the dynamic proprioceptive performance of two groups of elderly participants; those at increased risk of falling versus those at poor risk of falling with or without an ankle brace using the Biodex Balance System 3. Furthermore, the relationship between the elderly individuals' Fall Risk Index (FRI; as derived from Toba et al.) and their dynamic proprioceptive performance was also examined [4].

Methods

One hundred and seventy-three elderly individuals from seven of the old age retirement care institutions in the Highway area of Durban, Kwa Zulu-Natal, South Africa participated in a controlled, observational pre-test - post-test, randomized, cross-over investigation and provided voluntary, informed consent. Ethical approval was obtained from the School of Health Science Research Committee, University of Kwa-Zulu Natal (SHSEC009/13). The inclusion criteria for participants were: aged 60 years and older; residing in one of the seven old age retirement institution within the specified geographical location; voluntary participation; independent ambulation; not diagnosed with any seeing, hearing, or neurological disorders; and not on any psychoactive or anti-depressive medications. In this study, we controlled for all extrinsic factors except the improper assistive device. Similarly, all of the intrinsic factors were controlled except the advanced age. We employed a 22 question Fall Risk Questionnaire (FRQ) to categorize the participants and then used the Biodex system to access their stability with and without an ankle brace.

Fall Risk Questionnaire

All participants underwent an interview where the FRQ was administered by a graduate student who was thoroughly grounded in the research protocol and fluent in English and Afrikaans. Those participants who scored seven points or more were identified as at an increased risk of falling, as per the scoring devised by Toba et al. [4]. The FRQ probes the elderly individual's ability to walk independently, history of falls within the last 12 months, quality of their vision and hearing, the availability of hand rails in their surroundings and their fear of falling. The only questions that augmented the FRI were their history of previous falls and fear of falling.

Biodex dynamic proprioception test

After the interview, the participants were randomly allocated into either braced or unbraced groups (with the use of a random table) for performing the pre-test on the Biodex System 3. In the braced condition, both of the ankles were braced, providing bi-lateral ankle bracing. The use of a semi-rigid ankle brace served as an acute intervention, creating different scenarios under, which the elderly could be tested. Each group was tested twice, either braced-to-unbraced-or unbraced-to-braced as the pre-test-post-test cross-over.

All 173 participants underwent a Biodex dynamic proprioception test (bilateral dynamic limits of stability) that measured their proprioception in the frontal and sagittal planes. The fall risk test lasted 60

seconds in a bilateral stance (adapted from Ballard's protocol) [18]. During the course of this test, the balance platform was designed to become less stable, decreasing from level 12 to 2 stability. The overall stability index incorporates the anterior-posterior index, which measures the ankle stability in the sagittal plane, and the medial-lateral index, which measures the frontal plane stability. A high stability index score indicates poor stability.

Statistical analysis

The cohort was described using mode, mean, frequency and percentages. Data were further analyzed with inferential statistics using the chi-squared tests (X^2), two tail t-test adjusted for equal variance and Levene's test to assess the homogeneity of the variances. The chi-squared statistical test compares the counts or total of the categorical observed and expected results [19]. A two tailed t-test assumes that the difference between the two means could favor either group [19]. Levene's test is an inferential statistic used to assess the equality of variances for two groups. If the resulting p-value of Levene's test is < 0.05, the differences in the sample variances are unlikely to have occurred based on random sampling from a population with equal variances. The Levene's test indicates equal variance when $p>0.05$. The alpha was set a $p<0.05$.

Results

Fall Risk Index

The cohort was stratified into two groups using the FRQ: increased risk of falling (IRF) and poor risk of falling (PRF). Individuals who scored seven or above on their FRQ were categorized as IRF; those who scored below seven were categorized as PRF. Of the 173 elderly individuals, 41 (23.69%) had an increased risk of falling (X^2 p-value: 2.65e - 12).

Dynamic proprioception performance

Biodex proprioception score during the braced and unbraced conditions are presented in Table 1. The difference between the IRF braced versus unbraced scores was not significant ($p>0.05$). Similarly, the results were not significant between the PRF braced versus unbraced scores ($p>0.05$). Finally, the proprioceptive braced and unbraced scores between the IRF and PRF groups were also not significant ($p > 0.05$). These data suggests that prophylactic ankle bracing does not improve proprioception in the elderly. The average dynamic proprioception fell within the age normative range for this cohort 1.4 - 3.4 [18]. The correlative relationship between the FRI and dynamic proprioception was $r = 0.04$.

Table 1. Biodex proprioceptive scores for the IRF (n = 132) and PRF (n = 41) groups

Variables	PRF	IRF	p-value (between groups)
Unbraced	2.97 ± 0.48	2.90 ± 0.48	0.56
Braced	2.99 ± 0.46	2.80 ± 0.45	0.88
p-value (within groups)	0.58	0.95	

Demographic characteristics

The demographic measures (age, body mass, stature and FRI) of the IRF and PRF groups are presented in Table 2. The age, body mass and stature did not significantly differ between the IRF and PRF groups. However, the FRI did significantly differ between the groups. The predisposing risk factor of advancing age was statistically compared to the FRI and yielded a weak correlative score of $r = 0.16$. Similarly, the cohort's age was compared to their dynamic proprioceptive score and yielded a correlative score of $r = - 0.04$.

Table 2. Demographic measures of the IRF (n = 41) and PRF (n = 132) groups

Variables	IRF	PRF	p-value
Age	71.5 ± 6.7	73.46 ± 6.65	0.10
Body mass (kg)	66.44 ± 12.9	68.94 ± 13.51	0.28
Stature (m)	1.61 ± 0.09	1.61 ± 0.09	0.88
FRI	2.61 ± 1.98	9.46 ± 2.23	2.78e -43

Discussion

Fall Risk Index

Of the 173 elderly participants, 41 were identified as at an increased risk for falling, which agrees with previous studies, including Yoshida's report that the elderly aged 64 years and older have a 30% risk of falling [2,4]. There was a weak correlation between unbraced proprioception and the FRI. We recommend further investigations to determine the relationship between the elderly population's fall risk and dynamic proprioception. There was a weak correlative relationship between age and increased risk of fall, which differs from previous studies and suggests that advancing age predisposes elderly people to falls [4]. Further studies are recommended to validate this novel finding.

Dynamic proprioception

The dynamic proprioception of the IRF and PRF groups during the unbraced experiment did not differ significantly and were comparable. The comparison between unbraced and braced dynamic proprioception in the IRF group indicated no significant difference. This suggests that prophylactic bracing does not increase ankle stability, in agreement with previous studies [12,13]. Bot and Van Mecheleen and Anderson et al. postulated that prophylactic ankle bracing did not increase the mechanical restraint of the anterior talofibular and calcaneofibular ligaments [12,13]. Instead, the ankle bracing made the talocrural joint rigid, which reduced joint mobility and proprioception, facilitating the chance of falling. This suggests that prophylactic ankle bracing does not improve ankle stability and proprioception.

Demographic measures

The age, stature and body mass of the IRF and PRF groups did not significantly differ, suggesting that these factors did not increase the risk for falling.

Conclusions

This study demonstrated that prophylactic semi-rigid ankle bracing is not an effective assistive management device to improve proprioception in the elderly. These findings will benefit the elderly, medical practitioners and engineers. Indeed, these data can assist engineers in their attempt to manufacture an assistive device that will enhance the proprioception of the elderly. We found an unexpected weak correlation between age and increased risk of fall, which differs from previous studies and suggests that advancing age predisposes elderly to fallings. We recommend further investigations to validate this novel observation.

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