



EDITORIAL

Abdominal Compression as a Treatment for Postural Tachycardia Syndrome

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Postural tachycardia syndrome (POTS) is a chronic form of orthostatic intolerance defined by orthostatic tachycardia (an increase in heart rate from supine of at least 30 beats per minute in adults or 40 beats per minute in adolescents within 10 minutes of head-up tilt or standing) combined with chronic orthostatic symptoms including lightheadedness, fatigue, palpitations, and gastrointestinal upset.^{1,2} The origin of POTS is currently unknown and likely heterogeneous. POTS predominately affects premenopausal women and the onset is often triggered by an event such as a viral illness or injury.¹

See Article by Smith et al.

There is no standard treatment protocol for POTS, and care typically involves a multifaceted approach using both nonpharmacological and pharmacological interventions.³ There are also no pharmacological treatments that are currently approved by the US Food and Drug Administration to treat POTS, because of an absence of randomized controlled trials.³ However, in small studies it was found that many medications including β -blockers, fludrocortisone, midodrine, and intravenous saline have been shown to decrease POTS symptoms.³ Nonpharmacological approaches to treat POTS include increased salt and fluid intake, exercise, as well as leg and abdominal body compression.⁴ Few of these nonpharmacological options for POTS have been validated in clinical trials. Compression garment research has demonstrated effectiveness in other types of orthostatic intolerance including orthostatic hypotension (OH) and vasovagal syncope,⁵⁻⁹ but there are

few published studies using compression in POTS.¹⁰ One study in a pediatric POTS population showed that combined leg and abdominal compression decreased heart rate response to head-up tilt by 24 beats/minute, when compared with no compression.¹⁰ However, the cardiovascular effects of abdominal compression in POTS are not well understood.

In this issue of the *Journal of the American Heart Association (JAHA)*, Smith et al¹¹ investigated the acute effects of a custom inflatable abdominal compression device on orthostatic heart rate, blood pressure, and POTS symptoms in 19 adult participants with POTS. The effects of splanchnic venous compression were compared with, and used in combination with, low-dose (20 mg) propranolol, which is a common treatment for POTS. This study provides evidence that abdominal compression may be an effective treatment for POTS, especially when used in combination with a β -blocker. Overall, these findings support the use of abdominal compression for POTS. However, a few questions remain: (1) It is unclear how abdominal compression affects cardiovascular physiology in POTS, and (2) It is yet to be determined whether the findings in this acute laboratory study will translate into an effective chronic treatment.

HOW DOES ABDOMINAL COMPRESSION AFFECT POTS PATHOPHYSIOLOGY?

Despite the title of the study, it is uncertain whether the abdominal compression device used actually

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induces splanchnic venous compression because there were no measurements of splanchnic blood flow.¹¹ Previous studies have shown an increase in splanchnic venous capacitance during head-up tilt in some, but not all, participants with POTS.^{12,13} Part of the pathophysiology of neuropathic POTS includes an increase in blood pooling in the lower extremities and splanchnic veins during orthostasis.² This increase in blood in the splanchnic veins is likely passive because of decreased arterial vasoconstriction and an impaired skeletal muscle pump function.^{13,14} This results in decreased venous return, decreased stroke volume, and increased heart rate during orthostasis in POTS, to maintain cardiac output.⁹ In addition, blood volume is reduced in most patients with POTS,² which may exacerbate the effects of venous pooling by further reducing central blood volume. Splanchnic venous compression would decrease orthostatic heart rate in POTS by redistributing blood pooled in the splanchnic veins back to the central circulation and increasing stroke volume. With improved stroke volume, cardiac output is maintained without tachycardia. Surprisingly, the splanchnic compression device used in the study by Smith et al¹¹ did not decrease orthostatic heart rate when used alone or in combination with propranolol.

It is also unclear why systolic blood pressure was higher during standing with abdominal compression, since people with POTS do not experience a decrease in systolic blood pressure with orthostasis. In OH, improvement in systolic blood pressure with abdominal compression has been attributed to increased cardiac preload and stroke volume,⁹ as well as increased systemic vascular resistance and reduced splanchnic venous capacitance.⁵ Abdominal compression has also been shown to reduce inferior vena cava diameter, with no change in femoral vein diameter in the supine posture and during head-up tilt in OH.⁹ In a small study of pediatric patients with OH or vasovagal syncope, chest impedance was lower (indicating less fluid shifting) when participants wore an inflatable abdominal band.⁶ It is important to note that the study in this issue tests compression during active standing,¹¹ when the skeletal muscle pump is engaged; therefore, hemodynamic effects of compression may be different compared with studies in OH that used head-up tilt (passive standing). In addition, the rise in systolic blood pressure could be caused by a stress or arousal effect from wearing the device. It is possible that abdominal compression in POTS prevents splanchnic venous pooling, but additional studies are needed to confirm this and investigate other possible mechanisms of improvement.

ACUTE VERSUS CHRONIC COMPRESSION

The compression device used in the study was an inflatable pneumatic cuff that was tested in an acute laboratory setting. This type of device would not be feasible for people with POTS to use at home. Whether the results from this study will translate to a device that patients can use chronically has not been determined. There are a variety of medical grade and commercially available compression garments that are used by people with POTS, despite the lack of validation. These garments include compression socks, stockings, leggings, shorts, and abdominal shapewear. Each of these garments provides varying levels of compression and coverage. Previous studies of compression in OH typically used a combination of leg and abdominal compression, but some studies compared between leg and abdominal compression.^{5,8} In people with OH, compression garments improved orthostatic tolerance through better maintenance of systolic blood pressure while in the upright position.⁵⁻⁹ Overall, garments that compressed the abdomen were more effective than garments that compressed the lower extremities only at preventing the drop in blood pressure in patients with OH.^{5,8} In 1 study evaluating leg and abdominal compression in OH, systolic blood pressure and vascular resistance only significantly improved when abdominal compression was used, either alone or in combination with compression of the lower extremities.⁵ Compression of the legs at thigh level and below did not significantly improve systolic blood pressure compared with no compression.⁵ Further studies are needed to determine which type of compression devices are effective at controlling symptoms and hemodynamics in POTS (leg, abdominal, and full lower body). Compression garments can be uncomfortable and not well tolerated in people with POTS, especially in warmer weather. These barriers to use of compression garments are similar to what is experienced in populations with vascular disease who report challenges with discomfort, temperature issues, and lack of perceived benefits, among other factors.^{15,16} The authors report that the inflatable abdominal compression device used in the study in this issue was well tolerated,¹¹ but it is unclear whether an inflatable device would be feasible or tolerable for chronic use.

Finally, it is important to note that this study did not have a control for the compression treatment. Simply wearing the inflatable cuff may have made participants feel better. Placebo effects are not uncommon in pharmacological trials in POTS.³ Controlling for compression in a crossover design is more difficult than controlling for pharmacotherapy since participants are often aware of the difference in treatments

(true versus sham compression). In a sham-controlled study of compression in OH, systolic blood pressure with sham compression was significantly lower than systolic blood pressure with active compression.⁸ In the study in this issue,¹¹ abdominal compression only improved POTS symptoms when used in combination with propranolol, which was placebo controlled. Therefore, a placebo effect of compression is unlikely since it did not occur in both study arms. Additional sham-compression controlled trials are still needed to validate the effectiveness of abdominal compression in POTS.

ARTICLE INFORMATION

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Disclosures

None.

REFERENCES

- Shaw BH, Stiles LE, Bourne K, Green EA, Shibao CA, Okamoto LE, Garland EM, Gamboa A, Diedrich A, Raj V, et al. The face of postural tachycardia syndrome—insights from a large cross-sectional online community-based survey. *J Intern Med*. 2019;286:438–448.
- Sheldon RS, Grubb BP II, Olshansky B, Shen WK, Calkins H, Brignole M, Raj SR, Krahn AD, Morillo CA, Stewart JM, et al. 2015 Heart Rhythm Society expert consensus statement on the diagnosis and treatment of postural tachycardia syndrome, inappropriate sinus tachycardia, and vasovagal syncope. *Heart Rhythm*. 2015;12:e41–e63.
- Miller AJ, Raj SR. Pharmacotherapy for postural tachycardia syndrome. *Auton Neurosci*. 2018;215:28–36.
- Fu Q, Levine BD. Exercise and non-pharmacological treatment of POTS. *Auton Neurosci*. 2018;215:20–27.
- Denq JC, Opfer-Gehrking TL, Giuliani M, Felten J, Convertino VA, Low PA. Efficacy of compression of different capacitance beds in the amelioration of orthostatic hypotension. *Clin Auton Res*. 1997;7:321–326.
- Tanaka H, Yamaguchi H, Tamai H. Treatment of orthostatic intolerance with inflatable abdominal band. *Lancet*. 1997;349:175.
- Figuroa JJ, Singer W, Sandroni P, Sletten DM, Gehrking TL, Gehrking JA, Low P, Basford JR. Effects of patient-controlled abdominal compression on standing systolic blood pressure in adults with orthostatic hypotension. *Arch Phys Med Rehabil*. 2015;96:505–510.
- Podoleanu C, Maggi R, Brignole M, Croci F, Incze A, Solano A, Puggioni E, Carasca E. Lower limb and abdominal compression bandages prevent progressive orthostatic hypotension in elderly persons: a randomized single-blind controlled study. *J Am Coll Cardiol*. 2006;48:1425–1432.
- Smit AA, Wieling W, Fujimura J, Denq JC, Opfer-Gehrking TL, Akarriou M, Karemaker JM, Low PA. Use of lower abdominal compression to combat orthostatic hypotension in patients with autonomic dysfunction. *Clin Auton Res*. 2004;14:167–175.
- Heyer GL. Abdominal and lower-extremity compression decreases symptoms of postural tachycardia syndrome in youth during tilt table testing. *J Pediatr*. 2014;165:395–397.
- Smith EC, Diedrich A, Raj SR, Gamboa A, Shibao CA, Black BK, Peltier A, Paranjape SY, Biaggioni I, Okamoto LE. Splanchnic venous compression enhances the effects of β -blockade in the treatment of postural tachycardia syndrome. *J Am Heart Assoc*. 2020;9:e016196. DOI: 10.1161/JAHA.120.016196.
- Tani H, Singer W, McPhee BR, Opfer-Gehrking TL, Haruma K, Kajiyama G, Low PA. Splanchnic-mesenteric capacitance bed in the postural tachycardia syndrome (POTS). *Auton Neurosci*. 2000;86:107–113.
- Stewart JM. Pooling in chronic orthostatic intolerance: arterial vasoconstrictive but not venous compliance defects. *Circulation*. 2002;105:2274–2281.
- Stewart JM, Medow MS, Montgomery LD, McLeod K. Decreased skeletal muscle pump activity in patients with postural tachycardia syndrome and low peripheral blood flow. *Am J Physiol Heart Circ Physiol*. 2004;286:H1216–H1222.
- Raju S, Hollis K, Neglen P. Use of compression stockings in chronic venous disease: patient compliance and efficacy. *Ann Vasc Surg*. 2007;21:790–795.
- Montoya MI, Avila ML, Vincelli J, Williams S, Brandao LR. Understanding the barriers in compliance to elastic compression garments in the treatment of pediatric post-thrombotic syndrome: a qualitative study. *Thromb Res*. 2016;144:113–115.