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The role of zinc supplementation in wound epithelialization of a burn patient: A case report

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Abstract

Introduction: A burn injury is characterized by destruction of the skin, connective tissue, and blood vessels. Healing of a burn injury includes four phases- hemostasis, inflammation, proliferation, and remodeling. Epithelialization is a part of the wound healing process where keratinocytes proliferate in order to form new epithelium. The quality of wound healing may be influenced by nutrition. Zinc is a micronutrient that can affect epithelialization during the wound healing process.

Presentation of case: A 39 year old male with burn injury involving 17% total body surface area was given an adequate nutritional therapy with 40 mg of zinc sulphate for 11 days. The quality of wound healing was assessed through a reduction in raw surface, signifying the presence of epithelialization.

Discussion: Provision of adequate nutrition with zinc sulphate supplementation for 11 days leads to wound epithelialization. This is seen through a reduction in raw surface of the burn injury in the patient's thorax and abdomen. The changes seen in the wound indicate that zinc has a role in keratinocyte proliferation and as an antioxidant in preventing secondary damage to the wound.

Conclusion: Nutrition plays a role in wound healing of burn injuries. Administration of zinc for burn injury may help in the process of wound healing.

Keywords

burns; nutrition therapy; zinc; case report.

Abbreviations

BID: bis in die; kgBW: kilogram body weight; Kcals: kilocalories; mg: miligrams; SCARE: Surgical Case Report; TGFB: transforming growth factor beta; TID: ter in die.

Introduction

A burn injury would present with skin, connective tissue, and blood vessel destruction that may lead to complications such as sepsis and scarring if not treated properly [1]. Nutrition plays a key role in the wound healing process [1]. A micronutrient that plays a part in wound healing is zinc. It plays a major role in regulating every phase of the wound healing process; ranging from membrane repair, oxidative stress, blood coagulation, inflammation and immune defence, tissue re-epithelialization, angiogenesis, to fibrosis/scar formation [2]. This study will focus on the effects of zinc on epithelialization of a burn injury on a patient in a community hospital. This work is reported in line with the SCARE criteria [3].

Case Presentation

A 39-year old male electrician suffered from superficial to full thickness electrical burn, involving 17% of his total body surface area. The patient had a head trauma following his electrocution, causing an epidural hemorrhage and thus leading to a consequent open craniotomy. The patient was admitted to the intensive care unit after his surgery. The patient was given nutrition therapy consisting of an enteral formula administered through a nasogastric tube. The patient was also given zinc sulphate supplementation 20 mg b.i.d., 250 mg vitamin C b.i.d., 2 mg of vitamin B complex t.i.d., and 1 mg of folate once a day. The nutrition given to the patient was aimed to fulfill his total energy requirement which was estimated to be 1925 kcal/day according to Xie formula and protein requirement which was targeted to be at least 1,5 g/kg BW/day. Figure 1, 2, and 3 shows improvement of the patient's burn injury in his thorax, after supplementation of zinc for 1, 5, and 11 days.

Figures 1, 2, and 3 show the changes in wound quality over 11 days. It can be seen how the raw surface disappeared by the 11th day, looking at the absence of a wet bleeding surface. This can be seen in figure 3, in which there was a reduction in raw surface area, seen as an epithelial layer that covers the blood vessels underneath.

Figure 1: Burn injury on thorax and abdomen 1st day of zinc supplementation.

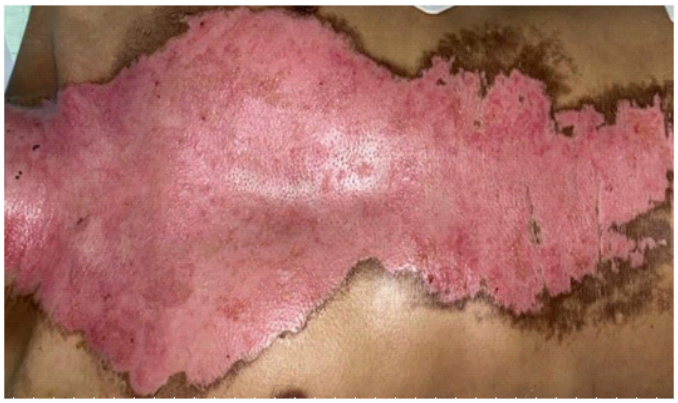

Figure 2: Burn injury on thorax and abdomen, 5th day of zinc supplementation

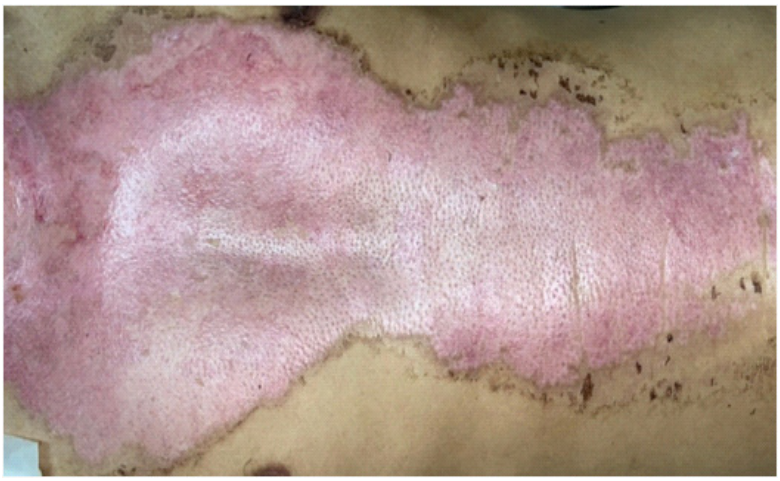

Figure 3: Burn injury on thorax and abdomen, 11th day of zinc supplementation

Table 1: Amount of zinc supplementation and protein given to the patient each day.

Day	Zinc supplementation (mg)	Total protein (g/kgBW)
1	-	0,2
2	20	0,8
3	40	0,8
4	40	1,1
5	40	1,7
6	40	1,8
7	40	2
8	40	2
9	40	2
10	40	1,5
11	40	1,5
12	40	1,5
13	40	2

Discussion

Zinc is a trace element with a role in wound healing, especially in the proliferative phase. In the proliferative phase, T regulatory cells are activated along with increased fibroblast activity, and collagen and extracellular matrix deposition. Zinc plays a part in increasing the number of T regulatory cells that will regulate inflammation, promote re-epithelialization, and increase wound contraction [4]. Zinc also has a role in fibroblast activity during wound healing. After two or three days after onset, fibroblasts would begin to enter the wound site and their accumulation is associated with collagen or extracellular matrix deposition, which serves as a scaffold for wound repair since collagen wound act as a bed for new epithelium, keratinocytes, and microvasculature. Deposition of extracellular matrix involves cell signaling using TGFB/SMAD pathway. Zinc is a cofactor for SMAD signaling and thus plays a major role in formation of granulation tissue [2].

During the formation of new epithelium, there is proliferation and migration of keratinocytes, fibroblasts, epithelial cells, and endothelial cells along with activation and differentiation of multiple epidermal stem cells. Within the epidermis, apoptotic and necrotic cells stimulate epidermal cell proliferation and migration over granulation tissue for epidermal repair. Zinc was shown to increase keratinocyte migration and participate in re-epithelialization of the epidermis [5].

The recommended daily value of consumed zinc for a 39 year old male would be 11 mg, whilst the recommended value would increase to more than 22 mg in burns [2]. The dosage of zinc supplementation given to this patient was 40 mg, which follows the recommended value for burns.

The study on the effect of zinc supplementation on wound healing was done by Berger et al [6]. where patients with burn injuries were given 20 mg of zinc sulphate for three weeks compared with those not given zinc at all. After three weeks of observation, those given zinc showed a lower grafting index, which was a ratio between the raw surface area and the total burn surface area. This indicates that after zinc supplementation, there is an increase in epithelialization seen from a reduction in raw surface area.

The patient in this case was given 40 mg of zinc sulphate for less than 3 weeks yet new epithelium can already be seen after only 11 days.

Aspects that should be considered in this case would be some confounding factors that might interfere with zinc in the wound healing process. The confounding factors were other vitamins given to the patient that might also have a role in wound healing [7]. However, the study of Berger et al. [6] have shown zinc's effectiveness by eliminating the confounding influence of other micronutrients. All the participants in the study were given other micronutrients, only differing by the presence of zinc supplementation in the intervention group. Another confounding factor would be the administration of antibiotics and povidone iodine that may also have a role in wound healing. A study by Kaisy et al. [8] analyses the administration of zinc supplementation in burn patients given topical povidone iodine and silver sulphadiazine, compared with those given topical drugs and not supplemented with zinc. The results showed that those given zinc had better wound healing than those only given topical drugs. This indicates that zinc has a role in wound healing despite administration of topical povidone iodine. Another confounding factor would be the amount of zinc given to the patient through enteral feeds, which would increase the amount of zinc given to the patient. Unfortunately data limitations on zinc content in the patient's enteral feeds disabled proper and accurate measurement of zinc supplementation given to the patient.

Zinc's bioavailability in this case may be influenced by protein consumption due to zinc's protein requirement in order to be transported to different areas in the body.[9] The patient in this case has consumed an adequate amount of protein as indicated by ESPEN's nutrition guideline for patients with burn injury (1,5 - 2 g/kgBW) [10].

Conclusion

Burn injury has to go through a healing process in order to recover tissues and the skin. Zinc is a micronutrient that plays a role in wound healing. This case report shows that zinc supplementation of 40 mg a day has a role in burn wound epithelialization through its functions in cell proliferation. Adequate amount of protein intake is essential for zinc's bioavailability.

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