

An Open-Label, Nonrandomized Pilot Study to Evaluate the Efficacy of a Bovine Cartilage–Based Wound-Dressing Powder for the Management of Deep and Subdermal Pediatric Burns

Cheon Jae Yoon, MD; Jin Kyung Cho, MD; Duk Ju Moon, MD; Seon Gyu Kim, MD

Skin-grafting procedures are the treatment of choice for the management of deep second- and third-degree burns. However, such procedures are highly invasive, require hospitalization, and are associated with a variety of risks, including infections, hematomas, anesthesia-related complications, and donor-site morbidity. Bovine cartilage–based preparations are well-established facilitators of wound healing, including burns. In this open-label, nonrandomized pilot study, a bovine cartilage–based wound-dressing powder was applied to deep and subdermal second- and third-degree burns in 41 children who were unresponsive to conventional therapy with silver sulfadiazine and whose parents refused recommended skin grafting. Healing time averaged 34.8 days, which included the first 2 weeks of conventional treatment. In all cases, the wounds healed completely, with no residual scarring. No infections were detected after the start of treatment with the bovine cartilage–based wound-dressing powder and no adverse effects were reported. Our experience suggests that a bovine cartilage–based wound-dressing powder may be a viable option for the management of pediatric burns.

Skin-grafting procedures are the treatment of choice for the management of deep second- and third-degree burns. However, such procedures are highly invasive, require hospitalization, and are associated with a variety of

risks, including infections, hematomas, anesthesia-related complications, and donor-site morbidity. Because such risks are often unacceptable to the parents of pediatric burn victims, skin grafting is often refused. Unfortunately, few alternative treatments are available.

Dr. Yoon is Director, and Dr. Cho is Physician, both at Department of Emergency Medicine, Bestian Burn Center, Bestian Hospital, Seoul, South Korea. Dr. Moon and Dr. Kim are Physicians, both at Department of General Surgery, Bestian Burn Center, Bestian Hospital.

The authors report no conflicts of interest in relation to this article.

This study was sponsored and funded by Lescarden, Inc.

Bovine cartilage–based preparations are well-established facilitators of wound healing.¹ In clinical studies, such preparations have been shown to accelerate wound healing and improve tensile strength, granulation, and vascularization.¹⁻⁴ A bovine cartilage–based wound-dressing powder has been shown efficacious in the management of a variety of wound types, including burns. In this open-label, nonrandomized pilot study, the bovine cartilage–based wound-dressing powder's efficacy in

Demographic Data

Patients, n	41
Male:female	22:19
Mean age, mo	25.1 ± 27.1 (range, 8–148)
TBSA, %	5.1 ± 5.3 (range, 1–20)
Wound type, n	
Acute, deep dermal burn	33
Full-thickness burn	8
Burn type, n	
Scald	29
Steam	8
Flame	2
Electrical	1

Abbreviation: TBSA, total body surface area.

healing burns was evaluated in deep and subdermal second- and third-degree burns in children who were unresponsive to conventional therapy with silver sulfadiazine and whose parents refused recommended skin grafting. This study was conducted at the Bestian Burn Center, Seoul, South Korea.

MATERIALS AND METHODS

We recruited 41 pediatric burn patients who presented to the Bestian Burn Center between February and March 2006. Twenty-two patients were male (mean age, 25.1 ± 27.1 months), and the percentage of the total body surface area (TBSA) of the burn was 5.1% (5.1 ± 5.3). In 33 patients, burns were defined as acute, deep dermal burns, and in 8 patients as full-thickness burns (Table).

All patients had acute, deep second- and third-degree burns that were unresponsive to 2 weeks of conventional treatment. Skin-grafting procedures were recommended for all patients but were refused by the parents. Included in the study were children requiring hospitalization, as well as children being treated as outpatients.

For the initial treatment, silver sulfadiazine and a gauze dressing were applied. If there were no signs of clinical infection, a polyurethane foam dressing was applied after 2 to 3 days of silver sulfadiazine therapy. If infection occurred, mafenide acetate, which is a topical antibacterial agent, or an antimicrobial barrier dressing was also applied.

If no healing or minimal healing had occurred after approximately 2 weeks of such treatment, a bovine cartilage-based wound-dressing powder was applied

following eschar lysis, with 1 g applied to the 4×4-cm² burn area. The bovine cartilage-based wound-dressing powder was changed every 2 to 3 days, depending on wound exudates. A polyurethane foam dressing and an elastic bandage were applied over the bovine cartilage-based wound-dressing powder.

RESULTS

All patients were treated with the bovine cartilage-based wound-dressing powder. The powder was used for a mean of 17.7 days, from postburn day (PBD) 13.8 to PBD 31.5, and was applied a mean of 8.7 times. These PBD differences were related to the TBSA, with larger burns requiring more time to heal. Healing time averaged 34.8 days, which included the first 2 weeks of conventional treatment. In all cases, the wounds healed completely, with no residual scarring. No infections were detected after the start of treatment with the bovine cartilage-based wound-dressing powder and no adverse effects were reported.

CASE STUDIES

Case 1

A 16-month-old girl presented with a deep second-degree scalding burn on her left forearm (Figure 1A). The burn covered 3% of the TBSA. A skin graft was recommended but was refused by the patient's parents. On PBD 12, conventional therapy had produced little healing and the bovine cartilage-based wound-dressing powder was applied (Figure 1B). During a 15-day period, from PBD 12 to PBD 27, the bovine cartilage-based wound-dressing powder was applied 7 times. Three days following the last application, on PBD 30, the burn was markedly smaller and new skin growth covered most of the burn surface (Figure 1C). The burn area at this time point was 13×5 cm².

Case 2

A 23-month-old boy presented with deep second- and third-degree flame burns on the left wrist and hand (Figure 2A). The burns covered 1% of the TBSA, and the patient's parents refused a skin graft. Two weeks of conventional therapy produced almost no healing, and the patient's parents continued to refuse surgical intervention. As an alternative, the bovine cartilage-based wound-dressing powder was applied 16 times from PBD 15 to PBD 53. After 12 applications, on PBD 40, a notable amount of healing had occurred, with new skin growth covering almost all of the burn area (Figure 2B). Eleven days after the 16th and last application of the bovine cartilage-based wound-dressing powder, on PBD 64, the burn was healed (Figure 2C). There was minimal residual scarring and the patient retained normal

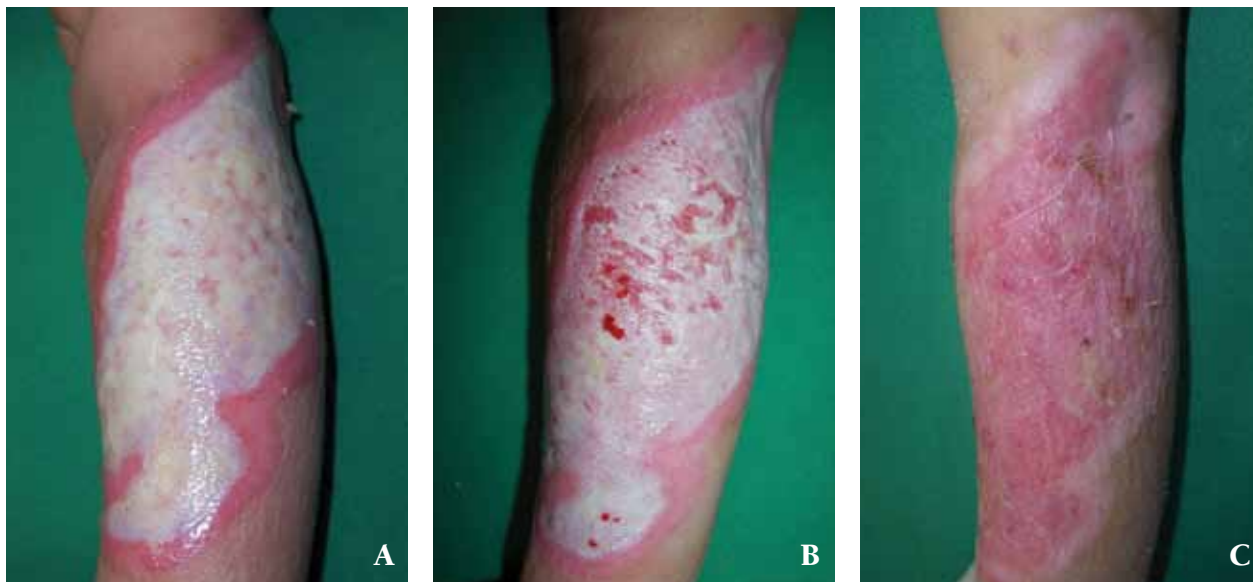


Figure 1. A 16-month-old girl with a scalding burn 8 days after conventional treatment (A), 12 days after conventional treatment (B), and 3 days after the last application of the bovine cartilage–based wound-dressing powder, on postburn day 30 (C), with the burn noticeably smaller.

hand and wrist motion. The burn area at this time point was $9 \times 3 \text{ cm}^2$.

Case 3

A 5-month-old girl presented with deep second- and third-degree contact burns to the forehead, cheek, chin, and neck (Figure 3A). The burns covered 4% of the TBSA, and the patient's parents refused a skin graft. More than 2 weeks of conventional therapy failed to produce any significant healing. As an alternative to surgery, the bovine cartilage–based wound-dressing powder was applied 7 times from PBD 19 to PBD 31. Six days after the first application of the bovine cartilage–based wound-dressing powder, on PBD 25, the burn area was greatly reduced in size and marked healing had occurred (Figure 3B). Five days after the last application, on PBD 36, the burn was healed and scarring was minimal. The burn area at this time was $4 \times 3 \times 2 \text{ cm}^2$ (Figure 3C).

Case 4

A 33-month-old girl presented with a third-degree electrical burn on her left hand. The burn covered 1% of the TBSA and her parents refused a skin graft (Figure 4A). Conventional therapy was applied for 3 weeks, but produced little improvement in the severity of the wound. Because the patient's parents continued to refuse surgery, the bovine cartilage–based wound-dressing powder was applied 14 times from PBD 24 to PBD 50. After 7 applications, on PBD 38, the burn area was reduced to less than half of its original size (Figure 4B). Six days after the last application, on PBD 56, the burn was healed (Figure 4C). Posttreatment scarring was minimal, and the patient retained full range of motion. The burn area at this time point was $2 \times 3 \text{ cm}^2$.



Figure 2. A 23-month-old boy with deep second- and third-degree flame burns on the left wrist and hand on postburn day 1 (A), after 12 applications of the bovine cartilage–based wound-dressing powder, on postburn day 40 (B), and 11 days after the last of 16 applications of the bovine cartilage–based wound-dressing powder, on postburn day 64 (C), with the burn healed.

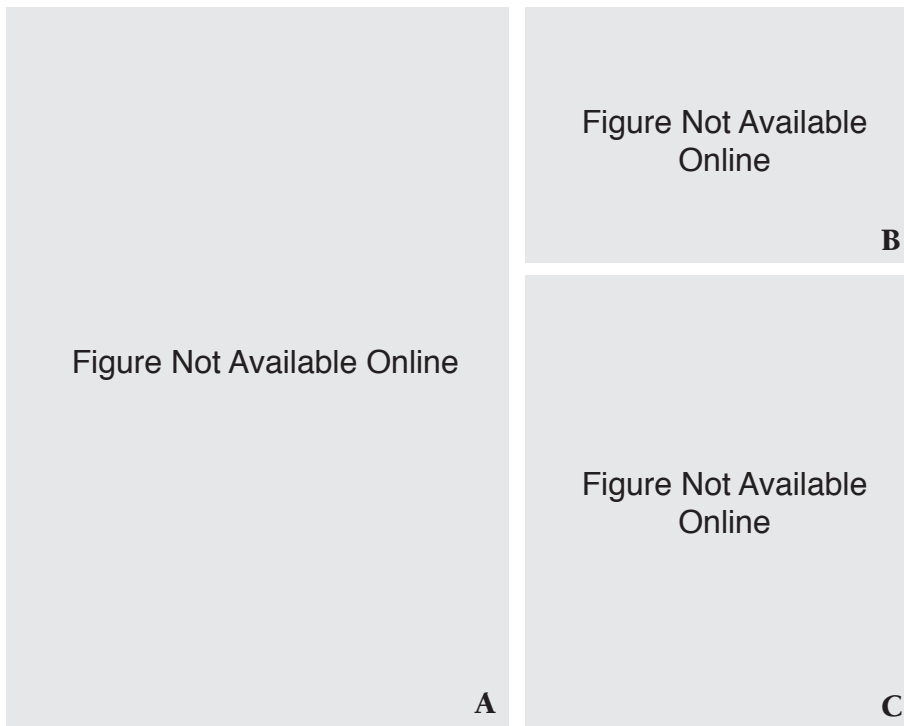


Figure 3. A 5-month-old girl with deep second- to third-degree contact burns to the forehead, cheek, chin, and neck, on postburn day 1 (A), 6 days after the first application of the bovine cartilage-based wound-dressing powder, on postburn day 25 (B), and 5 days after the last of 7 applications of the bovine cartilage-based wound-dressing powder, on postburn day 36 (C), with the burn healed and scarring minimal.

COMMENT

Cartilage is an established accelerator of wound healing.¹ In this observational pilot study, we applied a bovine cartilage-based wound-dressing powder to severe burns in pediatric patients. The powder, which is derived from bovine tracheal cartilage, is natural and biodegradable. It is composed of 73% protein, 18% mucopolysaccharides, and 5% of other cartilage components.⁵ The bovine cartilage-based wound-dressing powder is already

approved by the US Food and Drug Administration for the management of pressure, stasis, diabetic ulcers, foot ulcers, first- and second-degree burns, postsurgical incisions, radiation dermatitis, cuts, abrasions, skin irritations, partial-thickness wounds, and skin conditions associated with peristomal care.

The powder acts as scaffolding for regrowing skin and has several mechanisms of action that make it an attractive option for general wound management and for pediatric burns in particular. First, the bovine cartilage-based wound-dressing powder contains collagen, the main protein of connective tissue. The powder stimulates fibroblast migration and proliferation by as much as 12% and keratinocyte proliferation by 40%.⁶ Moreover, macrophage activity, which promotes angio-

genesis, appears to be increased in the presence of the powder.⁶ Collectively, these mechanisms increase scar strength (the resistance of the wound to tearing) and skin elasticity, and improve granulation and vascularization, thereby facilitating wound healing.²

In our patients, the bovine cartilage-based wound-dressing powder appeared to accelerate burn healing. Whereas 2 or more weeks of conventional therapy produced little to no healing, visible tissue regrowth



Figure 4. A 33-month-old girl with a third-degree electrical burn on the left hand, on postburn day 3 (A), after 7 applications of the bovine cartilage-based wound-dressing powder, on postburn day 38 (B), and 6 days after the last application of the bovine cartilage-based wound-dressing powder, on postburn day 56 (C), with the burn healed and minimal scarring.

was observed within days of the first application of the powder. The bovine cartilage-based wound-dressing powder was quickly and easily applied to the entire burn surface area repeatedly, and multiple applications were safe and feasible. No treatment-related adverse events were observed.

Although surgery was recommended for the patients, it was refused by their parents. The bovine cartilage-based wound-dressing powder was applied as an alternative to surgery and may offer several advantages to surgery because it is easy to handle, application does not require anesthesia or hospitalization, there is no donor-site morbidity, and the powder carries none of the risks typically associated with surgery (eg, infections, hematomas). Indeed, other than rare allergic reactions, which subside after discontinuation of treatment, the powder has not been associated with any adverse events.^{3,4}

Our study has several limitations because it was randomized and no direct comparisons of healing time with surgery were performed. Long-term follow-up and evaluation of scarring at 1 to 2 years are still required, and no economic analysis was performed. However, in the cases described in this article, healing was complete within weeks of the first application of the bovine cartilage-based wound-dressing powder, suggesting that this product has a place in the management of pediatric burns.

CONCLUSION

In our experience, this bovine cartilage-based wound-dressing powder was a safe and effective alternative to surgery. Healing time after the first application was relatively short, occurring within days to weeks, and scarring was minimal. The powder was associated with fewer risks than are typically associated with surgery. Our experience suggests that a bovine cartilage-based wound-dressing powder may be a viable option for the management of pediatric burns. Controlled studies are needed to evaluate the advantages of the bovine cartilage-based wound-dressing powder relative to conventional therapy for pediatric burns, with a focus on the potential benefits of beginning treatment of burns sooner than was done in the cases presented in this article.

REFERENCES

1. Prudden JF, Allen J. The clinical acceleration of healing with a cartilage preparation; a controlled study. *JAMA*. 1965;192:352-356.
2. Prudden JF, Teneick ML, Svahn D, et al. Acceleration of wound healing in various species by parenteral injection of a saline extract of cartilage. *J Surg Res*. 1964;4:143-144.
3. Torra i Bou JE, Casaroli-Marano RP, Martinez Cuervo F, et al. Collagen in the healing of wounds. *Rev ROL Enf*. 2000;10:10715-10722.
4. Torra i Bou JE, Soldevilla Agreda JJ, Martinez Cuervo F, et al. Collagen healing powder in the treatment of pressure ulcers. *Rev ROL Enf*. 2002;25.
5. Catrix [package insert]. New York, NY: Lescarden, Inc.; 2007.
6. Data on file. Vilaró SI, Reina del Pozzo M, Casaroli-Marano R. Characteristics and efficacy of Catrix®. Department of Cellular Biology, University of Barcelona, Barcelona, Spain, 2000. ■