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Bracing the trunk and neck in young adults leads to a more aged-like gait

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ABSTRACT

Older individuals typically walk at slower speeds, with shorter step lengths, greater step widths and spend a larger proportion of the gait cycle in double stance. Changes in neck and trunk mobility may underlie some of the changes in walking seen with increasing age. Consequently, this study was designed to assess whether externally increasing trunk/neck stiffness in young adults leads to similar changes in gait pattern observed with aging. Twelve young adults (20–29 years), sixteen old adults (60–69 years) and fifteen older adults (70–79 years) walked across a 20′ pressure sensitive GAITRite© instrumented walkway at their preferred speed. The young adults also walked under three bracing conditions: (1) Neck braced, (2) Trunk braced, and (3) Neck and Trunk braced. The results revealed that the old and older age groups walked significantly slower, with a shorter step length and with a narrower base of support (p's < 0.05) compared to the young adults. In young adults, combined neck and trunk bracing led to reduced walking speed, shorter step length, wider base of support and a larger proportion of the gait cycle spent in double stance (p's < 0.05). The walking speed and step length of older adults remained less than fully braced young adults (p's < 0.05). Overall these results indicate that artificially stiffening the trunk and neck of young individuals leads to systematic gait changes similar to aging. Consequently, age-related changes in mobility of the neck and torso may in part contribute to the decrements in walking seen for older adults.

1. Introduction

Walking performance typically declines with age. The preferred walking speed of older adults over 60 years of age is, on average, significantly slower than adults in their 20's, and walking speed continues to decline in the eighth decade of life [1]. The decrease in speed appears to arise primarily from a shortened step length [2–6], rather than a change in step time [5,7,8]. Further, it appears that older adults increase the proportion of time spent in double stance and reduce the proportion of time spent in swing [1,6]. This may be an effort to maintain stability which would also explain the observation of elderly individuals taking wider steps [9]. The combination of slower speed, shorter and wider steps has been characterized as 'cautious' gait and is particularly evident in older individuals with increased fear of falling [9]. However, declines in gait metrics may not simply be the consequence of age per se as several studies have found no difference in walking performance of healthy young and elderly adults, especially when the older individuals have been screened for potential physical impairments [7,8,10,11]. Consequently, it would appear that factors other than chronological age are likely to underlie the slower walking speeds observed in the typical elderly individual over 60 years of age. In particular, it has been reported that walking speed decrements could reflect fear of falling, slower processing time, decreased leg strength and/or reduced leg range of motion [9,12]. One potential factor that has received little attention in the literature is whether the reduction in the neck and trunk mobility reported for elderly adults could influence their gait.

There is a growing recognition of the contributions made by the trunk and neck to walking [13–15]. Ground reaction forces that are transmitted up through the legs to the pelvis are dissipated through these segments [13,15]. Rotations at the pelvis are also compensated by motion in the trunk to maintain balance [14]. Together, these findings illustrate the importance that the trunk and neck play in maintaining stability of the head during gait which enhances the accuracy of visual and vestibular systems [16,17]. While head stability can be maintained in older adults,

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upper body coordination during walking varies with age [18–20]. The increased stiffness of trunk and neck with age could be the source of these coordination differences. Older adults have been found to have reduced flexibility in the cervical and lumbar regions of the spine [21,22]. Both the intervertebral discs and vertebra themselves change in composition and morphology with age, leading to a stiffened spine and altered ability to transfer forces [23]. Additionally, muscles also display greater stiffness with aging, as a result of increased development of connective tissue [24]. Combined, these findings suggest that increased stiffness in the trunk and neck may contribute to the more 'cautious' gait observed with age.

As older adults are likely to have other deficits that could impact their gait, artificially stiffening the neck and trunk of young adults provides a means by which to determine its effect on walking performance, while minimizing the potential impact of other confounding variables. Neck and/or trunk stiffness of young adults has been experimentally manipulated through bracing in an effort to examine the impact on specific aspects of gait [25,26]. Wu and colleagues observed that bracing the trunk altered coordination between the legs, pelvis and thorax [25], while in a previous study we reported that bracing the neck and trunk changes control of the head during walking [26]. Both of these studies controlled gait speed in an effort to avoid the potential confounding effects of speed. Hence, the impact of bracing the neck and/or trunk on spatiotemporal parameters of walking is unknown.

The current study examined whether young adults could be made to walk with similar spatiotemporal gait parameters to older adults, through bracing the neck and trunk. Firstly, spatiotemporal parameters were compared between young adults and older adults (60–69 years and 70–79 years of age). Secondly, the influence of artificial stiffening of the neck and/or trunk on the gait of young adults was assessed. Finally, the gait of young adults with bracing was compared with older adults without bracing.

2. Methods

2.1. Subjects

Twelve young adults (Age: M = 21.3, range = 20–29; Height: M = 1.68 ± 0.09 m; 10 female), sixteen 60 year olds (Age: M = 64.4, range = 60–69; Height: M = 1.70 ± 0.13 m; 9 female) and fifteen 70 year olds (Age: M = 74.4, range = 70–79; Height: M = 1.70 ± 0.08 m; 11 female) volunteered for this study. All participants were in good physical condition and were free from any neuromuscular or musculoskeletal disorders that may have caused abnormal gait patterns. Informed consent was granted by participants in accordance with the university institutional review board.

2.2. Apparatus

A 20′ GAITRite© (CIR Systems Inc. Clifton, NJ 07012) instrumented walkway was used to quantify spatiotemporal parameters of gait. The neck was braced using a cervical collar (StifNeck, Laerdal Medical, Wappingers Falls, NY). The entire trunk was braced using a Kendrick Extrication Device (K.E.D., Ferno-Washington Inc., Wilmington, OH). In the combined neck and trunk bracing condition both braces were utilized and the head was secured to the trunk brace via a strap across the forehead (Fig. 1).

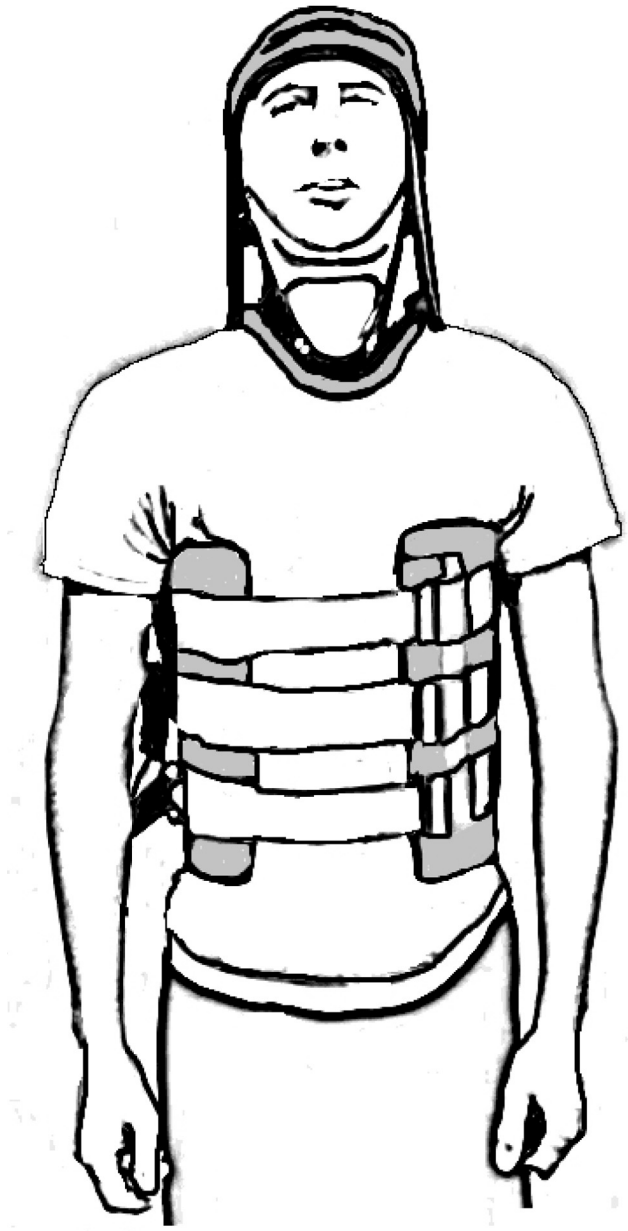

Fig. 1. The combined neck (cervical collar) and trunk (Kendrick Extrication Device) braces are shown with the head secured to the trunk brace via a strap across the forehead.

2.3. Procedures

All participants were instructed to look straight ahead and walk at their preferred speed across the instrumented GAITRite© mat. Walking started at least 2 m before the start of the mat and continued at least 2 m after the mat to avoid collecting data on speeding up or slowing down. After two practice trials, all participants completed three trials under the control (no brace) condition.

The young participants also completed three walking trials under each of three bracing conditions. These were: (1) Neck brace, (2) Trunk brace, and (3) Neck and Trunk brace. The control condition was always performed first, while the other three conditions were performed in a counter-balanced order.

2.4. Data analysis

Each footfall on the pressure sensitive mat was detected by GAITRite© software from which spatiotemporal parameters of gait were determined. These included: speed, right step time, right step