Relationship between functional mobility tests and pulse pressure in aged men: a preliminary report.

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**A R T I C L E I N F O**

**A B S T R A C T**

Aging is a biological companion of time, spares no organ or system, and in due course affects everything, from cell to thought. Blood pressure fluctuations have been associated with microvascular damage in older adults. Pulse pressure (PP), a putative marker of vascular integrity, may be associated with brain microvascular damage and age-related decline in functional mobility. Aim: The present study destined to examine the relationship between PP and functional mobility in young and older adult men with no diagnosed neurological dysfunction. Methods: The study included 50 male participants aged between 18 – 25 and 50 - 70 years. Functional mobility measures included the near tandem balance test, the six meter walk test, the sit to stand test with five repetitions and the alternate step test. Results: Older participants performed significantly worse than the younger participants in all of the functional mobility tests (p < 0.05). Correlation analyses examined the relationship between ankle pulse pressure (PP) [systolic blood pressure (SBP) – diastolic blood pressure (DBP)], age, and mobility tests. Significant correlations were found within the older group among all the functional mobility tests scores. Conclusion: Raised PP is more prominent in the lower limb (ankle) of aged men. Elevated ankle pulse pressure may index the impaired functional mobility with advanced age.

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1. Introduction

The pulsatile component, pulse pressure (PP) is determined by combination of factors including stroke volume, arterial compliance and wave reflection. PP is a putative marker of vascular integrity, may be associated with brain microvascular damage. Microvascular ability to respond to metabolic demand falls with aging [1]. Age related changes in the performance of functional mobility measures and physiological parameters are associated with an increased risk of falls and ongoing disability [2]. In older people altered hemodynamics with atherosclerosis of coronary and popliteal artery is common and may be clinically important; raised pulse pressure (PP) is more prominent in lower limb (e.g. ankle). With aging, the peripheral PP in muscular arteries of the upper and lower limbs may be influenced unequally. Ankle PP may be more informative than brachial PP in the elderly [3]. Therefore the present study investigated the relation between the PP and functional mobility tests in the young and the old men.

2. Methods

2.1 Participants

Twenty five young participants (25 men) aged 18 – 25 years and equal number of older people (25 men) aged 50 - 70 years performed tests of functional mobility. The young participants were undergraduate medical students while the older participants were selected during rural visit. Due to menarche and menopause, women were not chosen for this study. Exclusion criteria primarily included no previous history of smoking, diagnosis of hypertension/atherosclerosis, any neurological disorder and on medication. Institutional Ethics Committee of GSL Medical College approved the study and informed consent was obtained from participants prior to their work-up.
2.2 Blood Pressure (BP) measurements

Blood pressure measurements (in mmHg) were taken after 5min complete rest in supine position between 9:00 am and 11:30 am. The brachial and ankle BP was measured by automated BP monitor (Loyld Pharmacy, UK). The first values were ignored and then the mean of the second and third readings were used; ankle and brachial PP obtained (systolic BP – diastolic BP).

2.3 Functional Mobility Tests

2.3.1 Near Tandem Balance (NTB) /sec: In this test, participants were asked to stand in a near-tandem position with their bare feet separated laterally by 2.5 cm with the heel of the front foot 2.5 cm anterior to the great toe of the back foot. The time (seconds) that participants were able to stand in this position before a step was taken or the eyes were opened was the score.

2.3.2 Walking speed (m/s): Participants were asked to walk 6 meters along a straight, flat, well lit corridor at their normal walking speed. They were allowed to walk beyond 6 meters to ensure that walking pace was kept consistent through the task. Walking speed (m/s) was used as the test measure.

2.3.3 Sit to stand /sec - Participants were asked to rise from a standard height (43 cm) chair five times as fast as possible with their arms folded. Participants undertook the test barefoot. The time (seconds) from the initial seated position to the final seated position after completing five stands was the test measure.

2.3.4 Alternate step - This test involved alternatively placing the whole left and right foot (shoes removed) as fast as possible onto a step that was 19 cm high and 40 cm deep. The time (seconds) taken to complete eight steps, alternating between left and right foot comprised the test measure.

2.4 Statistical analysis: All statistical analysis was done by using SPSS 16 (trial version, MS Excel 2007). Values were presented as mean ±SD. Student ‘t’ test was used for comparison using SPSS 16 (trial version, MS Excel 2007). Values were presented as mean ±SD. Student ‘t’ test was used for comparison between the two groups and Karl Pearson coefficient of correlation was used for detecting the relationship between variables. For all statistical analysis, p<0.05 was considered as statistically significant.

3. Results

The range and the mean age of men in the two groups were 18 – 25 and 20 ± 1.5 years (n=25) for the young group and 50 – 70 and 58 ± 6.3 years (n=25) for the old group respectively. The mean of brachial and ankle systolic and diastolic pressures were shown in the Table 1. In each group, there was no significant (p>0.05) difference in brachial systolic, diastolic and PP between left and right sides while brachial to ankle blood pressures were significant (p<0.05). While there was no significant difference in the ankle pressures of the younger group from right to left, the right ankle PP was less significant compared to left side in older group (p<0.05; Figure. 1). The PP was found to be highly significant between left brachial and left ankle of the older group (p<0.001).

3.1 Functional mobility tests

The older participants (as a group) performed significantly worse in all tests than their younger counterparts (p<0.001; Figure. 2). No correlations were observed between the brachial PP and mobility tests in both groups. Within the older group 6mts walking test was inversely and significantly correlated with right ankle PP (r = -0.417; p<0.05) and sit to stand test (r = -0.533, p<0.05); there was no correlation with left ankle PP. NTB was significantly, inversely correlated with alternate step test (r = -0.531, p<0.05) while a significant positive correlation was observed between sit to stand and alternate step test (r=0.606; p<0.01; Table. 2).

In the younger group sit to stand was significantly, positively correlated (r=0.974; p<0.01) with alternate step test while other functional mobility tests remained unchanged.

Table 1. The mean ± SD of brachial and ankle blood pressures of both young (n = 25; 18 – 25yrs) and old (n = 25; 50 – 70yrs) groups

<table>
<thead>
<tr>
<th>GROUP</th>
<th>Mean</th>
<th>Mean</th>
<th>Mean</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>LBrSBP</td>
<td>YOUNG</td>
<td>117.04±22.48*</td>
<td>138.32±16.30</td>
<td></td>
</tr>
<tr>
<td>RBrSBP</td>
<td>YOUNG</td>
<td>119.84±7.52*</td>
<td>139.52±16.45</td>
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<tr>
<td>LBrDBP</td>
<td>YOUNG</td>
<td>78.36±7.05**</td>
<td>86.24±8.87</td>
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<tr>
<td>RBrDBP</td>
<td>YOUNG</td>
<td>7.20±6.14*</td>
<td>85.60±7.70</td>
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<tr>
<td>LankleSBP</td>
<td>YOUNG</td>
<td>121.20±2.72*</td>
<td>152.52±15.69</td>
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<tr>
<td>RankleSBP</td>
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<tr>
<td>LankleDBP</td>
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<tr>
<td>RankleDBP</td>
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<td>80.24±5.55</td>
<td>81.32±9.38</td>
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</table>

<table>
<thead>
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<th>Mean</th>
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<tr>
<td>NTB</td>
<td>-307</td>
<td>1</td>
<td>-326</td>
<td>-531**</td>
</tr>
<tr>
<td>Sig (2-tailed)</td>
<td>.127</td>
<td>.157</td>
<td>.104</td>
<td>.005</td>
</tr>
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<td>Walking speed</td>
<td>-417*</td>
<td>.286</td>
<td>1</td>
<td>-533**</td>
</tr>
<tr>
<td>Sig (2-tailed)</td>
<td>.034</td>
<td>.157</td>
<td>.005</td>
<td>2.26</td>
</tr>
<tr>
<td>Sitstand Peacock</td>
<td>.145</td>
<td>.326</td>
<td>.005</td>
<td>.606**</td>
</tr>
<tr>
<td>Sig (2-tailed)</td>
<td>.480</td>
<td>.104</td>
<td>1</td>
<td>.001</td>
</tr>
</tbody>
</table>

L Br = left brachial; R Br = right brachial; L ankle = left ankle; R ankle = right ankle; SBP = systolic blood pressure; DBP = diastolic blood pressure. * p < 0.0001; ** p < 0.01

Table 2. Karl Pearson coefficient of correlations between functional mobility tests and ankle pulse pressure of young and old groups.

*Correlation is significant at the 0.05 level (2 - tailed)
** Correlation is significant at the 0.01 level (2 - tailed)
microvasculature, such as brain. PP is a marker of arterial stiffness; highly perfused organs with a rich, autoregulated microvascular damage. This problem may be particularly salient in fluctuations during each cardiac cycle, potentially leading to These changes could expose smaller vessels to harmful pressure atherosclerosis, which further exacerbates arterial stiffening [6].

Arterial elasticity allows stretching to decrease pressure increases during systole and recoil to buffer decreased pressure during diastole [4]. These factors assist in the maintenance of relatively constant pressures at the level of distal arterioles and capillary beds. Changes in the elastin and collagen fibers within the elastic lamina of larger vessels may be responsible for stiffening of larger arteries with age [5]. As large arteries stiffen they lose compliance and no longer buffer fluctuations in pressure throughout the cardiac cycle. The resulting increase in pulsatile stress on the vessel wall may contribute to the development of atherosclerosis, which further exacerbates arterial stiffening [6]. These changes could expose smaller vessels to harmful pressure fluctuations during each cardiac cycle, potentially leading to microvascular damage. This problem may be particularly salient in highly perfused organs with a rich, autoregulated microvasculature, such as brain. PP is a marker of arterial stiffness; high PP (> 60 mmHg) may be a sign of generalized atherosclerosis (AS). Mobility tests are commonly used to assess function and frailty in older populations. Age-related changes in the performance of functional mobility measures and physiological domains are also associated with ongoing disability. In the present study, systolic pressures were higher in lower limbs of both groups. In the younger group ankle PP was lower than brachial PP both on the right and left sides. In the older group, brachial PP was lower than ankle PP on both sides; greater differences were observed between the young group’s ankle PP and older group’s ankle PP than between their brachial PPs. Mitchell et al., 2008 studied the relation between advanced age and hypertension; SBP increases with age while mean arterial pressure (MAP) remains constant and the DBP decreases, leading to elevated PP. Elevated ankle PP in the older participants may represent an indirect measure of arterial stiffness that occurs with age however the older participants in the present study were not screened for any cardiovascular risk factors previously or currently under medication. As the pressure cuff is fastened on the lower half of the calf muscles, the ankle pressure obtained was not confined to either posterior or anterior tibial artery alone; it was the cumulative pressure of both arterial territories.

Measures of pressure fluctuation and arterial stiffness such as PP have been associated with microvascular damage in older adults with hypertension and those with Alzheimer’s disease (AD); additionally elevated PP has been associated with declines in global cognitive functioning and memory in healthy populations [7]. The findings of the present study, the relationship between PP and measures of functional mobility tests were in consistent with reports of Nation et al., 2010 that PP and related measures were inversely correlated with global cognitive functioning and scores on language ability. Significant correlations among all the functional mobility tests in the older group indicate that older adults who performed poorly in one test were likely to perform poorly in all other tests. This suggests that to a larger extent these tests assess a common underlying “mobility” [8] construct rather than distinct functional abilities.

The six meter walk, sit to stand and alternate step tests showed smallest differences which are likely due to the fact that they are familiar and of low threat with respect to falling. Familiarization factor in the near tandem balance test was less similar to everyday tasks than tests such as the sit to stand and walking speed tests which are integral elements of activities of daily living [9]. Several studies have shown that a significant decline in the ability to perform balance tests commence at approximately 40 years of age [10, 11]. Similarly gait speed slows with age [12] and ageing process contributes to decline in stair negotiation ability [13] and lower limb strength [14].

The current study did not observe a significant relationship between PP and near tandem balance, sit to stand and alternate step test suggesting that other mechanisms of injury may be involved; there may be insidious neuropathologic changes associated with alterations in hemodynamic parameters. For example, both animal and human studies have found that elevated

![Figure 1. Ankle pulse pressure variation in young and old groups](image1)

L ank PP = left ankle pulse pressure
R ank PP = right ankle pulse pressure

![Figure 2. Performance of functional mobility tests in young & old groups](image2)

**FUNCTIONAL MOBILITY TESTS**

4. Discussion:

In healthy individuals, the elastic properties of aorta, carotid and other large arteries reduce pressure fluctuations that occur during the cardiac cycle. Arterial elasticity allows stretching to reduce pressure increases during systole and recoil to buffer decreased pressure during diastole [4]. These factors assist in the maintenance of relatively constant pressures at the level of distal arterioles and capillary beds. Changes in the elastin and collagen fibers within the elastic lamina of larger vessels may be responsible for stiffening of larger arteries with age [5]. As large arteries stiffen they lose compliance and no longer buffer fluctuations in pressure throughout the cardiac cycle. The resulting increase in pulsatile stress on the vessel wall may contribute to the development of atherosclerosis, which further exacerbates arterial stiffening [6]. These changes could expose smaller vessels to harmful pressure fluctuations during each cardiac cycle, potentially leading to microvascular damage. This problem may be particularly salient in highly perfused organs with a rich, autoregulated microvasculature, such as brain. PP is a marker of arterial stiffness;
blood pressure can cause reduced cerebral blood flow and increased cerebral atrophy, even in absence of frank vascular lesions [15]. More richly perfused cortical grey matter could be susceptible to damage or dysfunction from increased PP.

5. Conclusion:

Increased microvascular perfusion in the context of elevated PP may be associated with particularly high risk damage to higher brain centers. Thus PP may represent a measure of systemic vascular disease, a causative factor in cerebrovascular dysfunction, or some combination of both. Further studies examining the relationship between PP and cerebral structure, function and perfusion may provide more information regarding the mechanism of underlying the association between PP and motor function. The findings of the current study are limited by the nature of our sample, which was less in number of participants and lack of clinical investigations.

6. Acknowledgements:

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7. References


