Evidence-Based Edema Reduction for the Treatment of Wounds

Can multilayer compression dressings be used in patients with PAD?

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Introduction

Uncontrolled edema is a well-known cause of chronic, non-healing wounds. Numerous reports in the literature describe various products, such as multilayer compression dressings that facilitate reduction of lower extremity edema. The literature shows that in comparison to control groups, multilayer compression dressings help decrease edema, wound size, and time to healing, especially for venous leg ulcers. However, many patients have non-healing wounds with concomitant peripheral arterial disease (PAD). Based on our review of the literature, there are no evidence-based guidelines for the use of multilayer compression dressings in patients with peripheral arterial disease. In this article, we present a unique case of application of a four-layer compression dressing causing compression of collateral vessels and subsequent ischemic pain with immediate reperfusion after removal. We then review the evidence for three commonly used bandage systems and suggest further studies to establish evidence-based guidelines for use of compression dressings.

Case Report

A 64 year old male with a past medical history of hepatitis C virus, antiphospholipid syndrome, right lower extremity deep venous thrombosis, hypertension, venous stasis, and peripheral arterial disease with a chronic right lower extremity ulcer recalcitrant to conservative management was evaluated in the MedStar Georgetown University Hospital Center for Wound Healing. The ulcer had been present for approximately five years, and the patient had previously undergone multiple wound debridements. The patient endured worsening pain and drainage from the wound for three weeks. The patient was admitted with a plan for serial wound debridement and an ultimate goal of wound closure and healing with a split thickness skin graft.

There are no evidence-based guidelines for the use of multilayer compression dressings in patients with peripheral arterial disease.

Given the patient's history of peripheral arterial disease and recent right lower extremity deep venous thrombosis, the vascular surgery team was consulted to evaluate the patient for possible intervention in order to optimize the patient's blood flow for wound healing. He had previously undergone a right popliteal artery stenting one year prior.

The patient first underwent debridement of the right lower extremity ulcer with xenograft application by the podiatric surgery team to ensure the ulcer bed was well prepared for an autogenous skin graft. Post-operatively, a Profore four-layer compression dressing was applied from the base of the toes to the level of the tibial tuberosity of the right lower extremity, as is routinely done at our facility after this procedure. On arrival to the PACU, the patient was complaining of severe pain in the right lower extremity. The podiatric surgery team was called to evaluate and determined that the digits were cool to touch and capillary refill time was slowed relative to the contralateral extremity. Although the multilayer compression bandage was not applied under excessive compression, it was decided that the dressing would be taken down and the patient was transitioned to a Webril dressing and a light, non-compressive ACE bandage. Upon removal of the Profore, the patient expressed immediate pain relief and return of capillary refill was noted.

Immediately following the xenograft procedure, the patient underwent an initial angiogram of the right lower extremity for diagnosis and potential treatment. Intra-operatively, the vascular surgeon found that the popliteal artery stent was occluded and that there was very poor filling

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of the tibial vessels (Figure 1). It was noted at the time that the patient had a multilayer compression dressing intact to the operative extremity. Due to the fact that the multilayer compression dressing extended from the toe sulcus to the level of the tibial tuberosity, there was concern that the poor filling of the tibial vessels was secondary to an extrinsic compressive effect in addition to the patient's peripheral vascular disease. Therefore, no intervention was performed at that time. It was decided that the compressive dressing should be released in order to better visualize the tibial vessels and that the patient would then be brought back for percutaneous endovascular intervention.

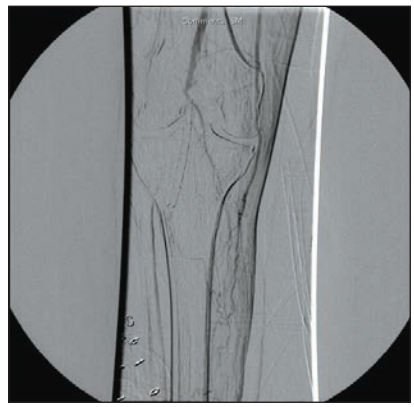

Figure 1: There is complete occlusion of the popliteal artery starting at the knee with the popliteal artery stent and poor visualization of tibial collateral vessels with Profore four-layer compression dressing intact to level of tibial tuberosity.

The patient returned to the OR for vascular intervention two days later with no compressive dressing on the right lower extremity. It was noted that there was, again, complete occlusion of the popliteal artery starting at the knee with the popliteal artery stent, with severe stenosis of the peroneal artery and anterior tibial artery. No posterior tibial arteries were visualized whatsoever. Thus, it appeared that the occlusion of the native arteries was likely due to true disease and not solely due to the external compression. However, it was noted that the tibial collateral vessels were better visualized on the repeat angiogram as compared to the initial angiogram both prior to and after intervention (Figures 2 & 3).

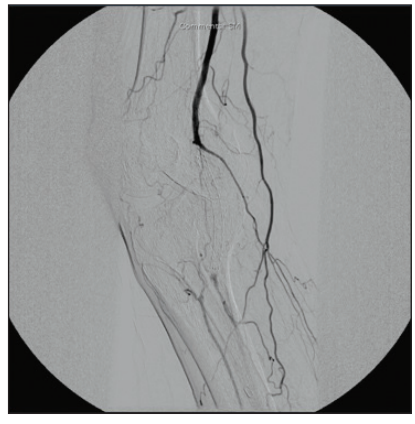

Figure 2: There is complete occlusion of the popliteal artery starting at the knee with the popliteal artery stent.

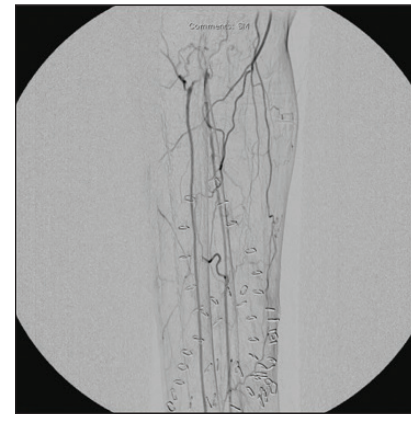

Figure 3: Improved visualization of tibial collateral vessels after removal of Profore compression dressing.

Approximately one week later, the patient returned to the operating room for a split thickness skin graft. Due to the large size of the ulcer, measuring 29 x 15 cm, split thickness skin grafts were harvested from bilateral anterior thighs in order to cover the ulcer on the leg. Due to concern for previous post-operative ischemic pain secondary to the prior Profore dressing, Webril and light, non-compressive ACE bandage were applied and tolerated well.

Discussion

The prevalence of lower extremity wounds is 0.2 to 2 percent overall and is up to 5 percent in persons over the age of 65.[1] Lower extremity wounds have varying etiologies, with venous and arterial wounds being the two most common types. Compression dressings have a significant impact on the healing of venous wounds, but their role in the management of wounds with an arterial component is unclear. In all the studies we reviewed, patients with signs of peripheral arterial disease such as ankle-brachial indices below 0.8 were excluded from the study. To our knowledge, there is no study that investigates what the minimum ABI should be for a patient to undergo compression therapy. In this section, we review the literature evaluating three commonly used treatments for lower extremity wounds: Profore, Coban 2, and Unna boot.

Profore

Profore (Smith & Nephew) dressings are a commonly used four-layer compression dressing. The main advantages for this system include once-a-week application, sustained compression after one week, and graduated compression. The official product website states that it should not be used on patients with an ABI below 0.8 or in diabetic patients with significant micro-vascular disease.

In 2000, Gupta, et al. studied the use of the Profore dressing system in 15 patients with venous leg ulceration in an open-label study. They followed the patients weekly and changed the bandage weekly unless there was excessive drainage. Of the 13 who completed the study, 10 experienced complete healing of the wound. They reported no study-related adverse events. They concluded that the Profore bandage system was effective and safe for the treatment of venous leg ulcers.[2]

Ukat, et al. compared Profore dressing versus short-stretch dressings for the treatment of venous leg ulcers in a randomized controlled trial. Their study included 44 patients in the Profore group and 45 patients in the short stretch group. They found that the healing time was significantly faster with the Profore group ($p = 0.03$). They also found that younger wounds healed significantly faster than older wounds ($p = 0.01$). They therefore concluded that Profore dressings are superior to short-stretch bandages both in terms of clinical outcomes

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as well as having a lower treatment cost.[3]

Another study by Moffatt, et al. confirmed the results by Ukat, et al. They compared the Profore dressing to a two-layer compression bandage system in a prospective randomized open parallel groups trial. In their 109 patients, 57 received the Profore bandage and 52 received the two-layer bandage. At both 12 and 24 weeks, the Profore bandage had superior results for ulcer closure compared to the two-layer bandage (70 vs. 58 percent and 88 vs. 77 percent, respectively). The two-layer bandage also had a higher number of withdrawals from the study (28 vs. 5 percent, $p = 0.01$). Furthermore, they found that the Profore group had a lower cost of treatment over 24 weeks.[4]

On the other hand, other studies have noted issues with multilayer compression bandages. Dale et al. showed that when four experienced clinicians applied various bandage systems, there were significant differences in the final pressures achieved by each individual ($p < 0.001$) as well as between bandage systems ($p < 0.01$).[5] In 2008, Moffatt, et al. found that the Profore system had greater bandage slippage when compared to a two-layer system, and that patients had a significantly higher preference for the two-layer system. They concluded that although there was no significant difference in wound healing rates, patients in two-layer dressings may have a greater health-related quality of life.[6] Partsch, et al. performed a multicenter, randomized, controlled trial of Profore versus short-stretch bandages for the treatment of venous leg ulcers and found that initial ulcer size was the main determinant for healing, not the type of bandage.[7]

Coban 2

Coban 2 (3M) is a compression bandage system consisting of a layer of padding and a layer of compression. The official product website states that it can be safe to administer high pressure therapy (35–40 mm Hg) for individuals with an ABI of greater than or equal to 0.8 and reduced pressure therapy (25–30 mm Hg) for an ABI of greater than or equal to 0.5. The advantages of this system include once-a-week application, ease of application, less bandage slippage, and greater patient comfort and quality of life as the dressing is not as bulky as four-layer systems.

The elastic nature of the bandage material of the Coban 2 makes it susceptible to some of the same issues of the Profore dressing.

Guest, et al. performed a retrospective cohort analysis of 600 patients with venous leg ulcerations that were treated with one of the three dressings: Coban 2, Profore, and KTwo. They found that in six months, the wound healing rates were 76%, 70%, and 64% for Coban 2, KTwo, and Profore, respectively ($p = 0.006$). Their study found that in comparison to the other two treatment options, the Coban 2 had superior time to healing, quality of life, and a lower mean cost of treatment per patient.[8]

The Coban 2 was compared to the Unna boot by Mosti, et al. in a prospective, multicenter, randomized controlled trial. They randomized 100 patients into two groups, one receiving Unna boots and the other receiving Coban 2 compression dressings. For both groups, both had near 100 percent healing at three months. There were no differences between the two groups in terms of pain, wound outcomes, or patient comfort level. It was determined that Coban 2 dressings were essential equivalent to Unna boots, which have traditionally been the standard of care.[9]

The elastic nature of the bandage material of the Coban 2 makes it susceptible to some of the same issues as the Profore dressing. Zarchi and Jemec showed that there was substantial variation in exerted pressure by the bandages. Less than two-thirds of clinicians applied the two-layer compression bandage within the optimal range of 30 to 50 mmHg. The amount of compression applied is user-dependent and there may be a large segment of patients who do not receive adequate compression with the Coban 2 system.[10]

Unna Boot

The Unna Boot is one of the oldest and most traditional forms of compression therapy for venous leg ulcers. It is an inelastic compression dressing comprised of a gauze roll coated with 10% zinc oxide paste, gelatin, glycerin, and water. The inelastic nature means that compression occurs only with contraction of the calf muscle. Thus, it is most effective in the ambulatory patient and significantly less effective in the non-ambulatory patient. The Unna boot can provide approximately 18–24 mm Hg of compressive pressure and can be left intact for 3–7 days, depending on the level of drainage. It is not recommended for patients with concomitant peripheral arterial disease.

In wounds with a purely venous etiology, compression therapy has long been the gold standard and is clearly indicated.

A prospective exploratory and quantitative longitudinal study by Luz, et al. in 2008 compared 32 patients with venous stasis ulcers who were treated with the Unna boot versus 11 patients (control group) who were treated with a simple, non-com-

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pressive bandage. The patients' ulcers were then followed for a period of three months. No significant difference in healing was observed between the two groups.[11]

Alternatively, de Abreu, et al. conducted a controlled randomized clinical trial in which the effect of inelastic compression (Unna boot) was compared to elastic compression for the treatment of venous leg ulcers. Elastic bandages theoretically maintain compression both with contraction of the muscles and with rest, unlike the inelastic Unna boot, which requires activity for full effect. Nineteen patients were divided into the two groups and followed for 13 weeks. This study demonstrated a significant difference in wound healing with a decrease in wound area by 69.41% in the Unna boot group and by 42.32% in the elastic bandage group. They also found that exudate was more significantly decreased with inelastic compression as compared to elastic compression. However, those in the inelastic compression group complained of more pain, which was accounted to the inability of the dressing to accommodate the fluctuating circumference of the leg.[12]

Conclusion

In wounds with a purely venous etiology, compression therapy has long been the gold standard and is clearly indicated. Similarly, in the individual with critical limb ischemia, it is equally clear that compression therapy is fully contraindicated. However, regarding patients with concomitant venous insufficiency and peripheral arterial disease, there remains a gray area in which the role of compression therapy has not yet been fully explored. Is compression therapy a viable treatment modality for patients with venous leg ulcers who suffer from mild-to-moderate peripheral arterial disease?

Currently, most manufacturers of compression therapy systems recommend that compression not be applied on patients with known peripheral arterial disease, and an ABI of less than 0.8. This recommendation is based on the definition of an ABI of less than 0.9 as PAD. However, it is an arbitrary cut-off for compression therapy in that there have been no evidence based studies utilizing compression therapy on patients with known arterial disease.

Additionally, ABI results are notoriously unreliable in the diabetic patient due to the presence of calcifications within tunica media and intima. ABI values also do not take into account the location of the wound and the vessel that corresponds to the appropriate angiosome.

Chimera, et al. reported that in their study of 20 healthy adults, compression from a Profore dressing resulted in increased skin perfusion pressure ($p = 0.049$), decreased edema, and decreased vascular resistance. Furthermore, it had the benefit of increased ankle dorsiflexion ($p = 0.02$), which may help the diabetic patient offload the forefoot. Their findings suggest that compression may offload the arterial structures and promote arterial wound healing.[13] Although these results are promising, the greatest limitation to this study is that they were performed in healthy individuals and may not be generalizable to the diabetic and vasculopathic populations.

In conclusion, there are clinical scenarios in which compression therapy is clearly indicated and scenarios where it contra-indicated. Multilayer compression therapy improves the healing of wounds of venous etiology. In patients with active signs of critical limb ischemia, compression therapy should always be avoided. Based on anecdotal evidence of the case we report in this article, compression may cause acutely worsened ischemia and should be contra-indicated in a patient with distal runoff primarily consisting of collateralization. However, patients who have venous ulcers with mild-to-moderate peripheral arterial disease may still benefit from compression therapy at a reduced pressure level, though clinical research has yet been done to demonstrate safety.

It would be useful to understand whether collateral vessels compress more easily (under lower pressure) than native arteries. Additionally, if calcified vessels are hard and non-compressible, theoretically, are we able to safely apply compression therapy to manage edema? Clearly, further research is warranted to gain greater understanding of the safety of compression therapy for the patient with venous leg ulcers and concomitant mild-to-moderate vascular disease. **PM**

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