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The use of lipid-colloid technology healing matrix dressings impregnated with silver and nano-oligosaccharide particles in the treatment of post-burn wounds of the right foot in a female patient with multiple thermal burns

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ABSTRACT

Among all injuries, burns occupy a fairly serious place. High temperatures, electric current chemicals, and ionizing radiation can cause burns. There are four degrees of burns, depending on the depth of tissue damage. The choice of treatment methods depends on the extent and degree of the burn, and the patient's condition. In this report, we present the clinical case of a 51-year-old patient. Patient was admitted to the Department of Plastic Surgery and Burns with burns affecting the hands, wrists, feet, ankle joints, right lower limb, right buttock, and face. On admission, the patient had first, second, and third-degree burns covering approximately 20% of the total body surface area. We immediately cleared patient for surgical treatment under general anesthesia, performed a necrosectomy of the burn wounds, and covered the skin defects with skin grafts harvested from the left lower limb. The grafts took well, and the donor sites healed without complications; however, graft lysis occurred on the dorsal surface of the right foot. The patient did not consent to undergo further surgery. Only one treatment option remained, which involved the use of specialized dressings. Dressings with a lipid-colloid healing matrix impregnated with silver (TLC-Ag) and those containing nano-oligosaccharide particles (TLC-NOSF) promoted rapid debridement of necrotic tissue, accelerated wound healing, and prevented epithelial disruption during dressing changes, thereby shortening the overall healing time.

Keywords: burn, specialized dressings, TLC-Ag healing matrix, TLC-NOSF healing matrix, wound infection

1. INTRODUCTION

Burns are among the most severe injuries. They can be caused by high temperatures, chemicals, electrical voltage, and ionizing radiation (Severyn et al., 2016). Burns can occur after exposure to temperatures above 42°C, leading to the denaturation of protein structures within the tissues. Just a few seconds of contact with a heat source above 60°C - or about 30 seconds at temperatures over 50°C - can damage the intermediate layers of the skin (Strużyna, 2006).

Several factors determine the extent of damage. These include the intensity, duration, force, and area of exposure, as well as individual susceptibility to energy transfer (Kaźmierski et al., 2002). Burns may involve deeper structures such as bones and muscles (Abubakar et al., 2015). They are classified into four degrees, depending on the depth of tissue damage (Jędrys and Chrapusta-Klimeczek, 2014). Metabolic changes in organs and body systems play a crucial role in treatment planning (Kaddoura et al., 2017).

2. LITERATURE REVIEW

In Poland, approximately 300000 to 400000 people sustain burns each year, with children accounting around for 50% of these cases. In recent years, significant progress has been made in the treatment of burn victims, leading to a reduction in mortality from the severe burns (Mądry et al., 2020). Depth and extent of injury are the key factors in a burns assessment. These factors determine the duration of treatment, the choice of treatment method, as well as the principles of nutrition and rehabilitation procedures.

We used the Rule of Nines and the Palm Methods to estimate the extent of burned skin. The Palm Method states that the patient's hand accounts for approximately 1% of the total body surface area (TBSA), (Kozłowska et al., 2014). The assessment of burn severity is crucial for determining the appropriate treatment approach and for predicting patient outcomes (Puchała and Strużyna, 2002). Table 1 shows the classification of burn severity according to the American Burn Association.

Table 1: Burn Severity Rating, According to the American Burn Association.

Type of burn	Degree of burn	% of body surface
light burn	1st degree burn	-
	2nd degree burn	less than 15% of the body surface area in adults
	2nd degree burn	less than 10% of the body surface in children
	3rd degree burn	less than 5% of the body surface
medium burn	2nd degree burn	involving 15-25% of the body surface in adults
	2nd degree burn	involving 10-20% of the body surface in children
	3rd degree burn	less than 10% of the body surface
	All burns involving hands, face, eyes, ears, feet and crotch	
severe burn	2nd degree burn	more than 25% of the body surface in adults
	2nd degree burn	more than 20% of the body surface in children
	3rd degree burn	more than 10% of the body surface, regardless of age
	3rd degree burns of the face, neck, feet, hands, perineum, circular	
	Inhalation, electrical and chemical burns	
	Burns complicated by other severe injuries or comorbidities	

Dressings made with lipid-colloid technology (TLC) are among the most advanced medical devices for topical wound care (White et al., 2015). Silver-impregnated TLC dressings (TLC-Ag) have shown high effectiveness in managing infected wounds with complex bacterial flora. Their favorable safety profile and excellent local tolerance are also well established.

Furthermore, TLC dressings enriched with silver demonstrate the potential to assist in wound cleansing and to stimulate the healing process (Zieliński et al., 2016).

The Nano-Oligosaccharide Factor (NOSF) is a compound that inhibits the activity of matrix metalloproteinases (MMPs) in the wound bed and promotes neovascularization (White et al., 2015). Additionally, polysaccharide-based fibers facilitate the removal of necrotic tissue, exudate, and slough from the wound surface.

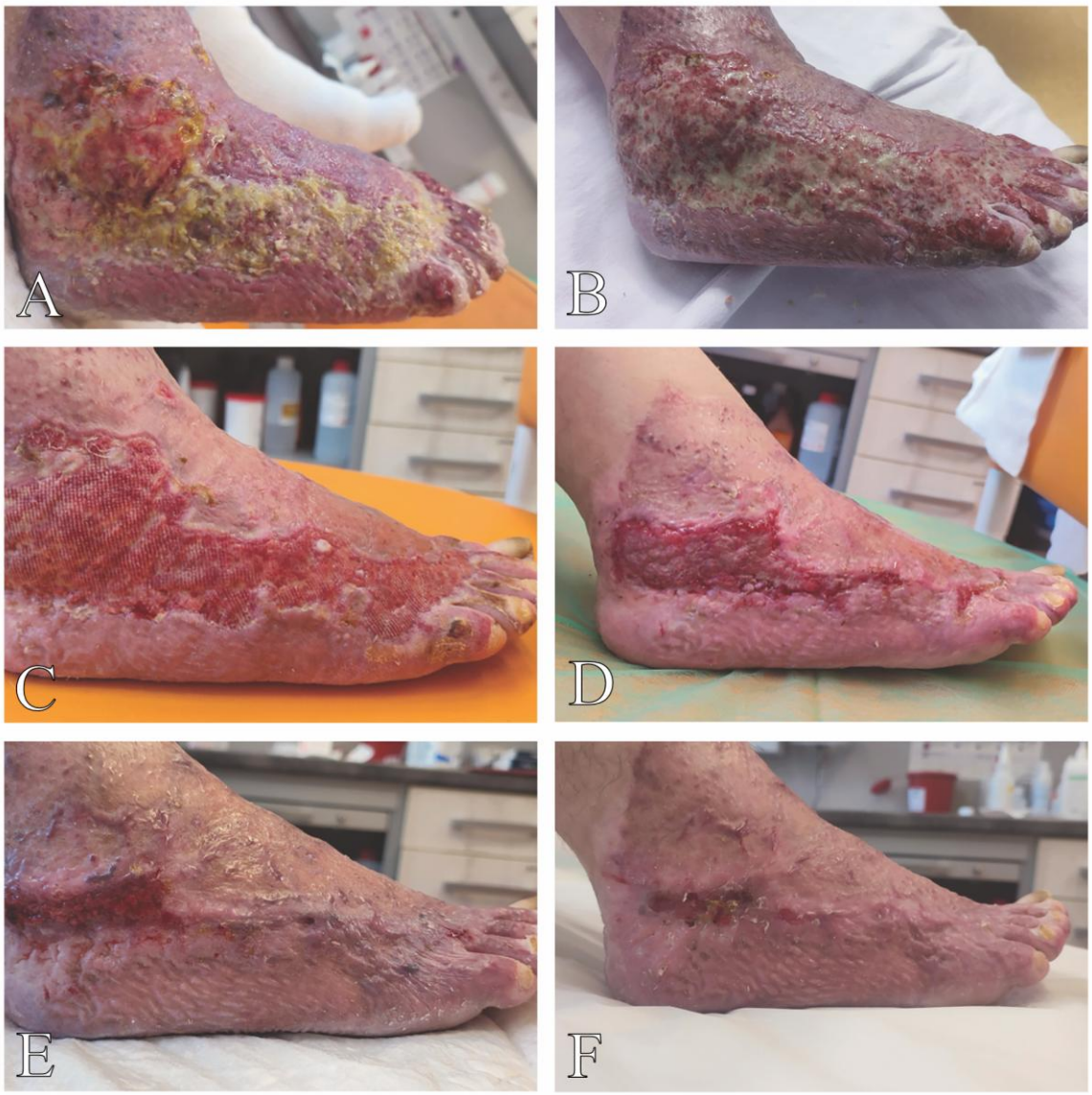

Figure 1 Postoperative photo after the first surgical debridement and lysis of the graft (A), change of dressings on the wound (B, C, D, E, F).

3. CASE REPORT

In this report, we present a clinical case of a 51-year-old patient. We admitted her to the Department of Plastic Surgery and Burns with first-, second-, and third-degree burns involving the hands, wrists, feet, ankles, right lower limb, right buttock, and face, affecting approximately 20% of the TBSA. The burn occurred in the workplace in the morning when an iron halter ignited. Her medical history was unremarkable. She was previously healthy, a non-smoker, consumed alcohol occasionally, and had no chronic illnesses. We placed patient under close observation with continuous monitoring and initiated fluid resuscitation, along with analgesics, anticoagulants, and empirical antibiotic therapy. Wound cultures were collected. Initial conservative management of the burn wounds resulted in adequate clearance of necrotic tissue. The patient was promptly deemed eligible for surgical intervention under general anesthesia. We performed necrosectomy on the burn wounds of both hands, wrists, feet, ankles, right lower limb, and right buttock. To cover the resulting skin defects, we applied skin grafts, harvested from the left thigh and lower leg. Microbiological examination of the burn wounds revealed a community-acquired infection caused by numerous coagulase-negative staphylococci, as well as Gram-positive and Gram-negative bacilli. The identified pathogens represented a potential threat to graft integration. We administered systemic antibiotic

therapy based on the results of antimicrobial susceptibility testing. The grafts and donor sites healed without complications, except for graft lysis observed on the dorsal surface of the right foot. The patient did not want to undergo another operation. We implemented conservative treatment with specialized dressings. The dorsal surface of the foot showed yellow-brown exudate and signs of infection. We subsequently performed wound debridement and disinfection.

Initially, a TLC-Ag dressing containing absorbent polyacrylate fibers was applied to cleanse the wound. Before each dressing change, the right foot was carefully washed and dried. Dressings were changed every other day, always performed in the designated dressing room following the administration of analgesics. Necrotic tissue on the wound surface was removed by gentle mechanical debridement using a curette or spoon technique.

Dressings were applied using the sandwich method and secured with specialized adhesive absorbent dressings. The patient reported that dressing changes did not cause pain. The use of a contact layer dressing, which prevented adherence to the wound and drying, along with the application of an antibiofilm silver dressing, which effectively cleansed the wound and absorbed exudate, likely contributed to this outcome. Following intensive conservative treatment with TLC-Ag healing matrix dressings, the wound on the dorsal surface of the right foot rapidly cleared and began to epithelialize from the edges.

After achieving this result, we applied TLC-NOSF to accelerate wound healing. We achieved an ideal wound environment. Dressing changes were painless and atraumatic, and did not disrupt the epithelium. This contributed to accelerated wound healing and reduced the overall healing time. Figure 1 shows a postoperative photo after the first surgical debridement, graft lysis, and dressing changes.

The patient has been discharged home with instructions to continue wound care and compression therapy. Follow-up appointments were scheduled once a week at the Department of Plastic Surgery.

4. DISCUSSION

Treatment strategies for skin burns focus on minimizing discomfort, preventing infection and complications, and expediting the healing process (Jeschke et al., 2020). Different therapeutic techniques were administered based on the severity of the burns and the time of diagnosis (Peterson and McLaughlin, 2012). First-degree burns respond well to cooling with water. Moisturizers and analgesic medications are effective in treating these mild injuries. We also use the wound dressings for treatment second degree burns, combined with wound cleansing and applicated local antibiotics. The treatment of third-degree burns, however, requires surgical intervention, excision of necrotic tissue, and closure of the defects with skin grafts. Systemic antibiotics and extensive rehabilitation therapies must also be employed.

There are many critical factors influence the selection of appropriate treatment methods for burns, such as depth, location, and extent of a burn. The overall condition of the patient and their chronic illnesses are also taken into account. In burn treatment, the sequence of actions is crucial. Performing surgery and excising necrotic tissue is very important (Strużyna et al., 2024). By preventing the absorption of harmful substances released by necrotic tissue, the need for extended antibiotic therapy is reduced, thereby lowering the risk of hospital-acquired infections.

Fast necrosectomy prevents wound infection, promotes graft integration, and facilitates the closure of skin defects. Unfortunately, infection of postoperative wounds covered with skin grafts can lead to their lysis. Although the epithelial growth process is lengthy, the use of TLC-Ag and TLC-NOSF dressings has demonstrated rapid and effective wound healing. Such dressings are especially beneficial in anatomical areas where surgical intervention is complex to perform (White et al., 2015).

5. CONCLUSION

Silver-impregnated TLC dressings (TLC-Ag) have shown high effectiveness in managing infected wounds with complex bacterial flora. They effectively cleanse wounds without damaging deeper tissues and also absorb wound exudate. Additionally, TLC-NOSF dressings inhibit microorganism-derived matrix metalloproteinases (MMPs), thereby protecting tissues from nosocomial infection. By supporting angiogenesis, these dressings help accelerate the wound healing process. Non-adherent dressings prevent damage to the epidermis during dressing changes and support the epithelialization process. TLC technology-based dressings significantly improve the quality of life for patients requiring long-term wound care.

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Author's Contribution

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Supervision: Żanna Gawrysz
Project administration: Żanna Gawrysz
All authors have read and agreed with the published version of the manuscript.

Informed consent

Written & Oral informed consent was obtained from individual participants included in the study.

Ethical approval

Not applicable.

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Conflict of interest

The authors declare that there is no conflict of interest.

Data and materials availability

All data associated with this work are present in the paper.

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