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REVIEW

Compression therapy in patients with orthostatic hypotension: a systematic review

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ABSTRACT

Aim: Orthostatic hypotension is common, especially in the elderly, and it is strongly associated with discomfort and falls. Physicians may sometimes prescribe compression therapy, but the beneficial effect of this treatment in orthostatic hypotension is unclear. The aim of this review was to summarise all available evidence on the effect of four different levels of compression therapy in the treatment of orthostatic hypotension: knee-length, thigh-length, full-length and abdominal compression only.
Methods: A systematic search was performed in PubMed, Embase and Cochrane databases.
Results: A literature search identified 1232 reports; 11 publications were selected for inclusion in this review. The quality of studies was heterogenous and generally poor. Full length compression (lower limbs and abdomen) and compression of solely the abdomen were found to be superior to knee-length and thigh-length compression. Both significantly reduced the fall in systolic blood pressure after postural change. Symptoms of orthostatic hypotension experienced by patients were improved the most by full-length compression.
Conclusions: When other interventions fail to ameliorate symptoms, compression therapy can be considered. This review demonstrates that compression treatment should include the abdomen as this has the greatest beneficial effect. However, this review also displays the paucity of evidence for compression therapy for patients with orthostatic hypotension, and further investigation is certainly warranted.

KEYWORDS

Compression therapy, orthostatic hypotension, review

INTRODUCTION

Changing from a supine to an upright position causes pooling of blood in the lower extremities and abdomen. As a result, the venous flow to the heart is reduced, decreasing cardiac output. Baroreceptors are subsequently stimulated, activating the sympathetic nervous system and thereby inducing peripheral vasoconstriction, maintaining stroke volume and increasing the heart rate. If such compensatory mechanisms are inadequate, blood pressure may fall when shifting postural position.[1] Formally, orthostatic hypotension (OH) was defined as a reduction in systolic blood pressure (SBP) of at least 20 mmHg or at least 10 mmHg decrease in diastolic blood pressure within three minutes of standing or after a head-up tilt of at least 60° on a tilt table.[2] The extent of the orthostatic hypotension can be influenced by several factors such as age, temperature, hydration and medications.[2] The prevalence of orthostatic hypotension is particularly high in the elderly, rising to as much as 50% in hospitalised geriatric patients[3] and 70% of nursing homes residents.[2]
Orthostatic hypotension can be a major issue for patients, leading to falls and subsequent fractures and immobility. Prevention or treatment of this disorder is therefore indicated. If possible, causative factors such as medication should be removed. Additional posture and exercise instructions can be given to help patients cope with this disorder.[4] Multiple sources, such as the European Federation of Neurological Societies guideline on the management of orthostatic hypotension[5] as well as a myriad of review articles on this topic,[6-8] also suggest the option of lower limb compression therapy. The underlying rationale is that external pressure reduces venous pooling in the legs and improves venous return to heart, thus preventing a reduction in stroke volume and maintaining cardiac output.[9]

In the Netherlands approximately 360,000 patients wear elastic stockings.[10] It is not known what percentage of those stockings is prescribed as treatment for orthostatic hypotension. However, in an Irish survey performed in 2011, 43 of 48 participating physicians working in geriatric medicine stated that they prescribed elastic compression stockings for patients suffering from orthostatic hypotension.[11]

Several types of compression garments are used in the management of orthostatic hypotension. Apart from knee-length compression stockings, thigh-length garments and abdominal bandages are also recommended for the reduction of symptoms of orthostatic hypotension.[8,12] The aim of this systematic review was to collect all available evidence on the use of lower limb compression therapy in orthostatic hypotension and to determine the effectiveness of four different levels of compression: knee-length, thigh-length, full-length and abdominal compression only.

METHODS

Search strategy and selection criteria

An extended search was performed in PubMed, Embase and Cochrane on 26 November 2012, using the following syntax: (postural hypotension OR postural hypotensive OR orthostatic OR ortostatic); in title/abstract AND (stocking* OR compress* OR bandages OR bandaging OR elastic OR hosiery OR tights OR counter-pressure OR (counter AND pressure) OR band OR binding OR bands OR bindings OR binders); in all fields. Studies with less than ten patients were excluded as these were considered to lack sufficient statistical power. In addition, studies focusing only on orthostatic hypotension in the context of spinal cord injury, anaesthesia, rare syndromes such as the Nutcracker syndrome or post-space flight were excluded. No limitations were applied to the language or year of publication.

The titles and abstracts of all studies retrieved by the search were assessed by one author (HS) to determine which were eligible for further investigation. All potentially relevant articles were subsequently screened as full text by two authors (HS and MK). Selected studies were cross-referenced to retrieve any additional relevant citations.

Data extraction

Data regarding study design and results were extracted from each included study. Extracted items were: methods of study (definition of OH, manner of postural change, timing of measurements, use of sham compression, site and strength of compression) and study population (age, gender, comorbidity, number of participants with OH at baseline). All data were extracted by one author (HS) and subsequently cross-checked by a second (MK). In case of insufficient data in the original publication, authors were contacted wherever possible to retrieve additional data.

Quality assessment

The methodological quality of the studies was independently assessed by two authors (HS and MK), using the Cochrane Collaboration's tool for assessing risk of bias in clinical studies.[13] A summary of this tool can be found in *Appendix 1a* in the Supporting Information on the journal's website. In case of disagreement among the reviewers, the assistance of a third reviewer (MH) was enlisted.

Data synthesis and analysis

As a result of heterogeneity in patient populations and outcome measures, a formal meta-analysis was not possible. Therefore, the study results were summarised to describe the main outcomes of interest: i.e. change in standing systolic blood pressure, change in postural drop (which is calculated by subtracting the change in SBP when changing position with compression from the change in SBP without compression) and orthostatic symptoms as reported by the patient. If not reported in the publication, these outcomes were calculated from the available data wherever possible. A distinction was made between different levels of compression in the studies. The four categories were knee-length compression, thigh-length compression, abdominal compression only or full-length compression, which was defined as compression of both full length of the legs as well as the abdomen.

RESULTS

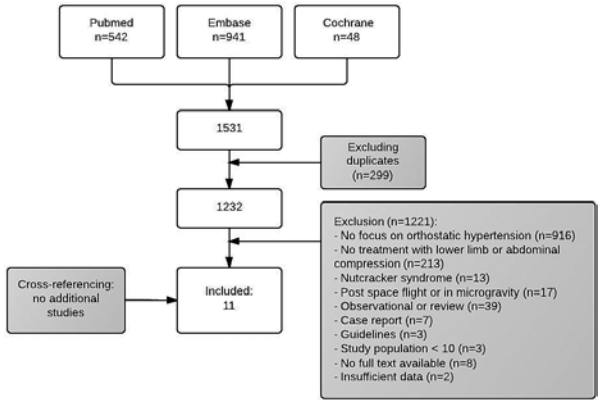
Search and selection

The literature search yielded 1531 citations (*figure 1*). After exclusion of 299 duplicates and 1221 publications for other reasons, a total of 11 publications were considered suitable for inclusion in this review (*table 1*). Although two additional studies did investigate the influence of compression stockings on blood pressure, one was excluded because it lacked a description of the study methods and the use of statistics,[14] and the other because no relevant data could be extracted from the publication to allow its inclusion in this review.[15] Cross-referencing of included studies yielded no additional results.

Quality assessment

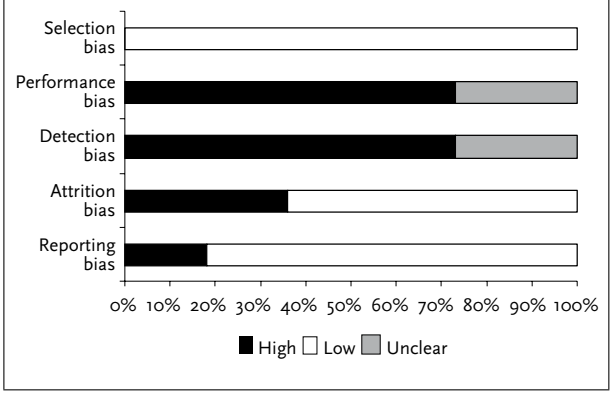
The summarised results of the quality assessment can be found in *figure 2*; full details can be found in *Appendix 1b* in the Supporting Information on the journal's website. Reviewer agreement was over 95% for all aspects. The

Figure 1. *Search and study selection*



OH = orthostatic hypotension.

Figure 2. *Risk of bias in the included studies*



risk of bias due to patient selection was considered low, as all studies were self-controlled, thus rendering issues such as randomisation not applicable. Although three studies used some form of sham compression,[9,16,17] it was unclear whether the placebo was sufficient to prevent a performance or detection bias. For this reason, those studies were scored as having an unclear risk of bias on these items. The remaining studies did not use sham compression, thus resulting in a high risk of a performance and detection bias. The risk of an attrition bias was low in most studies,[16,18-23] but was considered high in four,[9,17,24,25] mostly because of unexplained loss of participants. The risk of a reporting bias was considered to be high in two studies[20,21] due to incomplete reporting.

Study characteristics

The characteristics of the 11 included studies are summarised in *table 1*. Sample sizes were generally small, with a median size of 15 patients (range 10-61). Definitions of orthostatic hypotension varied somewhat between the studies (*table 1*) and in three studies no definition was provided.[21,22,25] In six studies all participants had a history of orthostatic hypotension at baseline,[17-19,21,24,25] whereas in two studies all participants were free from OH;[9,22] the remaining studies included a mixed population. Comorbid conditions were common, varying from chronic haemodialysis[23] to neurological diseases such as multiple system atrophy (MSA) or progressive autonomic neuropathy (PAN).[18,21,25]

Changing of postural position was carried out passively in six studies, mostly using a tilt table.[9,17-20,24] In the other five studies, the patients changed their postural position themselves.[16,21-23,25] Two studies investigated seating-induced orthostatic hypotension.[20,24]

The effect of merely knee-length compression was investigated in two studies,[9,18] six studies addressed thigh-length compression[17,18,20-22,24] and in four studies the effect of full length compression including the abdomen was studied.[16-19] Three studies focused on the effect of abdominal pressure alone.[18,23,25]

In five studies the effect of compression was expressed as the difference in SBP in standing position with and without compression.[9,17,18,24,25] Six studies reported the effect as change in postural drop.[9,16,19,20,22,24] Seven of the eleven studies reported whether compression therapy had an effect on subjective complaints of orthostatic hypotension in symptomatic patients.[9,17-19,21,23,24] The method of assessing these complaints varied greatly between studies, with some only inquiring after dizziness or palpitations[9,19-21,24] and others using a standardised score or questionnaire.[17,18]

Evidence for the effectiveness of compression therapy

Table 2 provides an overview of the effects of compression therapy on systolic blood pressure and symptoms. Full details can be found in *Appendix 2* in the Supporting Information on the journal's website.

Neither of the two studies that investigated the effect of knee-length compression found a beneficial effect on SBP.[9,18] Nevertheless, one of these studies did report a moderate improvement of symptoms in two out of 14 patients.[18]

Two of the six studies using thigh-length compression found a significant improvement in the decline of SBP with postural change,[22,24] while a third reported a significant improvement of standing SBP with compression, with a median of 15 mmHg.[17] Five of these six studies also investigated the effect of compression on symptoms of orthostatic hypotension. Although all found some improvement of symptoms, rates varied widely from 14-86% of patients.[17,18,20,21,24]

Of the four studies assessing full-length compression, two reported a significant positive effect on standing SBP[17,18] and a third study showed a significant reduction in

Table 1. *Study characteristics of included studies*

Study	OH definition	Postural change	Time of measurements (minutes after change in position)	Applied pressure (mmHg)	Compression site				Sham compression	N	% Male	Age in years, mean (SD)	Comorbidities	% with OH at baseline
					C	C+T	C+T +A	A						
Denq, 1997[18]	≥3 min decline in SBP of ≥30 mmHg or mean BP ≥20 mmHg	Passive, 80° tilt	?	40	+	+	+	+	None	14	36%	62 (12)	OH due to MSA, PAF or DAN	100
Gorelik, 2004[20]	≥20 mmHg decline in SBP or ≥10 mmHg decline in DBP	Passive, lying to seating	1-5	30		+			None	61	33%	78 (10)	Conditions requiring bed rest	56
Gorelik, 2009[24]	≥20 mmHg decline in SBP or ≥10 mmHg decline in DBP	Passive, lying to seating	5	40 (ankle)		+			None	49	34%	75 (9)	Decompensated heart failure	100
Hasegawa, 2000[21]	?	Active, upright standing	10	?		+			None	10	70%	63 (range 52-82)	Autonomic neurological disease	100
Henry, 1999[19]	Fall of ≥20 mmHg in SBP	Passive, 90° tilt	3	20-30 (ankle)			+		None	10	34%	77 (2)	History of falls	100
Morrison, 2012[16]	≥40 mmHg decline in SBP or ≥20 mmHg decline in DBP within first 15 sec	Active, upright standing	1	10-15			+		Placebo garments	15	100%	27 (4)	None	40
Podoleanu 2006[17]	Symptoms after 3 asymptomatic min or decline of SBP to ≤90 mmHg	Passive, 60° tilt	10	20-60 (from abdomen to ankle)		+	+		Elastic bandages; 5 mmHg	21	43%	70 (11)	Various	100
Protheroe 2011[9]	SBP ≤80 mmHg, HR ≤50 or ≥180; or presyncopal symptoms	Passive, 60° tilt + graded LBNP	30	29 (knee) to 35 (ankle)	+				Calf placebo (no compression)	15	60%	26 (1)	None	0
Smit, 1997[25]	?	Active, upright standing	3	40				+	None	12	43%	? (35-79)	OH due to MSA, PAF, PAN or other	100
Tezuka, 1997[22]	?	Active, upright standing	?	8 (thigh) to 20 (ankle)		+			None	15	0%	46 (2)	None	0
Yamamoto, 2006[23]	>15 mmHg decline in SBP or symptoms	Active, upright standing	1	20				+	None	25	80%	68 (11)	Chronic haemodialysis	68

A = abdomen; BP = blood pressure; C = calves; DAN = diabetic autonomic neuropathy; DBP = diastolic blood pressure; HR = heart rate; LBNP = lower body negative pressure; MSA = multiple system atrophy; PAF = pure autonomic failure; PAN = progressive autonomic neuropathy; SBP = systolic blood pressure; T = thighs.

postural drop of 19.9 mmHg.[19] The fourth study reported a deterioration in both standing SBP and postural drop when compression was used, but these findings were not significant.[16] Three of four studies addressing symptoms reported an improvement after compression in the majority of patients, with response rates varying between 70-93%.[17-19] In the fourth study, six patients reported symptoms in both the control and the compression setting, but four patients were unable to complete the protocol with compression due to pre-syncope symptoms.[16]

Compression of the abdomen only was investigated in three studies, all of which demonstrated an improvement of orthostatic hypotension when applying abdominal pressure. Standing SBP increased by 12-21 mmHg when compression was used.[18,23,25] In addition, one of these studies reported a reduction in postural drop of 17 mmHg.[23] Two studies investigating the effect of compression on symptoms showed improvement, with rates of 30 and 36% of patients.[18,23]

Table 2. *Effect of compression on systolic blood pressure (SBP) and symptoms of orthostatic hypotension. Full details can be found in Appendix 2 in the Supporting Information*

Study	N	Change in SBP in upright position[1]	Change in postural drop[2]	% of participants experiencing improvement in symptoms after compression
Knee-length compression (calves)				
Denq 1997[18]	14	-		14%
Protheroe 2011[9]	15	-	-	0%
Thigh-length compression (calves +thighs)				
Denq 1997[18]	14	-		14%
Gorelik 2004[20]	61		-	S
Gorelik 2009[24]	49	-	+	45%
Hasegawa 2000[21]	10			50%
Podoleanu 2006[17]	21	+		86%
Tezuka 1997[22]	15		+	
Full length compression (calves+thighs+ abdomen)				
Denq 1997[18]	14	+		93%
Henry 1999[19]	10		+	70%
Morrison 2012[16]	15		-	
Podoleanu 2006[17]	21	+		90%
Abdominal compression only				
Denq 1997[18]	14	+		36%
Smit 1997[25]	12	+		
Yamamoto 2006[23]	25			30%

[1]Difference in SBP in standing position, without and with compression ($SBP_{standing}$ with compression minus $SBP_{standing}$ without compression); [2]Difference in change in SBP when moving from supine to upright position without and with compression ($SBP_{standing}$ without compression minus SBP_{supine} without compression) minus ($SBP_{standing}$ with compression minus SBP_{supine} with compression)); + significant improvement; - no significant improvement; S significant improvement, no percentages extractable.

DISCUSSION

This systematic review demonstrates that the effect of lower limb compression therapy on orthostatic hypotension is poorly investigated. The available evidence, however, shows that full-length compression and compression of solely the abdomen are superior to knee-length and thigh-length compression. The first two significantly reduced the fall in SBP after postural change. Symptoms of orthostatic hypotension experienced by patients were most improved by full-length compression.

In this review, a comprehensive overview is given of all available evidence on the effect of compression therapy of the legs on orthostatic hypotension. A distinction was made between four different levels of compression, resulting in a fair comparison between the studies. Nevertheless, this review has some limitations. For instance, it was not possible to perform a formal meta-analysis, because the studies included in this review differed significantly in the type of compression, the pressure that was used, the method by which postural change was achieved and the timing of measurements. Furthermore, not all publications provided sufficient information on the study methodology.

The beneficial effect of compression of the abdomen on orthostatic hypotension found in this review is supported by bio-impedance studies, which report that the abdomen is by far the biggest fluid reservoir in the body,[26] accounting for over 70% of orthostatic body fluid shifts. By contrast, the lower limbs account for less than a third of such fluid shifts, explaining why compression of only the legs appears to have a very limited effect on orthostatic hypotension. Consequently, there appears to be no place for solely lower limb compression in the treatment of orthostatic hypotension.

Although the evidence for full-length compression and abdominal compression only is more promising, the paucity of data and the heterogeneous and generally small study populations mean that these data should be interpreted with caution. Furthermore, although compression therapy is relatively harmless, it also has disadvantages. Some patients complain about cutting-off of circulation, stockings being too hot to wear, limb soreness, poor cosmetic appearance or itching.[27] Stockings can also be difficult to put on, particularly for elderly patients who may require home care nurses to help them with it. In addition to the extra cost of such care,[28] this decreases the

patients' independence, as they will have to wait each day for someone to help put the stockings on and take them off again in the evening. These drawbacks are important to take into account before prescribing compression stockings.

However, despite these facts, there does seem to be a place for compression therapy if it is not possible to take away the primary cause of orthostatic hypotension. Alternative therapeutic options, including a range of different medications, carry the potential for serious side effects.[29,30] For example, midodrine – one of the most researched drugs for this condition – can cause urine retention, paresthesia and hypertension.[29] Moreover, evidence for the use of such medication is also quite poor.[30]

CONCLUSION

The paucity of evidence for the benefit of compression therapy in addition to the potential discomfort does not justify the routine prescription of lower limb compression therapy for patients with orthostatic hypotension. However, treatment with compression therapy including the abdomen can be considered if other interventions, such as evaluation of medication, treatment of supine hypertension and postural manoeuvres, do not adequately ameliorate symptoms of orthostatic hypotension. Definitive conclusions on the benefit of this type of treatment will require further evidence from well-powered and well-documented clinical trials.

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