The effect of attentional focus in imagery on sagittal ankle muscle power in able-bodied inactive elderly

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Abstract

Objective: The study was performed aimed at investigating the effect of attentional focus type in a period of imagery practice on mechanical power inactive elderly ankle muscles during walking. Methodology: The research was done using pretest-posttest matched-groups design on 20 men and women with a age range of 60 to 80 years old, which were selected as purposive. After initial training of imagery, the participants were divided into two matched groups of imagery with internal and external attentional focuses based on MIQ-RS questionnaire scores on by ABBA method, and practiced five sessions. Motion analysis cameras and force plate were used to calculate the muscle power. Data was analyzed by using the mixed 2 * 2 MANOVA for dependent variables of minimum and maximum of ankle muscle strength. Results: The main effect of attentional focus in imagery and test as well as their interaction on minimum and maximum of ankle muscle power was not significant (p > 0.05). Conclusion: Five sessions of imagery practice with changing attentional focus does not cause different impact on mechanical power of the ankle, and further studies on other joints are recommended during the intervention period.

Key words: attention, mechanical power, mental practice, ankle joint, older adult

Introduction

Increase in the elderly population due to declining birth, improved health conditions and increased life expectancy has increased the need to further attention to the problems of this group (WHO1, 2002). The global population is ageing at a rapid rate, In 1950, just over five percent of the world’s population was 65 years or older. By 2006, that number had jumped to eight percent. By 2030, experts anticipate that older adults will comprise 13 percent of the total population-one in eight people will be 65 or older (Lopez, 2006). Therefore, the society must pay more attention and sensitivity to meet the requirements and solve the problems of this class of population. Gait, as a basic skill, forms the greatest part of daily human movement activity (Gordon, 2004). This skill associated with some problems in old age is considered as an indicator to determine independence achievement in doing daily affairs of this group of the community. Hence, identification of effective factors and constraints of gait in aging times and effective methods in delaying the onset of these problems have been considered by researchers. Winter and his colleagues (1990) reported that elderly people had a shorter step length, increased double support time, reduced push-off power and a more flat-footed landing compared to the younger group. Krrigan et al. (1998) studied the effects of age and walking speed on biomechanical parameters in 31 able young and old subjects. They found that age and

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1 world health organization
speed had no effect on parameters such as maximum hip extension, anterior pelvis tilt, and ankle plantar flexion, while the ankle power generation could be affected due to different walking speeds. Macrae et al. (1992) claimed that muscular weakness in hip abductors, knee extensors and flexors and ankle dorsiflexor muscles were related to the risk of falling when moving and walking. In fact, the changes occurring in biomechanical capacities of elderly cause falls, injuries resulting from and disturbed elderly ‘gait’. changes such as reduced stride length and decreased stance support during gait. The need for adequate muscle strength has drawn the researchers’ attention to study the possible effect of strength training in older age and improved motor function in this group of people in the society. Sadeghi et al. (2001) announced that in the elderly, with age increasing, some changed in lower limb muscle function, and consequently, some abnormalities in biomechanical gait pattern and parameters such as step length and speed would occur. They also expressed that in elderly, the hip sagittal muscle power affected the stance phase and balance control while walking compared to the younger people. The results of research conducted by Sadeghi et al. in 2004 showed that in addition to the importance of balance control in gait of able-bodied aging participants, the muscle activity provided important assistance in push-off. Asymmetry of gait in the elderly seems to be related to different degrees of energy generated by lower limbs for the push-off, while both organs provided similar cooperation in balance controlling. In a study in 2009 conducted by Monaco et al., the steps and parameters and peaks of kinematic and kinetic patterns in two healthy young and elderly groups were compared. The results showed that the hip and knee concentric power of during the stance phase in elderly were higher than in young participants, despite their decreased ankle plantarflexor kinetics. Learning rate and optimized performance of skill depends on individual attentional focus. Attentional focus is a state in which attention to irrelevant stimuli reduces and the focus on relevant stimuli increases (Wulf, 2012). In a study conducted in 2005 by Canning, the influence of verbal cues on the spatial–temporal parameters of walking in elderly with Parkinson’s disease was tested. The results showed that the dual task of carrying tray with empty glasses while walking with external attentional focus in comparison with of the single task walking without attentional focus increased the walking speed and stride length. In a study conducted by Cohen in 2010, the effects of attentional focuses manipulation on elderly walking were studied. The results showed that the use of internal and external attentional focuses had significant effects on walking speed and the gait stability ratio and step time variance compared to not-using of them.

Furthermore, the use of attentional focus may be useful in modifying the walking performance during rehabilitative interventions; scientific evidence support the clear effectiveness of mental training on implementation and learning of motor skills (Feltz and Landers, 1983; Feltz et al., 1988; Murphy, 1994; Weinberg and Gould, 2003). In the field of sports psychology, mental training is considered as psychomotor skills, which has been much considered by researchers due to its impact on human motor function, especially in seniors. In a study conducted by Bakker et al in 2007, two types of motor imagery of gait and visual imagery were compared with the actual walking. According to the results, the movement time increased with increasing path length and decreasing path width; crucially, the effect of path width on movement time was significantly stronger during motor imagery and the actual walking than during visual imagery. In 2008, Callari found that mental practices should be focused on an external effect of the movement directly related to the movement technique (e.g., the trajectory of the rocket) rather than on a more distant effect, such as the anticipated trajectory of the ball. The efficiency of processes involved in maintaining balance and controlling posture decreases in aging. The muscular weakness of lower limbs during aging period is one of the factors causing reduced balance (Payne and Isaacs, 2012). Although according to the conducted studies, imagery and imagery training associated with body exercise has been effective on performance improvement of elderly ‘s gait, but recent studies have gone beyond the individual factors and seek to investigate the interaction of different influencing factors on elderly gaiting, and further research should be done regarding attention and imagination. According to what was said, one instance regarding reduced abilities in aging process is related to skeletal muscles strength (Edington and Edgerton, 1976). The research has shown that muscle power is a good indicator of a person’s ability to control lower limbs, which combines both kinetic and kinematics information from which joint mechanical energy of can be estimated (Sadeghi et al., 2002). Due to retrograde developmental changes in multiple organ systems during aging, the ability to perform daily and functional tasks in life decreases. Among secondary outcomes of aging that causes disturbance and inability in functional activities is disorder in control balance (Wells et al., 2003), which is a vital prerequisite for walking and performing voluntary fast movements (Shumway - Cook and Woollacott, 2012). Based on useful effects of external attentional focus as well as mental imagery on balance and gait, it is assumed that imagery training with external
attentional focus has an effect on old people walking. Therefore, the present study was performed aimed to investigate the effect of attentional focus type in a five-session course of imagery exercises on muscle power of inactive elderly during walking.

**Material and Method**

**Participants**

The participants of this quasi-experimental study included 20 elderly (10 inactive able men and 10 inactive able women) that were selected from Tehran healthy elderly population, aged 60-80 years old, who were able to walk independently and perform their daily activities. However, they had no regular physical activity, and were considered inactive with regard to Baeck Questionnaire of Habitual Activity. In addition, they had no previous history of diseases such as musculoskeletal or neurological disorders, pains limiting daily activities, hearing and vision problems and vestibular system, Parkinson disease, mental disorders and lack of alertness, Alzheimer's disease or other orthopedic ailments such as trauma or new surgeries that may affect their gait pattern. Due to the nature and purpose of the research, after the call to participate in the research through Tehran Seniors Center in the parks of Tehran, from 400 healthy volunteers intending to participate in the study, 40 participants meeting the requirements were selected as purposive from the home health of Taslilhat Park. Written informed consent was received from all participants after verbal explanation of the experimental design.

**Instruments**

Three-dimensional motion analysis system consisting of six IR cameras, model VICON 460 (1200 Hz), with opto track technology, and the infrared photocell system synchronized to two Kistler force plates with sampling frequency of 1000 Hz (Made in Switzerland), as well as multiple 1*1cm reflective markers that the cameras are able to track them down. In addition, three questionnaires were used to collect data:

1. MIQ-RS\(^1\) Questionnaires to measure the imagery ability of the subjects (Gregg et al., 2010); (Which consists of seven activities that after performing the actual movement, the person is required to imagine the movement as both visual imagery and kinesthetic imagery).
2. PR-Score Body Health Questionnaire to ensure the healthiness of subjects participating in the study; (Which includes questions about the physiological status and general health of the body).
3. Baeck Questionnaire for evaluating the subjects’ physical activity (Baecke et al., 1982); (which contains 16 multi-value questions).

**Procedure**

First, to determine the health history of the participants and their active or inactive status, PR-SCORE and BEACK physical activity questionnaires and information provided by the physician in the home health were used. In the pretest, performing four tests, including kicking a ball, hopping on a single limb, climbing stairs and starting walking from the paired feet to identify the dominant leg (Sadeghi et al., 1997), for defining marker places. For the detection of foot metatarsus, three markers were placed over the lateral malleolus, the heel and lateral border of the fifth metatarsophalangeal joint. Before starting the measurement, the space walkway was calibrated. During data collection, two force plates were placed with a distance of a normal step of together (0.6 m) in the middle of the walkway, which was determined by a flooring, 3 * 1.2 (m) in a room with the dimensions of 4 * 6 (m). The subjects were asked to walk at self-determined pace along the walkway. The walkway was designed to allow the subjects to walk comfortably and to make contact with the force plates. The duration of data collection was based on the subjects’ natural walking performance (two consecutive gait cycles). The subjects started to walk before the data collection was initiated; as the subject entered the calibrated space, the trigger was pressed to let the system collect the data (approximately 4 seconds). Then, elderly’s’ ability of imagery were evaluated using the MIQ-RS. Based on the questionnaire scores, the subjects with imagery ability below average were trained in the next session after the pre-test and practiced initial imagery to reach the moderate level. During the experimental treatment period, the picture of walkway in the Ergonomics laboratory was displayed in the home health for each of the mental imagery groups with internal and external focuses that in the middle of path a balance beam

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\(^1\) The Movement Imagery Questionnaire-Revised
as 30 cm wide (about the size of a normal step width) was designed. They were asked to close their eyes in a sitting position and imagined according to the instructions provided. The internal attentional focus group members were asked to look at the path from their angle of view (Fig. 1 a) and imagined themselves that were walking on the balance beam by focusing on thigh's moving forward and taking long strides. The external attentional focus group members were asked to look at the path from their angle of view (Fig. 1 b) and imagined themselves that were walking on the balance beam by focusing on markers along the side of the balance beam and taking steps next to them. The markers had been designed at the same intervals equal to a normal step length. The imagery practices expressed by the examiner were provided for both groups during 5 sessions in different days, each session lasting over 20 minutes with repeating five times of the instructions and one minute rest between the repeats as group. The posttest that was actually an intertask transfer of imagery of walking on the Balance Beam to the actual walking on the ground surface, was done 48 hours after the last session of practice, and the muscle power was measured exactly as same as the pretest. The instantaneous ankle muscle power (Pa) was calculated from product of the net ankle muscle moment (Ma) (using force plates and cameras data) and the ankle joint angular velocity (ωa) (using cameras data) in sagittal plane during the stance phase of gait cycles and expressed (Pa = Ma . ωa). Joint moments and angular velocities acting in the same direction resulted in power generation, whereas power absorption was obtained when angular velocity and moment had different polarities. Muscle powers were normalized with respect to the subjects’ body mass.

Statistical analysis

The effect of attentional focus of groups’ imagery on minimum (A1) and maximum (A2) powers were investigated using statistical method 2 (group) * 2 (test) multivariate analysis of variance with repeated measures of test factor at significant level of p <0.05.

Results

The assumption test of normal distribution of measured variables (Kolmogorov – Smirnov test) showed that the distributions of the dependent variables in each level of group and test factors were normal (p > 0.05).

The Box test indicated that the assumption of homogeneity of covariances was true (F(3,21415.9) = 0.291, p = 0.832). The Levin test also showed homogeneity of variances for A1 and A2 (respectively, $F_{(1, 14)} = 0.028, p = 0.87$; $F_{(1, 14)} = 0.066, p = 0.801$).

Figures 2 and 3 show the mean minimum and maximum of ankle muscle powers in stance phase in sagittal plate for pretest – posttest of internal and external attentional focuses groups (A1S: the first letter refers to the joint and the number indicates the sequence of the power burst. the second letter identifies the plane of motion). As can be seen in the Figure, although the increase in muscle power after the experimental period was more in the imagery group with internal attentional focus group, however, the results of mixed two-factor multivariate analysis of variance for maximum and minimum muscle power of ankle joint (Table 1) showed no significant main effects and interaction.
Table 1: Results of mixed 2*2 MANOVA for ankle joint mechanical power variable

<table>
<thead>
<tr>
<th>Variation Source</th>
<th>Λ</th>
<th>F</th>
<th>Hypothesis Degree of freedom (df)</th>
<th>Error df</th>
<th>Meaningfulness level (P)</th>
<th>η²</th>
</tr>
</thead>
<tbody>
<tr>
<td>group</td>
<td>0.857</td>
<td>1.089</td>
<td>2</td>
<td>13</td>
<td>0.365</td>
<td>0.143</td>
</tr>
<tr>
<td>test</td>
<td>0.937</td>
<td>0.436</td>
<td>2</td>
<td>13</td>
<td>0.656</td>
<td>0.063</td>
</tr>
<tr>
<td>Group * test</td>
<td>0.837</td>
<td>1.267</td>
<td>2</td>
<td>13</td>
<td>0.314</td>
<td>0.163</td>
</tr>
</tbody>
</table>

Discussion and conclusion

The purpose of this study was to investigate the effects of imagery training with changing the attentional focus on the ankle muscle power of inactive elderly during walking. To cover a certain distance while walking, the cooperation of different muscle groups is needed, and the rates of bending, opening, distancing and approaching to step, depends on muscle power. Some researchers have proposed that mental training not only is involved in the programming and planning of the motion, but also is involved in the implementation and is similar to physical activity (Feltz and Landers, 1983). Given that loss of motivation in elderly and the fear of falling and/or physical problems, which are followed by atrophy of muscle strength, this study was trying to find a new horizon in solving the elderly motion limitations by help of mental training as well as helping other researchers in rehabilitation training. Although the results showed that imagery training with an internal attentional focus was effective on increased of plantarflexor and dorsiflexor muscles power, but this positive effect was not significant. In a study by Rees et al. (2008), the effects of
vibration exercise on power and isokinetic strength (force-producing capacity) of flexors and extensors of hip, knee and ankle of older adults were reviewed, which more significant improvements were seen in ankle plantar flexors; however, no significant difference was seen between the power and strength of hip extensors and flexors; whereas the power of knee extensors and flexors was significantly different, and its strength had no significant improvement. The study results were in contrasts with the present study. Monaco et al. (2009) found out since proximal and distal extensor muscles contributed to the same functional tasks during walking (e.g., stabilization, forward acceleration of the trunk, body support against gravity), ageing would involved a different sharing of muscle efforts among leg joints, increasing the work load of the proximal extensor muscles. Our results also would support this hypothesis of an age-related redistribution of kinetics among leg joints (De vita and Hortobagyi, 2000) consisting of reducing efforts at the calf ones. This would highlight the distal extensor or flexor muscles seem to be less employed during stance phase, it may due to a strategy aimed at increasing the efforts of the muscle with greater size. Therefore, The results of our research confirm the Monaco et al. (2009) results relaying on little distribution of kinetics at the ankle. Chol et al. (2010) claimed the Physical balance training with visual feedback as well as mental balance training with motor imagery is effective. Therefore, postural balance training with motor imagery is an effective therapeutic method for improving the dynamic balance control ability of healthy subjects. From our results, motor imagery training with internal attentional focus exhibited improving in elderly's lower muscle power during gait. Wulf et al. (2012) studied the effect of different verbal instructions related to the attentional focus on performance and learning of complex motor skills. The results showed the performing of this motor skill in external attentional focus group was better than other groups. Also, Caliari conducted a study in 2008; given the results, he suggested that mental practice would be more beneficial if focused on an external effect of the movement directly related to the motion technique, rather than on a more distance effects. The results of the present study are in contradiction with existing studies suggesting the performance improvement with external attentional focus. However, in a research conducted by Cohen in 2010, the effects of using internal and external attentional focuses on elderly walking is examined compared to not using them. The results of that research do not confirm the improved performance with external attentional focus, which is consistent with the current study. It seems that for better understanding of the effect of attentional focus on imagery training, we need to increase the number of training sessions, and meanwhile controlling the physical exercise, different percentages of mental and physical training must be examined.

The results of the current study demonstrated the imagery training period with an internal attentional focus produced improvement in muscle power of ankle, but it was not significant. According to the research findings suggesting the insignificance of muscle power in post-test of two internal and external attentional focus groups, it can be concluded that none of the attentional focus types is superior in the imagery training to increase the muscle power compared to the other one.

References


