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ORIGINAL ARTICLE

Effects of Patient-Controlled Abdominal Compression on Standing Systolic Blood Pressure in Adults With Orthostatic Hypotension

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Abstract

Objective: To assess the effects of patient-controlled abdominal compression on postural changes in systolic blood pressure (SBP) associated with orthostatic hypotension (OH). Secondary variables included subject assessments of their preferences and the ease-of-use.

Design: Randomized crossover trial.

Setting: Clinical research laboratory.

Participants: Adults with neurogenic OH (N=13).

Interventions: Four maneuvers were performed: moving from supine to standing without abdominal compression; moving from supine to standing with either a conventional or an adjustable abdominal binder in place; application of subject-determined maximal tolerable abdominal compression while standing; and while still erect, subsequent reduction of abdominal compression to a level the subject believed would be tolerable for a prolonged period.

Main Outcome Measures: The primary outcome variable included postural changes in SBP. Secondary outcome variables included subject assessments of their preferences and ease of use.

Results: Baseline median SBP in the supine position was not affected by mild (10mmHg) abdominal compression prior to rising (without abdominal compression: 146mmHg; interquartile range, 124−164mmHg; with the conventional binder: 145mmHg; interquartile range, 129−167mmHg; with the adjustable binder: 153mmHg, interquartile range, 129−160mmHg; $P=.85$). Standing without a binder was associated with an −57mmHg (interquartile range, −40 to −76mmHg) SBP decrease. Levels of compression of 10mmHg applied prior to rising with the conventional and adjustable binders blunted these drops to −50mmHg (interquartile range, −33 to −70mmHg; $P=.03$) and −46mmHg (interquartile range, −34 to −75mmHg; $P=.01$), respectively. Increasing compression to subject-selected maximal tolerance while standing did not provide additional benefit and was associated with drops of −53mmHg (interquartile range, −26 to −71mmHg; $P=.64$) and −59mmHg (interquartile range, −49 to −76mmHg; $P=.52$) for the conventional and adjustable binders, respectively. Subsequent reduction of compression to more tolerable levels tended to worsen OH with both the conventional (−61mmHg; interquartile range, −33 to −80mmHg; $P=.64$) and adjustable (−67mmHg; interquartile range, −61 to −84mmHg; $P=.79$) binders. Subjects reported no differences in preferences between the binders in terms of preference or ease of use.

Conclusions: These results suggest that mild (10mmHg) abdominal compression prior to rising can ameliorate OH, but further compression once standing does not result in additional benefit.

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Orthostatic hypotension (OH) is a disabling condition that is thought to affect as many as 5% to 30% of adults aged >65 years.[1] The range of its etiologies is wide and includes but is not limited to medication effects, cardiac impairment, neurogenic causes (eg, autonomic failure, spinal cord injury), hypovolemia, and deconditioning/prolonged bed rest. Symptoms may be as mild as transient lightheadedness or as severe and disabling as frank syncope. Although OH is typically defined as a >20mmHg drop of systolic blood pressure (SBP) or a 10mmHg drop of diastolic blood pressure (DBP) within 3 minutes of standing,[2] its fundamental cause is the inability of the body to maintain a sufficient cardiac output during orthostatic stress. Treatment, whether with dietary changes, medication, or compression garments, often remains unsatisfactory.

Venous pooling has been identified as a major contributor to the pathophysiology of the condition.[3] Two treatment approaches to improve venous return to the heart are in common use. The first uses dietary and pharmacologic manipulation to increase either the vascular system's blood volume (eg, sodium supplementation, fludrocortisone) or vasomotor tone (eg, midodrine). The second, however, focuses on mechanical compression of large capacitance venous vessels with a resultant improvement of venous return, cardiac filling, and cardiac output. In practice, the latter strategy is customarily performed through use of lower-extremity compression garments. Although compression of the lower extremities' veins is intuitively reasonable, it turns out that the splanchnic venous vascular bed forms the largest of the body's blood reservoirs (20%−30% total blood volume).[4] At least in the laboratory setting, its compression with pneumatic antigravity suits appears more effective in lessening OH than similar compression applied to the lower extremities.[5-7] Although the efficacy of abdominal compression has been proven under strict experimental conditions, it remains to be clearly established whether more clinically relevant compressions with binders are effective or whether adjustments in binder compression once standing can provide additional benefits.

Given this, we undertook a study to investigate the usefulness of conventional elastic and a more easily adjustable pullstring abdominal binder in increasing standing blood pressure in adults with OH. Our hypothesis was that both binders would be beneficial but that the adjustable binder, given its potential for simpler adjustment, would be more effective.

Methods

This randomized crossover treatment trial was reviewed and approved by our institutional review board and carried out in the Research Autonomic Laboratory at the Mayo Clinic in Rochester, Minnesota, between July 2010 and June 2012. All subjects signed informed consent prior to participation. Trials took place during the morning in a room at ambient temperature of 22°C to 24°C. Subjects were told to maintain good hydration and fast for at least 4 hours before testing. They were also instructed to abstain from medications and substances known to affect the results of autonomic testing for at least 2 half-lives (eg, ethanol for 24h, nicotine for 4h, caffeine for 12h).

List of abbreviations:

DBP diastolic blood pressure
IQR interquartile range
OH orthostatic hypotension
SBP systolic blood pressure
VAS visual analog scale

Participants

Thirteen adults with neurogenic OH were recruited using the Mayo Clinic Autonomic Laboratory Database (Rochester, MN). Subjects were included if they met clinical and laboratory criteria for moderately severe neurogenic OH as follows: supine to standing blood pressure drops of ≥30mmHg SBP and ≥15mmHg DBP; diagnosis of Parkinson disease, diabetic neuropathy, multiple system atrophy, or another neurologic condition associated with autonomic failure; and laboratory evidence of moderately severe adrenergic failure as measured by the compensatory hemodynamic responses to Valsalva-induced hypotension.[8] We recruited only those who were ambulatory and able to stand for at least 3 minutes without developing presyncope, discomfort, or cognitive difficulties severe enough to impair ability to follow commands.

Exclusion criteria

Exclusion criteria included the following: positive pregnancy tests in premenopausal women or lactation, motor impairment affecting hand coordination, dementia, severe systemic illness, inability to tolerate withholding of anticholinergic-/alpha- and beta-adrenergic agonist therapies for at least 5 half-lives prior to the study, and inability to withhold midodrine the night before evaluation. Fludrocortisone doses of ≤0.2mg/d were permitted.

Measurements

Hemodynamic variables

Continuous beat-to-beat arterial blood pressure was measured using plethysmography of the left index finger (Finapres model 5,[a] 2300e Finapres NIBP monitor[a]) held at the heart level in a manner that has been shown to accurately reflect changes in intra-arterial blood pressure both at rest[9] and during orthostatic stress.[10] Continuous heart rates were measured using a 3-lead electrocardiogram. Data from the Finapres and electrocardiogram devices were recorded and monitored on a computer console that displayed heart rate, SBP, DBP, and mean blood pressure continuously.

Orthostatic intolerance

The Orthostatic Symptom Scale[6,11] grades the severity of orthostatic symptoms that occur during 5 minutes of standing. The subject reports on a visual analog scale (VAS) the severity of symptoms ranging from 0 (no symptoms) to 10 (syncope or presyncope), with intermediate scores of 2, 4, 6, and 8 defined as tiredness or momentary light-headedness, mental sluggishness or difficulty concentrating, dizziness or unsteadiness, and blurred vision or faintness, respectively. The Symptom Change Scale[6,12] is a VAS that assesses whether subjects perceive themselves have changes in their ability to stay erect longer or the severity of their symptoms as a result of a study maneuver. Changes are marked on the scale as follows: −3 (much worse), −2 (moderately worse), −1 (mildly worse), 0 (no change), 1 (mildly improved), 2 (moderately improved), and 3 (much improved).

Binder preferences

Two VAS scales were used to assess binder preferences. The first, an ease of use scale, was created to grade the difficulty of adjusting the compression with the abdominal binder while