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ORIGINAL PAPER

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Foot pump prophylaxis for deep venous thrombosis—rate of effective usage following knee and hip arthroplasty

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Abstract We recorded the usage of foot pumps during the post-operative period in 29 patients undergoing knee or hip arthroplasty and made 621 recordings. Effective utilisation of foot pumps was seen in 37.2% of cases. There was a gradual reduction in correct utilisation with each day that passed post-operatively (day 1, 60.4%; day 2, 48.8%; day 3, 28.8%; day 4, 21.4%; day 5, 23%). This gradual reduction was statistically significant (P=0.001) and mainly occurred between the second and third post-operative days. Effective usage was 60.2% overall at night and 36.4% during the day. Our results question the efficiency of foot pumps in deep venous thrombosis prophylaxis in the context of a true clinical setting.

Résumé Nous avons étudié l'usage de pompes plantaires chez 29 malades pendant la période postopératoire aprés arthroplastie du genou ou de la hanche. Un total de 621 enregistrements a été fait. Une utilisation efficace des pompes a été notée dans 37.2% de cas. Il y avait une réduction graduelle de l'utilisation correcte au fil des jours post-opératoires (1er jour, 60.4%; 2e jour, 48.8%; 3e jour, 28.8%; 4e jour, 21.4%; 5e jour, 23%). Cette réduction graduelle était statistiquement significative (P=0.001) et s'est principalement produite entre les 2e et 3e jours postopératoires. L'usage efficace était de 60.2% la nuit et 36.4% dans la journée. Nos résultats questionnent l'efficacité des pompes plantaires dans la prophylaxie de la thrombose veineuse profonde dans un contexte clinique réel.

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Introduction

Following hip arthroplasty, the rate of deep venous thrombosis (DVT) and fatal pulmonary embolism (PE) in the absence of any prophylaxis varies between 45 and 57% and 0.1and 0.4% respectively [7]. Moreover, the DVT and fatal PE rates following knee arthroplasty, in the absence of any prophylaxis, vary between 40 and 84% and 0.20 and 7% [7]. Prophylaxis for DVT can be achieved by either chemical or mechanical means. Chemical prophylaxis consists of anticoagulant medications, whereas mechanical prophylaxis is in the form of graduated compression stockings or intermittent compression devices.

Intermittent compression devices consist of plastic wraps, which intermittently inflate and deflate, compressing the soft tissues of the limb. Foot pumps are a form of such devices that intermittently compress the plantar venous plexus of the foot increasing venous return. They also cause local activation of the fibrinolytic system [8, 12]. They have been shown in prospective randomised control trials to be as equally effective in DVT prophylaxis as low-molecular-weight heparin and heparin following total knee and hip replacement [2, 3, 6, 13]. They have also been shown to be as equally effective as anticoagulant agents in trauma patients [10, 11]. Furthermore, as mechanical compression devices do not affect systemic coagulation mechanisms, they are associated with less surgical wound complications such as peri-operative wound drainage, excessive bleeding, and haematoma formation than pharmacological agents [13].

DVT prophylaxis is recommended for at least 7–10 days following elective total hip or knee arthroplasty [4]. For foot pump systems to be effective, it is recommended they are worn continuously when the patient is non-ambulant. When worn, they must be applied correctly so they exert sufficient pressure to compress the plantar venous system and return blood to the heart. Foot pumps have been shown to be applied properly and function correctly 59% of the time in trauma patients [1].

However, there is lack of evidence as to the rate of effective usage of such devices following total knee and hip arthroplasty. We performed a prospective cohort study to determine the rate of effective usage in patients undergoing elective total knee or hip arthroplasty and whether the effective usage rate changes as the patient is progressively mobilised post-operatively.

Material and methods

Twenty-nine consecutive patients who had elective total knee or hip arthroplasty in our unit over a 6-month period were included in the study. Patients were included only if they had foot pumps as the sole means of DVT prophylaxis. These patients were nursed in a 28-bed ward consisting of three main bays and four side rooms. During the day, the ward was normally staffed by three-to-four staff nurses and, at night, by two staff nurses.

Foot pumps (Duo system) are routinely used in our unit following knee or hip arthroplasty by two of six attending consultants. All nursing staff have been taught the purpose, use, and benefits of foot pumps and trained to apply and use them appropriately. Our patients spend 24 h in bed after knee or hip arthroplasty and are gradually mobilised with weight bearing. According to our unit protocol, patients must wear foot pumps when lying in bed, day and night, until discharge from hospital.

The foot pumps were assessed for correct application by two of the authors who randomly visited the patients once between 22:00 and 07:30 h (night-time assessment) and one to five times between 07:30 and 22:00 h (daytime assessment). Visits were at least 2 h apart and at random times, as determined by computer-generated random numbers the day before. During each visit, it was checked whether the pumps were worn and, when worn, whether they were functioning correctly. Moreover, an assessment for any clinical evidence of DVT or PE was performed. Readings were made during the first 5 days post-operatively or until the patient was discharged, if this occurred prior to 5 days. Readings were made only if the patient was in bed.

Completion of 500 observations with at least 100 per day was selected as the study's end point. Neither nursing staff nor patients were aware these observations were being recorded. When the foot pumps were either not worn, applied incorrectly, or not functioning, the nursing staff were informed. On the first visit, patients were also asked whether they understood the foot pump's function. If they did not, they were informed verbally.

Results

We made 621 observations in 29 patients. Foot pumps were found to be worn, applied properly, and functioning correctly on both legs only 231 of 621 times (37%). On 390 occasions, the pumps were either not worn (288) or worn but not turned on or not applying sufficient pressure (102). Clinically, no evidence of DVT or PE was found in any patient during any observation.

As shown in Fig. 1, there was a gradual decrease in the rate of effective usage as post-surgery days increased. To determine whether this decrease was statistically significant, a score of zero was given for an incorrect utilisation reading and a score of 1 for a correct reading. These scores were then averaged per day for each patient. Each patient's score during the first 5 post-operative days was compared to determine if correct utilisation changed with time. Only 25 patients that had readings taken for 5 days were analysed. A two-way ANOVA using Friedman's test showed day-to-day decrease which is statistically significant (P=0.001). Further examination showed the main decrease occurred between the second and third post-operative days (Wilcoxon matched-pairs rank-sum test). The night-time score was then compared to the averaged daytime score (Wilcoxon matched-pairs rank-sum test). Correct utilisation rate was significantly higher at night compared to daytime on the fourth (P=0.0005) and fifth days (P=0.002) but not in the first 3 days. When questioned during our first visit, eight of 29 (28%) patients did not know the purpose of wearing foot pumps.

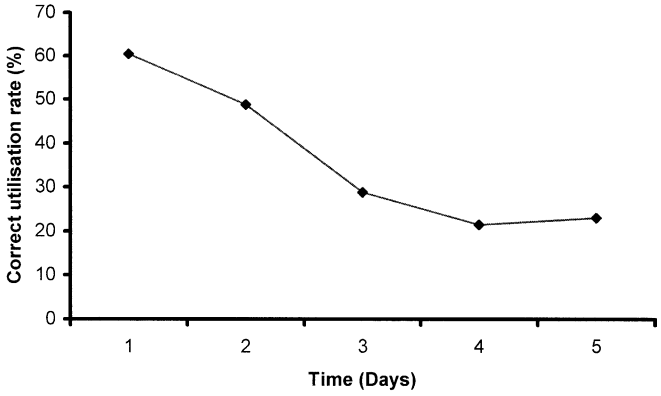

Fig. 1 Correct utilisation rate of foot pumps with time

Discussion

DVT prophylaxis is recommended for at least 7 days post-elective knee or hip arthroplasty [13]. It is recommended that, for mechanical compression devices to be effective, they must be used continuously when the patient is non-ambulant. It has been shown that the effect of foot pumps in activating the fibrinolytic system is rapidly reversed when their use is temporarily stopped [9]. Pharmacological agents administered once or twice daily would exert their effect throughout the 24-h period. In contrast, mechanical devices tend to be worn only when the patient is lying in bed.

Previous studies suggest that the rate of effective usage of external compression devices may be low in true clinical settings. Comerota et al [5] evaluated the use of calf pumps in 138 patients. Patients on routine wards had properly functioning calf pumps during 48% of the visits compared with 78% in the intensive care unit (ICU). Follow-up of patients transferred from an ICU to a regular nursing unit showed that functional application decreased from 82% to 33%. In that study, the compression devices were not applied in 84% and were properly in place but non-functional in 16%. Anglen et al. [1] showed that foot pumps were properly applied and functioning correctly 59% of the time in trauma patients. As in the Comerota [5] study, effective usage was higher in the ICU as compared to a trauma orthopaedic ward.

In our study, the effective utilisation rate post-knee or hip arthroplasty was 37%, which is worse than that reported for trauma patients. This may be attributed to the fact that post-arthroplasty patients tend to be mobilised earlier than trauma patients, who may have significant injuries other than limb fractures. This reasoning is suggested by the observed decline as days pass post-operatively. It seems that as patients get in and out of bed more frequently, their foot pumps are re-applied less often. It was disappointing to see a low effective utilisation rate (60.2%) during night hours when patients are confined to bed. The exact reasons for this were not examined, but may be attributed to foot pumps causing discomfort or noise that might interfere with sleep.

Although almost one third of our patients were unaware of the exact function of foot pumps in the beginning, they were all informed about it following our first visit. This would suggest that low rates are seen, even when patients know the importance of wearing foot pumps.

In summary, we have shown that the effective usage of foot pumps may be low in true clinical settings following knee or hip arthroplasty. This must be taken into consideration when deciding the best means of DVT prophylaxis in such patients, especially those who have a previous history of DVT or PE. The gradual decline in effective utilisation rate that occurs as time elapses from operation may suggest that foot pumps should be used in the first 24 h post-operatively when patients are confined to bed and the risk of bleeding from the surgical wound is high. As the patient is mobilised and starts spending more time out of bed, pharmacological DVT prophylaxis may be more appropriate.

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