Debridement of Necrotic Eschar With 40% Urea Paste Speeds Healing of Residual Limbs and Avoids Further Surgery

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Report of Cases

A 50-year-old man with diabetes (patient 1) underwent left below-knee amputation (BKA) for a nonhealing infected foot ulcer. Necrotic eschars developed on the residual limb (Figure 1). He was referred to the dermatology department postoperatively for wound care prior to a planned above-knee amputation (AKA).

A 62-year-old man with diabetes (patient 2) underwent bilateral BKA for gangrene secondary to foot ulcerations. One month postoperatively he was referred to the dermatology department for wound care of necrotic eschars involving both distal residual limbs.

A 56-year-old man (patient 3) with diabetic neuropathy affecting both upper and lower extremities developed cellulitis and gangrene following thermal burns to the left sole. One month following BKA, the wound dehisced, and an adherent necrotic eschar formed at the distal residual limb.

A 62-year-old woman with diabetes (patient 4) with ischemic gangrene of the left toes underwent BKA. After amputation, her residual limb developed ischemic necrosis with painful adherent eschar formation.

The Cutting Edge: Challenges in Medical and Surgical Therapeutics

Therapeutic Challenge

Adherent, painful eschars precluded mechanical debridement of our patients’ residual limbs. The incidence of soft tissue necrosis following lower extremity amputation ranges between 8% and 21% of cases and is commonly associated with ischemic vascular disease in combination with tight sutures. Below-knee amputation is preferable to AKA because preservation of the knee allows for a more functional prosthesis. However, in a study of 50 patients undergoing BKA, the wounds of 7 patients (14%) never healed, and amputation above the knee was required. Faced with this consequence in our patients, we attempted to avoid mechanical debridement by using 40% urea paste.

Solution

Application of 40% urea paste to a necrotic eschar involves 6 “key” steps: (1) Cloth tape (1/2-in thickness) is applied to outline the wound and protect the surrounding skin. (2) Forty percent urea paste is applied liberally (1/2-in thickness) over the entire eschar. (3) A liquid adhesive (Mastisol; Ferndale Laboratories Inc, Ferndale, Mich) is applied (1/2-in frame) around the cloth tape. (4) Polyethylene film (Saran Wrap plastic film; Dow Chemical Company, Midland, Mich) is cut and applied to adhere to the liquid adhesive. (5) Cloth tape (1-in thickness) is applied to fix the polyethylene film margins. (6) Elastoplast tape is applied over the entire dressing. The dressing is removed at 72 hours, followed by immediate debridement. The softened eschar can be gently elevated and removed in a plane above viable tissue. The eschar hardens within minutes if not debrided immediately.

In patient 1, daily saline gauze packing was begun, but 1 month into therapy the exudative wound yielded cultures positive for Pseudomonas aeruginosa and Serratia marcescens (Figure 2). Therapy was changed to 0.25% acetic acid–soaked gauze packed daily with polyethylene occlusion. The wound was almost fully granulated 6 weeks following the urea debridement (Figure 3). Complete healing of the wound was achieved 16 weeks after urea debridement (Figure 4). In patient 2, after daily saline gauze packing with polyethylene occlusion, the wound was completely healed at 8 weeks. In patient 3, the same therapy achieved complete healing at 16 weeks. In patient 4, urea was applied 6 weeks postoperatively. Daily saline gauze covered with polyethylene film resulted in complete healing of the residual limb 15 weeks following urea application. A prosthesis was successfully fitted in each patient.

Comment

Painful ischemic ulcerations with adherent eschar formation complicate and prevent healing of BKA residual limbs. Reamputation above the knee may be necessary because unhealed limbs cannot be fitted with a prosthesis.
sis and pose a risk for infection. In addition to a second surgical procedure requiring anesthesia, AKA decreases the functional capacity of the limb.

Surgical or sharp debridement of ischemic eschars on residual limbs after BKA is difficult because of pain and adherence of the eschars. Often, sharp debridement requiring anesthesia can remove viable tissue and/or lead to progressive necrosis. Chemical debridement of necrotic eschars with enzymatic agents, including papain-urea (Accuzyme ointment; Healthpoint, Fort Worth, Tex), fibrinolysin-desoxyribonuclease (Elase ointment; Fujisawa Pharmaceutical Co, Deerfield, Ill), and collagenase (Collagenase SANTYL ointment; Knoll Pharmaceutical Company, Mt Olive, NJ), is marginally and slowly effective and may be complicated by increased inflammation and pain.4,5

In our expanding experience, urea paste provides fast and effective softening of large and small eschars. The rapid action of urea results from its strong osmotic effect on the skin.5 With diffusion in and around corneocytes, urea disrupts hydrogen bonding and thereby exposes water-binding sites. Urea rehydrates the stratum corneum by drawing water from deeper epidermal and dermal tissues. This humectant property explains its ability to soften hard, devitalized tissue.6,7 Conversely, after removal of the urea paste from the skin, exposure to air rapidly reverses its humectant effect. For this reason, immediate debridement is required once the urea-occluded wound is uncovered.

Following chemical debridement, we proceeded with once-daily packing using either 0.25% acetic acid or saline gauze kept moist with polyethylene. The occluded wounds remained pain free. Time to complete healing following urea application ranged from 8 to 16 weeks. None of the ulcers required a second surgical or chemical debridement to remove necrotic tissue. In contrast, a study of pressure ulcers (with documented normal ankle-brachial indices) found that an 86.5% reduction of necrotic tissue was achieved after 21 daily applications of papain-urea.5 Collagenase reduced necrotic tissue by 37.3% over the same duration. Complete healing time was not assessed. We found only 1 study that evaluated enzymatic agents for the treatment of ischemic ulcerations.4 This study evaluated removal of necrotic tissue prior to skin grafting and found no difference between fibrinolysin-desoxyribonuclease solution and saline placebo.

In low concentrations (10%-25%), urea has long been used as both a moisturizer and skin-softening agent. More effective skin-softening properties are achieved with the 40% concentration, available commercially in both cream and ointment bases (Table). Urea in a 40% concentration has been used under occlusion for a traumatic loosening and avulsion of dystrophic nails, callus removal,
and debridement of ischemic ulcerations in multiple settings. Our wound debridement protocol uses the same 40% urea mixture used for nail avulsion. The major difference is a shorter urea contact time (3 days for a necrotic eschar vs 4-7 days for nail avulsion).

To prepare 40% urea paste, our pharmacy compounds urea crystals (48 g) in anhydrous lanolin (24 g), paraffin wax (6 g), and white petrolatum (42 g), which yields a total volume of 120 g. Chemical debridement with urea is painless, avoids wound traumatization, and is inexpensive. Two ounces of paste costs $15. In contrast to Accuzyme ointment ($57.28 per oz) and Elase ointment ($24.22 per 30 g), cost savings to the patient are evident. Possible adverse effects of 40% urea paste (not observed in our experience) include irritant dermatitis caused by contact with surrounding healthy skin or contact allergy to the vehicle.

Our cases illustrate a significant role for the ability of urea to soften and debride necrotic or devitalized skin. From our experience with eschar formation on distal residual limb wounds, we believe that debridement with 40% urea paste is the preferred efficient and effective method to remove adherent eschars, prevent AKA, and enhance quality of life.