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Effect Of Circumferential Pneumatic Compression On Orthostatic Hypotension Among People With Disorders Of Spinal Cord

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Abstract

Background and purpose: Orthostatic hypotension is a frequent problem interfering with physiotherapy among people with disorders of Spinal cord. Purpose of this study is to determine effect of circumferential pneumatic compression on orthostatic hypotension during standing in subjects with spinal cord injury.

Subjects and methods: Ten subjects with spinal cord lesions at or above 6th thoracic spinal cord segment and with Orthostatic hypotension were included in this study. Subjects were kept in the supine position on a tilt table. Blood pressure was measured manually using standard sphygmomanometer in the supine position and 3 minutes after tilting up to 90°. Measurements were done initially without any interventions and were repeated after application of circumferential pneumatic compression of 30 mmHg for 10 minutes.

Results: Circumferential pneumatic compression of 30 mmHg abolished Orthostatic hypotension in five subjects. There was an increase in standing systolic BP by 21mmHg at 90° of elevation after application of circumferential compression (P=0.029). No significant change was noted in diastolic BP. There were no complications.

Conclusion : Circumferential pneumatic compression was effective in management of orthostatic hypotension during passive standing in subjects with spinal cord lesions.

Key words : Blood pressure, Circumferential pneumatic compression, Orthostatic hypotension Spinal cord injury, passive standing.

Introduction:

Disorders of Spinal cord often causes weakness of lower limbs, resulting in osteoporosis, hypercalciuria, pressure ulcers, hypostatic pneumonia and constipation. Passive standing helps in preventing some of these complications, but may not be possible in these subjects due to orthostatic hypotension (OH). Prevalence of OH following SCI varies between 37 % and 57%[1,2]. OH interferes with therapy, hinders rehabilitation process, delays achievement of treatment goals and increases hospital stay [3].

Circumferential Pneumatic Compression

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(CPC) of extremities is used as a treatment of pain, dysautonomia, contractures, spasticity, edema and deep venous thrombosis [4,5]. CPC of lower limbs is useful in the treatment of hypotension during spinal anesthesia [6]. Moiseev noted that compression with an inflatable antioverexertion gear (AOG) helped in treatment of OH [7]. Objective of current study is to assess efficacy of CPC in treatment of OH in subjects with disorders of Spinal cord during passive standing.

Subjects and Methods

Ten subjects, 8 men and 2 women with disorders of Spinal cord and OH, attending physiotherapy and who gave consent to participate were included in the study. Clinical evaluation was done according to "The international standards booklet for neurological and functional classification of Spinal Cord Injury[8]. OH was defined as a reduction in systolic BP of at least 20mmHg or diastolic BP of at least 10mmHg within 3 minutes of standing on being raised by greater than 60^0 on a tilt table [9]. The lowest caudal segment with normal sensations and motor power was taken as the level of the lesion[8]. Details of all subjects including age, sex, clinical diagnosis, level of lesion, completeness of the lesion, total motor and total sensory score, current medications and duration of injury were noted. Subjects who were on medications for OH like fludrocoristone and medications with cardiovascular effects were excluded from the study. Pneumatic splints fabricated with polythene material were connected to the sphygmomanometer and inflated with an air pump with a pressure of 30 mmHg. The design and fabrication of this splint have been published earlier [10].

Subjects were kept in the supine position on the tilt table without any tilt and were fastened with straps, one over the chest region and one over both knees. After 10 minutes, BP was recorded from the right upper limb using standard manual sphygmomanometer held at the level of subject's apex beat. A standard adult pneumatic cuff was applied over the upper arm just above the elbow. Appearance of Korotkoff sounds on auscultation over brachial artery at the elbow was taken as systolic blood pressure and its total disappearance as diastolic BP. The table was then tilted to 90^0 in 50 seconds and the BP recording was repeated at 3minutes after achievement of 90^0 tilt. Subjects were asked to report any symptoms appearing on tilting. On report of any symptoms the procedure was stopped, and the subject was immediately brought back to supine position and BP was recorded again. A pneumatic splint was fastened to both lower limbs from mid thigh to ankle. CPC was applied by inflating the splint to 30 mmHg using the air pump of sphygmomanometer. Supine BP was recorded 10 minutes after application of CPC. The subject was tilted to 90^0 and BP was recorded after three minutes. Pulsation of dorsalis pedis artery and color of the limbs were checked at 10 minutes interval through out the procedure after application of CPC. In patients who developed symptoms such as giddiness, nausea, vertigo, blurring of vision, feeble pulse and low BP the procedure was stopped and the tilt table was lowered to 0^0 immediately.

Results

Age, severity, etiology, duration of symptoms and level of the lesion of 10 subjects are shown in table 1. While there was increase in tone in lower limbs in two subjects, the rest had flaccid lower limbs. Reduction in systolic BP on passive standing at 90^0 without any intervention varied from 156 mmHg to 24 mmHg (Mean = 77.8 mmHg + 67.8, median= 50 mmHg). After application of CPC mean reduction in standing systolic BP at 90^0 was 33.4 + 47.1 mmHg (median = 20 mmHg). The

Table - 1 : Orthostatic hypotension in Spinal cord disorders: Response to Circumferential Pneumatic compression

Patient No.	Age	Sex	Level of Lesion	Asia Serverity grade	Diagnosis	Systolic BP		
						0^0	90^0	90^0 With CPI
1	31	M	T2	B	Neuro Syphilis	130	Not recordable	120^0
2	38	M	C7	A	Trauma	156	Not recordable	Not recordable
3	26	M	C5	A	Tuberculosis with spinal arachnoiditis	130	Not recordable	128*
4	21	M	T2	B	Trauma	120	76	78
5	30	M	T7	A	Transverse myelits	118	62	70
6	40	W	C3	C	Tuberculosis of	130	Not	120*
					spine		recordable	
7	46	W	C5	B	Multiple Selerosis	134	90	100
8	40	M	C3	A	Prolapsed	130	90	100
9	65	M	T2	B	Cervical	120	80	80
10	62	M	T6	C	Transverse myelits	124	96	124*

CPC-Circumferential pneumatic complication. ASIA-American Spinal Injury Association M=Men, W-women, C=cervical, T=Thoracic, *Responders

increase in systolic BP with CPC ranged from 0 mmHg to 128 mm Hg (Mean 44.4 + 54.9 mmHg median –19mmHg). This difference was statistically significant (paired t test - 2.856, df =9, p = 0.029). Overall five subjects did not have OH (fall in systolic BP of < 20 mmHg on standing) with CPC (Table 1). With CPC, systolic BP on standing increased in three other subjects, but they continued to have OH (a reduction of systolic BP of <20 mm Hg on standing). CPC did not change standing systolic BP in two subjects. The mean diastolic BP at 90^0 without and with CPC were 73.5-+12.4 mmHg and 79.1+19.4 mmHg respectively. This difference was not statistically significant. None of the patients had any complications including ischemia or autonomic dysreflexia due to application of CPC.

Discussion

Standing is an important therapeutic activity for subjects with disorders of Spinal cord. Benefits of standing include prevention or reversal of osteoporosis and resultant hypercalciuria, prevention of contractures and improvement in joint range of motion [11]. OH is a frequent problem limiting standing during physiotherapy in subjects with disorders of Spinal Cord [3] .To achieve early weight bearing and standing, it is essential to control OH.

Treatment of OH includes administration of drugs such as ephedrine, fludrocoristone and ergrotamine. But the effect of drugs on OH is unpredictable and unsatisfactory [12]. Non-pharmacological approaches by using abdominal binders and elastic stockings have been tried to increase venous pressure and reduce pooling of blood. Tanaka et al reported improvement in OH with inflatable abdominal binders[13]. Elastic compression hosiery has also been reported to be an effective in preventing OH by enhancing venous return and cardiac

out put in the standing posture [14]. Another technique useful in control of OH is functional neuromuscular stimulation (FNS). Elkoda etal noted that FNS of knee extensors and foot plantar flexors to minimize cardiovascular changes during postural changes in individuals with Spinal Cord Injury[15]. In a similar study Sampson et al observed that subjects with Spinal Cord Injury could tolerate higher angles of incline with FNS[16].

CPC has been used to prevent DVT, correct and prevention deformities, control bleeding and treat edema, shock, spasticity and pain [4,5,10]. Lower limb compression using inflatable splints can be used to prevent hypotension during spinal anesthesia for caesarian section [6]. Moiseev used a special AOG gear consisting of an abdominal, two thigh, and two knee inflatable rubber cuffs to treat OH in 10 patients with Spinal cord injury. This AOG prevented OH enabling the patients to maintain an erect position for 10 minutes and longer[7]. In the present study we noted that CPC over lower limbs to helped control OH during passive standing in 5 of 10 subjects with disorders of Spinal cord.

Elastic hosiery and compression stockings are used in the treatment of OH**.** Henry et al noted that seven out of 10 subjects from a geriatric falls clinic, benefited from compression hosiery, which applied pressure over abdomen and lower limbs [14]. In our study, OH during passive standing could be abolished in five patients of 10 subjects with disorders of Spinal cord, with CPC. We applied compression only over lower limbs. Application of compression over abdomen may result in better response.

CPC improves venous return and thus increases stroke volume and systolic BP [13]. We noted that while CPC improved systolic BP, it did not have any significant effect on diastolic BP. This may be because diastolic BP is more dependent on peripheral arterial resistance, on which CPC did not have any significant effect.

This study has several limitations. The sample size is small. There is a possibility of investigator bias as it was not a blind study. The second tilt is less likely to be associated with OH due to adaptation and angiotensin release during the initial tilt. In the present study, the second tilt was given 30 minutes after the initial tilt. A double blind study with larger sample size and random application of CPC may help in further validating our results.

Complications of CPC include limb ischaemia and compartment syndrome. Pneumatic pressure applied to lower limb can stop microcirculation and produce anoxia [17, 18]. In our study none of the subjects had this complication. Frequent monitoring of dorsalis pedis pulse, color of the limb and evidence of swelling may help in preventing complications of CPC. Incorporation of blow-off valves and continuous monitoring of inflation pressure are other safety measures.

Conclusion

CPC resulted in a significant reduction OH during passive standing in subjects with SCI. None of the subjects developed any complications. Further studies with larger number of patients may establish the usefulness of this technique in treatment of OH.

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