

# A pilot study investigating the utilization of crest pads for treatment of toe callus and ulceration

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*Patients with lesser-toe deformities are at increased risk of developing calluses and ulcers on the distal ends of the affected digits because of the increased pressures applied to these areas. The number of diabetic patients in the United States continues to increase, along with associated comorbidities such as peripheral vascular disease and peripheral neuropathy. These conditions predispose patients to developing foot ulcerations, especially if foot deformities are present. Crest pads are a simple-to-make, inexpensive option to treat calluses and ulcerations on the distal ends of digits; however, there is no research available that support their use. Crest pads consist of rolled gauze covered in moleskin, with a large opening that fits over several toes and lies on the dorsal aspect of the foot, with the padded portion resting under the toes. Over several days of use, the pad molds to the plantar aspect of the toes, offloading pressure from the distal end of the affected digit(s). The sample was obtained through a retrospective chart review of patients identified as having had at least one nail care visit and at least one follow-up visit at a vascular surgery practice between August 2011 and December 2014. Potential subjects with toe deformities who presented with callus or ulcer on the distal end of a digit were considered for inclusion, if they received a crest pad as part of their treatment plan. The scholarly project was a preintervention or post-intervention design with subjects acting as their own controls. McNemar's test was used to analyze the results which were statistically significant ( $P < .0001$  at first callus follow-up and  $P = .0002$  at second callus follow-up) for callus, hemorrhagic callus, and/or ulcer improvement following the crest pad intervention. The results of this scholarly project support the use of crest pads in patients with lesser-toe deformities to treat distal toe calluses and/or ulcerations. (J Vasc Nurs 2015;33:157-163)*

Foot care is an often neglected aspect of patient self-care. In diabetic patients, particularly those with neuropathy and foot deformities, this lack of care can have devastating consequences. Many patients, both with and without diabetes mellitus, present with calluses or ulcers on the tips of their toes because of abnormal pressures caused by lesser-toe deformities.

More than 60% of all nontraumatic lower extremity amputations were performed on patients with diabetes, and the risk for the general population older than age 45 years for vascular-related amputation at or proximal to the transmetatarsal area is eight times higher in diabetic than nondiabetics.<sup>1</sup> Foot ulceration precedes lower-extremity amputation in approximately 80% of cases.<sup>1</sup> King<sup>2</sup> noted that the most common cause of preventable amputations in the diabetic, neuropathic patient population is painless repetitive trauma, which leads to callus and ulceration. These calluses and ulcers can occur as the result of lesser-toe deformities, such as hammertoes, mallet-toes, or claw-toes, and can develop in diabetic and nondiabetic patients. Foot deformity and

hyperkeratotic lesions (corns and calluses) place all patients at an increased risk for ulceration, infection, and potentially, amputation.<sup>1</sup> The combination of an insensate foot, high foot pressures over bony prominences related to deformities, and repetitive stressors such as walking in improperly fitting shoes, leads to skin breakdown.

Biomechanics, the study of the consequences of forces applied to living tissue, is important in the study of foot ulceration because the abnormally high pressures need to be redistributed, or offloaded, to protect the high-risk, high-pressure areas.<sup>3</sup> Repetitive pressures over bony prominences cause deep tissue injury and callus development, a "surface marker" for high-pressure areas. Hemorrhagic callus, bleeding within the callus tissue, should be considered a preulcerative lesion and treated aggressively to prevent further damage.<sup>3</sup> Cavanagh and Bus<sup>4</sup> stated that removal of the callus can reduce pressure by up to 30%, but the length of time this is effective is unknown.

The key to healing wounds is to identify and eliminate or control the underlying cause.<sup>5</sup> The development of callus or ulceration on the distal aspect of hammertoes signifies abnormal pressures on the area, caused by repetitively striking the ground during ambulation. Boulton<sup>3</sup> noted that offloading high-pressure areas is the key step in neuropathic ulcer management. One treatment option designed to reduce this pressure is a crest pad. The article by Coughlin<sup>6</sup> includes a photograph of a crest pad that is available commercially and has an elastic band to hold the pad in place. There are also commercial toe crest pads that are entirely constructed of silicone, with a ring that fits over an individual toe to hold the pad. Either of those designs could predispose a patient to complications including ischemia or ulceration. Insensate

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patients will not notice a silicone or elastic band that is too tight and is in effect causing a pressure ulcer. An overtightened elastic band can produce a tourniquet effect, leading to an ischemic toe. Crest pads for this scholarly project were always made for each individual at the time of the visit. The Crest pad consists of rolled gauze covered in moleskin, with a large opening that fits over several toes and lies on the dorsal aspect of the foot. Over several days of use, the pad molds to the plantar aspect of the toes. The pad thus offloads pressure from the distal end of the affected digit(s).

This author noted anecdotally that the use of crest pads consisting of rolled gauze covered with moleskin and placed under the affected toes is extremely effective in reducing the amount of callus present and healing ulcerations on the distal end of digits. Crest pads have been recommended in the literature to treat distal digital callus when associated with lesser-toe deformities. Unfortunately, there are no research studies that examine the use of crest pads. The purpose of this scholarly project is to evaluate the efficacy of crest pads in reducing the severity of callus, hemorrhagic callus, or ulceration in patients with lesser-toe deformities.

## CONCEPTUAL MODEL

In his seminal paper *Causes* published in 1976, Rothman<sup>7</sup> delineated a model of causation necessary for a disease to occur. Causes, which invariably produce a given effect, are referred to as sufficient causes, although in many diseases or conditions multiple components together form a sufficient cause. Rothman<sup>7</sup> noted that most causes of interest in health care are components of sufficient causes, and blocking the causal role of one component of a sufficient cause prevents the effect. In this study, one component cause of toe callus, hemorrhagic callus, or ulceration pressure, is alleviated through offloading with a crest pad.

Reiber et al<sup>8</sup> applied the Rothman model of causation to subjects with diabetic foot ulcers, 92 from Manchester and 56 from Seattle. A modified Delphi process was used by a multidisciplinary group of foot care clinicians to delineate component causes for each patient case reviewed. According to Reiber et al,<sup>8</sup> 32 unique causal pathways to ulceration were identified, but a critical triad of neuropathy, foot deformity, and minor trauma was present in 63% of cases. Edema, ischemia, and callus were present in 37%, 35%, and 30% of all total pathways, respectively.<sup>8</sup> Peripheral neuropathy alone was present in 78% of cases.<sup>8</sup>

Lavery et al<sup>9</sup> evaluated 87 subjects with 103 existing or recently healed ulcers to determine causal pathways and pivotal factors associated with ulcer development. Seven variables were evaluated, including neuropathy, callus, deformity, elevated peak pressure, vascular disease, improper footwear, and penetrating trauma.<sup>9</sup> Twenty-seven unique causal pathways were identified, although the seven most common pathways accounted for 64.1% of cases.<sup>9</sup> Neuropathy was the most common condition, present in 92.2% of the study group, whereas deformity and callus accounted for 63.1% and 60.2%, respectively.<sup>9</sup> Using a cluster analysis, four distinct clusters were identified: penetrating trauma; ill-fitting footwear; vascular disease; and neuropathy, deformity, callus, and elevated peak pressure.<sup>9</sup> Lavery et al<sup>9</sup> found that ill-fitting footwear, penetrating trauma, and vascular disease were



**Figure 1.** Example of a moleskin crest pad. The first photo shows a newly made crest pad. The second photo demonstrates how the pad is positioned under the affected toes.

essentially separated from the group during analysis using a dendrogram, which identifies them as pivotal events. Lavery et al<sup>9</sup> concluded that intervention pertaining to a component cause may decrease morbidity, recommending proper shoe fitting, callus removal, and accommodating foot deformities specifically.

McGuire<sup>10</sup> also reviewed Rothman's model for ulcer development in diabetics. In subjects with biomechanical problems, this cascade of events includes foot deformity, mechanical instability, connective tissue glycosylation, autonomic and peripheral neuropathy, callus formation, peripheral vascular disease, and impaired wound healing.<sup>10</sup> McGuire<sup>10</sup> also noted that ulcers occur in response to constant, sustained low pressures, repetitive moderate pressure, or short durations of high pressure. Pressure redistribution through accommodative footwear aims to reduce ulceration risk.

## Project design

The purpose of this scholarly project was to examine the use of crest pads in the treatment of toe callus, hemorrhagic callus, and ulceration in subjects with lesser-toe deformities. The project was a pre-postintervention design with subjects acting as their own controls. The retrospective chart review was performed for potential subjects seen between August 1, 2011, and December 31, 2014, who were treated with a crest pad. All subjects were seen by this clinician, and all Crest pads were made by this clinician at the time of the initial and subsequent visits for each individual subject. Callus and ulcer characteristics were compared before and after intervention; each subject acted as their own control. Data were collected a maximum of four times postintervention—there would have been a minimal number of subjects who had five or more follow-up visits within the timeframe for data collection. The crest pads were to be worn daily, removed for showering, and at bedtime.

## Definition of terms

The following terms are defined for the purposes of the scholarly project:

**Crest pads.** Crest pads used in this scholarly project are rolled gauze covered in moleskin, with an opening cut out for two or three toes depending on the number of toes affected. The moleskin loops over the dorsal aspect of the toes to hold the pad in place. The rolled gauze portion of the crest pad molds itself to the patient's toes over several days of use, offloading pressure from the distal ends of the affected digits, see [Figure 1](#).

**Offloading.** Redistributing pressure to treat or prevent injury such as callus, hemorrhagic callus, or ulceration. In this scholarly

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