

Introduction

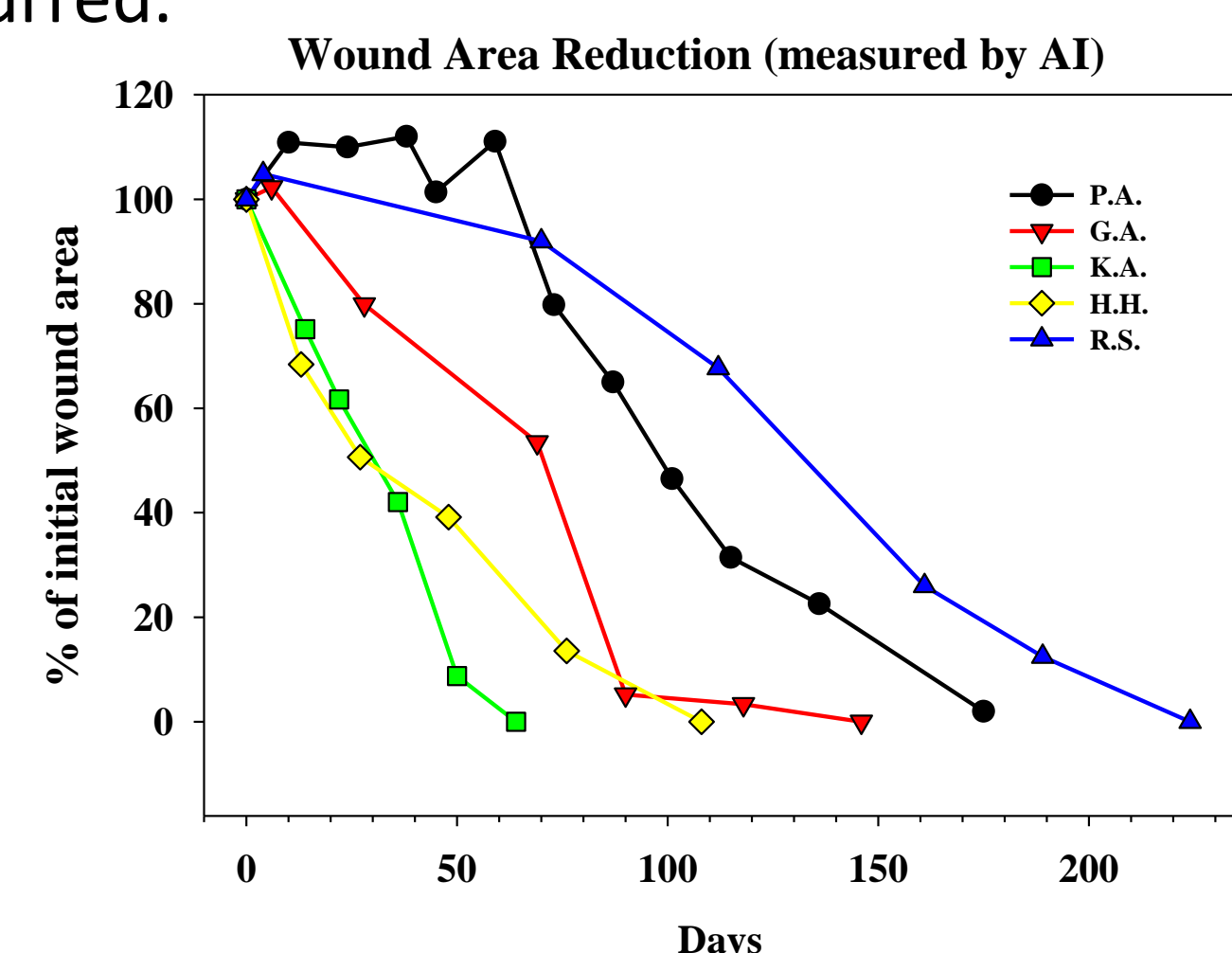
Necrotic wounds present a significant challenge in wound management due to their compromised healing potential and susceptibility to infection. Copper dressings are known and approved for their wide spectrum antibacterial activity. Their effect on angiogenesis and granulation tissue production was demonstrated in molecular biology testing in animal trials as well as in clinical practice and publications (Borkow et al. (2010) Wound Repair and Regeneration 18: 266; Melamed et al. (2021) Medicina 57(10):1129). Due to favorable results, we have extended our copper dressing utilization to more complicated, necrotic and ischemic wounds.

Methods

All patients were diabetics. Three patients were ischemic with PVD. Two patients were on hemodialysis. Two patients had residual necrosis following cellulitis and necrotizing fasciitis. Two of the patients were in terminal condition, thus the treatment was palliative. Eleven wounds with over 75% necrotic tissue were treated with copper dressings. Five wounds were major amputation stumps planned for revision surgery. Wound size was analyzed by an artificial intelligence (AI) software (Tissue Analytics), and the necrotic and granulation tissue was estimated by both the AI software and the physician determinations.

Results

The mean initial wound size was $42.6 \pm 52.2 \text{ cm}^2$ (range: 9 to 180 cm^2). The initial necrotic tissue composed $91.4 \pm 10\%$ of the wound size (range: 75 to 100%). In all 11 wounds complete autolytic debridement was achieved. 8 wounds completely healed within 10 weeks. We had full antibacterial protection without prescription of antibiotics and no infectious episodes occurred.



Discussion

We have found effective autolytic debridement effect by copper dressings, which encourage the body's natural enzymatic action even in wounds with 70-100% necrotic tissue. This was combined (or initiated) with intense angiogenesis and granulation tissue formation and was proceeded with epithelization.

Since copper serves as a cofactor of collagenases and MMP enzymes, we hypothesize that the low concentration of copper ions released from the dressings into the wound bed amplify the enzymatic activity of these autolytic enzymes. In addition, the autolytic effect is achieved through the stimulating effect that the copper ions have on angiogenesis and granulation tissue formation.

We conclude that the copper dressings have a potent autolytic effect on necrotic tissue. Copper dressings therefore can serve as a simple, inexpensive and safe treatment modality to manage necrotic tissue, with the advantage of exerting potent healing and antibacterial capabilities at the same time.

Case No.1 (P.A): 60 years old diabetic patient developed full thickness skin and subcutaneous tissue necrosis in front of the ankle secondary to infection from IV catheter in the ankle. CT (upper left corner) demonstrated the depth on the infection down to the extensor tendons.

The infection was eradicated with antibiotic treatment and debridement surgery was contemplated for the eschar, to be followed by skin grafting.

Home treatment with COD was without antibiotic treatment for the whole period. The eschar peeled away gradually, and the necrotic tissue underneath was auto-debrided by the growing granulation tissue. Epithelization happened almost from the beginning, with skin growth underneath the eschar first, and then over the granulation tissue.

At 5 months the wound was closed. COD was continued on the dry healed skin to promote maturation and a smaller eschar. It is noteworthy that the extensor tendons were never exposed as granulation crawled over them, thus their full function was preserved.

Melamed, E., Rovitsky, A., Roth, T., Borkow, G. (2022) Archives of Clinical and Medical Case Reports 6: 501-510



Case No.2 (G.A): 64 y.o. man with type 2 DM suffered chemical burn to the dorsal aspect of the foot 3 weeks prior to arriving to our clinic. The dry eschar measured 85x25 mm without signs of infection. Ultrasound revealed damage to the skin and subcutis fat, not involving the extensor foot tendons. COD were applied. Skin crawled into the wound, the eschar peeled away at first on the lateral side, where the damage was more superficial. In the medial aspect wound closure was preceded by granulation tissue. At 4.5 months the wound was closed. No infection occurred throughout the healing period.



Case No.3 (R.S): 62 y.o. man with type 2 DM and PVD (ABI = 0.72 & 076, TP & DP) developed pressure injury on the dorsomedial aspect of the foot, apparently as a result of tight bandage after lateral ray resection. The wound turned into dry black eschar measuring 55x37mm, without infection or discharge. Adhesive copper bandage were applied and replaced every 5-7 days. After 4 months the eschar detached and trimmed away, revealing mixed white necrotic and granulation tissue. The necrosis was replaced by red granulation tissue, which in term was exchanged by invading epithelium. At 8 months the wound was closed. One year follow up revealed firm closed wound with some scarring in the center or the original eschar. Although healing was slow, due to the poor blood supply, the copper dressing was very convenient and inexpensive, and conferred full antibacterial protection without infectious episodes or need for an antibiotic.



References: Borkow et al. (2010) Molecular mechanisms of enhanced wound healing by copper oxide impregnated dressings. Wound Repair and Regeneration 18:266.
Melamed et al. (2021) Stimulation of Healing of Non-Infected Stagnated Diabetic Wounds by Copper Oxide-Impregnated Wound Dressings. Medicina 57(10):1129.
Melamed et al. (2022) Anterior Ankle Full Thickness Skin Necrosis Treated with Copper Oxide Dressings without Debridement and Skin Graft – A Case Report. Archives of Clinical and Medical Case Reports 6:501.