*Lesson of the week***Pneumatic compression boots for prophylaxis against deep vein thrombosis: beware occult arterial disease**

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Patients with occult vascular disease may develop ulcers after treatment with pneumatic compression boots

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Prophylaxis against venous thromboembolism after joint replacement remains contentious.¹ The incidence of deep vein thrombosis is between 45% and 75%.²⁻⁵ The rate of fatal pulmonary embolism is considered to be 1-3%,²⁻⁵ but this is a gross overestimate.¹ Pharmacological techniques for preventing deep vein thrombosis (such as dextran 40, aspirin, warfarin, and heparins) are effective in reducing its incidence but are associated with important complications such as haemorrhage, wound haematoma, and haemarthrosis.^{3 6-8}

Mechanical methods such as intermittent pneumatic compression devices have been developed to avoid these problems. These provide similar prophylaxis against deep vein thrombosis⁸⁻¹⁰ and are considered free of important complications.⁸ We report the occurrence of ulcers in patients using these devices according to approved guidelines.

Guidelines

Consideration of the evidence led the orthopaedic directorate of Glasgow Royal Infirmary and Stobhill NHS Trust to change its policy on prophylaxis against deep vein thrombosis at the end of 1995. Under the previous protocol heparin had been used in combination with graduated compression stockings. All patients having elective surgery who are at moderate or high risk of deep vein thrombosis now wear graduated compression stockings on both legs under pneumatic compression boots (AV Impulse System, Novamedix, Andover) (fig 1). Their design is based on the foot's physiological pumping mechanism.¹¹ The boot applies pulsatile compression to the sole of the foot (fig 2). Patients receive

Fig 2 Inflation cycle at two pressure settings of pneumatic compression boot. Boot inflates for 1 s during every full cycle of 20 s

pneumatic compression treatment on the ward until they are fully mobile; treatment is interrupted for physiotherapy. The compression boots do not interfere with the operative site and are effective prophylaxis against deep vein thrombosis.¹²⁻¹⁵

The contraindications described by the manufacturer are congestive heart failure, pre-existing deep vein thrombosis, thrombophlebitis, and pulmonary embolism. The manufacturer also includes advice on care of the patient's skin and advises that extra attention should be given to patients with poor circulation, fragile skin, insensitive extremities, diabetes, and problems with tissue viability, and to those taking anticoagulants. These conditions are not regarded as contraindications.

Case review

The new protocol was implemented in December 1995 and the first problem occurred two months later. The compression boots were used on about 200 patients over the five months analysed. Five patients developed foot ulcers. These were deep and situated on patients' heels or bunions, or both. In four cases the ulcers occurred on one foot and in one case on both feet. The ulcers were not necessarily on the leg that had been operated on. All ulcers healed slowly over 3-10 months.

Causes of ulcers

We considered that the ulcers had four possible causes. Firstly, the ulcers may have been due to poor nursing care. The five patients were, however, operated on by four different consultants working in the two separate trusts with a common orthopaedic directorate. Nursing care was provided by experienced staff in three wards dedicated to elective orthopaedic surgery at the two sites.

Secondly, the patients could have had occult vascular insufficiency, but all of them had palpable foot pulses before surgery and none had a history that suggested vascular claudication. However, one patient (case 1) had a diagnosis of neurogenic claudication secondary to spinal stenosis and another (case 2) took quinine sulphate

Fig 1 Pneumatic compression boot (top); as worn by patient (bottom)

for cramps at night. In two cases (3 and 4) postoperative angiography revealed lesions amenable to treatment. We retrospectively reviewed the ratio of ankle to brachial pressure in the other three patients. In one (case 2) it was significantly reduced at 0.55 (normal value is about 1; significant insufficiency is <0.7). Thus three patients (cases 2, 3, and 4) had vascular insufficiency that, because of poor exercise tolerance related to the problem in the joint, was not identified earlier. In cases 1 and 5 the index was inconclusive, and without further investigation vascular insufficiency cannot be proved.

Thirdly, the boots could have caused ulceration through chafing, for example. Two patients (cases 3 and 4) reported discomfort while using them. The skin looked normal on close inspection and they continued to use the boots but with more frequent checking of the skin. Postoperative confusion in two further patients (cases 1 and 5) may have reduced their ability to communicate their discomfort.

Finally, other associated diseases could have resulted in ulcers. The patients had osteoarthritis, rheumatoid arthritis, and avascular necrosis, but no other common factors could be found.

Discussion

We had had no similar postoperative problems before the introduction of the new regimen for prophylaxis

against deep vein thrombosis, and we have been unable to find reports of problems with the new protocol in the published work. We believe that these five cases are not an unrelated flurry of unfortunate cases. The review of the cases has led us to conclude that the problem is multifactorial. Occult vascular insufficiency seems to be important but was not detected preoperatively because of the low demand these patients place on their blood system. In two patients (cases 3 and 4) a severely diseased vessel might have become occluded during the manipulation required for joint replacement.

Inflation in the pneumatic compression boot lasts only for 1 second in a cycle of 20 seconds. In some cases this may be sufficient for the stocking to be gradually tightened with each pulse, which may lead to a build up of pressure. This constant pressure could be much more important in the aetiology of the ulcers than the pulsatile pressures generated by the boots themselves.

In retrospect some ulcers could have been avoided by removing the compression boots at the first indication of discomfort. Medical and nursing staff now use a specially designed algorithm to aid decision making about continuing treatment with the pneumatic compression boots when patients experience discomfort (fig 3). This has prevented further cases of ulcers developing in patients.

Both medical and nursing staff have a greater awareness of the problems of occult vascular disease, and there is now a lower threshold for removing the boots and changing management strategies. Because this seems to have controlled the problem we have not implemented routine Doppler ultrasound examinations. We remain committed to this method of prophylaxis against deep vein thrombosis but will continue to monitor our results.

Fig 3 Algorithm used in management of patients experiencing discomfort while using pneumatic compression boots

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