

Usefulness of intermittent pneumatic compression in medicine

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Edyta Sutkowska

Department and Division of Medical Rehabilitation, Wrocław Medical University, Poland

Abstract

Many studies exist that document the use of intermittent pneumatic compression in lymphedema, venous ulcers, prophylaxis of deep vein thrombosis and limb ischaemia. This article discusses the basics and usefulness of this therapy on the basis of available studies and recommendations. As the method is characterized by lack of serious side effects, good patient compliance, and high effectiveness, intermittent pneumatic compression should be taken into consideration as an alternative or additional treatment in many conditions.

Key words: intermittent pneumatic compression, chronic venous insufficiency, lymphedema, critical limb ischaemia

Introduction

In the 21st century, physiotherapy is a very complex academic discipline owing to the dynamic development of different branches of medicine which have displaced physiotherapy from its traditional role in the treatment of patients. Undoubtedly, this is a discipline which requires patience from both therapists and patients, which, in today's fast paced life, may be difficult to accept, especially by patients. Finally, the efficacy of some forms of physiotherapy is undermined because of lack of evidence-based medicine support, which in accordance with the current knowledge forms the grounds for acknowledgment as proper therapy, inclusion into the guidelines, as well as reimbursement of services by the national health service. Meanwhile, the increasingly ageing society presents a new challenge to physiotherapists owing to numerous chronic illnesses which require multiple drug therapy; this, in turn, is bound with many side effects. Physiotherapeutic procedures lack serious side effects and may be performed multiple times because there are no special contraindications to their application.

One of the established therapies is intermittent pneumatic compression (IPC), which originated in the 19th century [1]. There exist many studies documenting the use of this technique in different illnesses. The overwhelming majority of the applications refer to elderly patients.

Mechanism of action

Currently, in the majority of countries IPC is most often performed in the therapy of lymphedema or venous ulceration, possibly in the treatment of significant oedema of veno-lymphatic aetiology. These indications result from the mechanical, as well as systemic effects of IPC. A special pump successively inflates and deflates the cuff to promote the return of blood from the tissues. The pressure applied externally is transferred to deeply situated tissues and in this way moves the retained fluids from the subcutaneous tissues, venules and small lymphatic vessels to larger vessels and finally into the main vascular trunks, from which the fluids are directed towards the heart. On the other hand, the provoked tempo-

ral ischaemia of the skin during the compression phase results in hyperaemia due to the mechanism of reactive vasodilatation, which increases the blood flow to the peripheral arteries [2–7]. In this way (a reduction of venous pressure with an increase of arterial pressure) [8], the arterial-venous pressure gradient increases, thus improving the perfusion of the tissues, as well as their oxygenation and nourishment [9–11]. Apart from the described mechanism of action, this form of intermittent compression affects coagulation and is responsible for releasing many substances beneficial to the vessel walls [4, 12–16].

Chronic venous insufficiency

Because of the reasons described above, IPC is not considered controversial in the treatment of venous insufficiency, mainly in active venous ulcers and in venous thromboembolism (VTE) prophylaxis, or in lymphatic insufficiency [13, 17–24]. The lack of consensus in regard to the recommendations for venous ulceration treatment results from differences across many studies with reference to such factors as: the pressure applied in the therapies, the inflation and deflation time and their proportions, the number of chambers used, the total duration of the therapy, the disease severity (the total area of the ulcer). An additional issue is small sample sizes. Despite these problems, however, the results of randomized controlled trials suggest that IPC may reinforce the healing process as compared with no compression, especially if applied as an additional procedure [25].

Venous thromboembolism prophylaxis

The positive effects of IPC on the coagulation system result from improving at least two of the Virchow's triad elements (increasing venous blood flow velocity and reversing hypercoagulability by moderating the procoagulant activity through elevation of the D-dimer level). This has led to accepting the method in VTE prophylaxis in a selected group of patients. The American College of Chest Physicians has recommended mechanical methods (foot or low leg pneumatic pump) alone primarily in patients at high risk of bleeding [26] and, because

of their extra benefit, as an additional modality in prophylactic procedures in patients after orthopaedic surgery [27–30]. The same indications are found in the Polish guidelines [31].

Complete decongestive therapy

In the treatment of lymphedema, despite the lack of consensus [32–39] regarding additional benefits of IPC, it is an integral part of complete decongestive therapy. This comprehensive procedure is useful in the treatment and prevention of lymphedema after breast cancer surgery, but it turns out effective in any case of lymphedema not only because of its very action but also owing to good patient compliance. Serious complications are rare, although skin bullae, itching at the compression site, and other minor adverse effects have been reported.

With the consideration of the pathophysiology of lymphedema and venous or lymphatic insufficiency, as well as the risk factors of deep vein thrombosis, the use of IPC is widely accepted. Despite the limited access to the appropriate devices, the awareness of IPC application in the above described conditions is quite large.

Sports injuries

Oedema is a cause of pain and may be responsible for further tissue destruction. Therefore, IPC is a physical method often utilized in sports medicine, and it constitutes an element of the RICE (rest, ice, compression, elevation) method, applied in the treatment of acute injuries [40].

Critical limb ischaemia

Other potential indications are unfortunately less appealing to physicians and physiotherapists. The effect is that in many countries, including Poland, IPC is not indicated or even remains contraindicated in the treatment in diabetic foot or limb ischaemia. This misunderstanding and lack of knowledge regarding the benefits of IPC deprive many patients of the opportunity for optimal treatment.

Reduction of oedema, anticoagulant activity, as well as vasodilatation resulting from nitric oxide (the most powerful vasodilator) [41] release should entice physicians to a wider

use of IPC in cases of critical limb ischaemia and diabetic foot (neuropathic and related to insufficient blood flow) [42]. An undeniable benefit of IPC is the significant reduction in pain in these patients. Much evidence exists conforming the efficacy of IPC in the group of patients who have no surgical (revascularization) option [8, 43–49]. A variation of rubber calf therapy could be a plastic device – circulator boot [50, 51]. It is also used to locally apply active substances, e.g. antibiotics. Considering the benefits reported by some authors, application of this therapy can be regarded an additional procedure in patients with claudication [10, 16, 52]. This refers to patients who cannot be properly treated with the traditional method, i.e. walking exercise (e.g. because of rheumatoid arthritis).

In the literature, individual reports can be found about reduced risk of amputation and improved healing after revascularization procedure in patients in whom IPC was applied [53]. Patients with cholesterol embolism may also benefit from this treatment [54].

Despite unsatisfactory conclusions (low-quality evidence) drawn by two independent authors of systematic reviews [43, 44] concerning IPC implementation in ischaemic legs, one should remember that there is no alternative therapy for patients who do not qualify for revascularization procedures and suffer from rest pain and/or ischaemic ulceration.

Summary

IPC as a primary or supplementary treatment seems to be a relevant alternative in the management of chronic venous and lymphatic insufficiency, as well as, paradoxically, limb ischaemia. Additionally, in acute conditions such as limb injury or cholesterol embolism, the inclusion of IPC in the treatment should also be considered.

Because of its low cost, as well as ease of application, the described method can be implemented both in hospital or ambulatory settings and by properly trained patients at home. The possibility of multiple application and almost complete lack of side effects constitute a strong argument for including this treatment in chronic therapy.

Conflict of interest statement:

Authors state no conflict of interest.

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Address for correspondence

Edyta Sutkowska
Department and Division of Medical Rehabilitation
Wrocław Medical University
ul. Borowska 213
50-556 Wrocław, Poland
e-mail: edytasutkowska@yahoo.com

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