

Management of Large Pediatric Wound Defects Using a Continuous External Tissue Expander

Youna K. Choi, MD*
Sagar T. Mehta, MD†
Jessica Luo, MD‡
Faizi Siddiqi, MD, FACS‡
Barbu Gociman, MD, PhD‡

Summary: Both internal and external tissue expanders take advantage of the innate adaptive mechanisms the skin exerts in response to mechanical tension, known as the stress-relaxation phenomenon. Internal tissue expander use is time-consuming and can be complicated by infection and extrusion. In this case series, continuous external tissue expanders used to manage large pediatric wounds were assessed. Fourteen patients (ages: 4 days to 17 years) with large wounds underwent continuous external tissue expansion intraoperatively. The success of wound closure was assessed. In addition, the size of the patient's wounds, duration of device application, and postoperative complications were evaluated. The continuous external tissue expander was applied to wound sizes ranging from 14.7 to 560 cm² for 5 to 10 days until the wound was amenable for direct closure. In 11 of the 14 patients, delayed primary closure was achieved. The device significantly reduced the wound sizes of the remaining three cases (average 80% size reduction). There was no incidence of wound dehiscence or infection. This case series demonstrates the benefit of the continuous external tissue expansion in managing pediatric wounds that would not otherwise be amenable to primary closure. The method allows for timely closure with limited risk of infection or extrusion, and should be in the armamentarium of reconstructive plastic surgeons. (*Plast Reconstr Surg Glob Open* 2021;9:e3723; doi: [10.1097/GOX.0000000000003723](https://doi.org/10.1097/GOX.0000000000003723); Published online 5 August 2021.)

INTRODUCTION

Tissue expanders take advantage of the innate adaptive mechanisms the skin exerts in response to mechanical tension, known as the stress-relaxation phenomenon.¹ Constant strain applied by the tissue expander to the skin eventually relaxes and allows for gradual advancement and delayed primary wound closure.¹ Histological studies of expanded skin have demonstrated increased fibroblast and collagen synthesis, increased mitotic activity, and neovascularization.¹ To date, the report on the management of large wound defects with continuous external tissue expansion (CETE) devices in the pediatric population has

been limited. This is the first study to evaluate the effectiveness and management of large wound defects with CETE in a series of pediatric patients.

MATERIALS AND METHODS

A retrospective review of patients with large wound defects closed with the DermaClose (SYNOVIS, Birmingham, Ala.) CETE device at the Primary Children's Hospital from 2015–2017 was conducted. Patient selection was based on a senior plastic surgeon's assessment and included large wounds where primary closure or a local flap could not be done, but closure was thought possible after the application of the CETE device. The parameters assessed were the patient's age, wound characteristics (location, etiology, and size), duration of device application, complications, and further interventions.

The CETE device was applied in a standard fashion for all cases. Once a clean wound bed was achieved through debridement, the wound edges were undermined in the suprafascial plane, and anchors of the device were applied and stapled to the skin. Each CETE device consisted of three pairs of skin anchors placed 2–3 cm apart and 1.5–2 cm from the wound edges. Larger wound defects required the application of multiple CETE devices. The tension line

From the *Department of Surgery, Albany Medical College, Albany, N.Y.; †Division of Pediatric Plastic and Reconstructive Surgery, Department of Surgery, University of Arkansas Medical Sciences, Little Rock, Ark.; and ‡Division of Plastic Surgery, Department of Surgery, University of Utah Hospitals and Affiliates and Primary Children's Hospital, Salt Lake City, Utah.

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Drs. Choi and Mehta contributed equally to this work.

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of the device was passed through the skin anchors and tightened per manufacturer's instructions. Protective nonadherent gauze was applied between the CETE device's tension line, underlying skin, and wound bed to prevent pressure necrosis. The device's intrinsic mechanism prevents over-tightening and maintains tension at 11.7 Newton (1.2 kg).² The device was tightened to the maximum allowed tension in all instances. If the wound was edematous, measures such as extremity elevation and ACE wrapping were applied. Once the swelling subsided, device was retightened once at the bedside. The patients were hospitalized for the duration of the expansion. The device was removed after achieving adequate tissue expansion. The expanded cutaneous flaps were advanced into the wound and approximated to each other using interrupted deep dermal PDS sutures and interrupted vertical mattress superficial Prolene sutures. Postoperative clinical evaluation occurred at 1, 3, 6, and 12 months.

RESULTS

The CETE device was used on 14 large pediatric wounds ranging between 14.7 and 560 cm² (average 122.6 ± 151.7 cm²). The patients were aged between 4 days and 17 years old (average 9.5 ± 6.3 years) with various preoperative diagnoses. (See **table 1, Supplementary Digital Content 1**, which demonstrates patient demographics, perioperative assessments, and outcomes. <http://links.lww.com/PRSGO/B727>.)

Delayed primary closure was achieved in 11 of the 14 large wound defects (**Fig. 1**). These wounds were amenable to closure after applying the device for 5–10 days (average 6.5 ± 1.6 days). None of the closures were complicated with infection or wound dehiscence. The majority of patients experienced epidermolysis at the level of the skin anchors that healed with conservative management. (See **figure 1, Supplemental Digital Content 2**, which displays (a) The lateral leg wound 1-week s/p ORIF of tibia and fibula fractures with leg fasciotomies. (b) Application of CETE device on lateral leg fasciotomy wound. (c) Intraoperative appearance of the wound after closure. Mild epidermolysis is visible on the edges of skin closure where device anchors were applied. (d) Wound appearance at 6-week follow-up. (e) Wound appearance at 1 year follow-up. <http://links.lww.com/PRSGO/B728>.) No additional pain management was required above what was needed for the patients' original conditions.

Despite the use of the CETE device, three wounds could not undergo delayed primary closure. Nonetheless, a significant decrease in wound surface area (average 80%) was achieved. One patient had a history of extensive cutis aplasia. Acellular dermal matrix (ADM) was used for calvarial reconstruction. After the advancement and marsupialization of the expanded scalp flaps, the residual exposed portion of the ADM was allowed to heal by secondary intention. The other two patients had severe trauma to the dorsum of the foot, significant soft-tissue loss, and exposed tendons and bone. Enough vascularized soft tissue, but not enough skin, was generated by the expansion process. (See **figure 2, Supplemental Digital Content 3**, which displays (a) The dorsal foot wound with tendon and bone exposure

before application of the CETE device. The wound measured 8 × 5 cm. (b) Application of the CETE device. (c) Dorsal foot wound after removal of the CETE device and before the inset of the expanded flaps. (d) After the inset of the expanded flaps and before the placement of the skin graft. The wound measured 8 × 1.5 cm after application of the device. <http://links.lww.com/PRSGO/B729>.)

After the advancement and marsupialization of the expanded flaps, full-thickness skin grafts were applied. All three wounds healed without any further complications.

On long-term follow-up, one patient developed a wide, thick hypertrophic scar successfully treated with excision and serial triamcinolone acetonide injections. No other significant long-term complications were encountered.

DISCUSSION

Compared with adults, pediatric wound management can be significantly different, as they do not always have the same breadth of tissue to allow reliable wound coverage.³ For traumatic wounds that cannot be closed primarily or by secondary intention, several alternatives are available. These include immediate reconstruction with grafts or flaps at the cost of donor site morbidity, or delayed reconstruction with either internal or external tissue expansion. Skin grafts can result in unsightly scars and limit growth potential in pediatric patients.

Internal tissue expanders exploit the same stress-relaxation phenomenon as the external expanders, but are time-consuming and have their own set of complications.^{4,5} A study on 191 internal expanders in 105 pediatric patients reported 6% infection, 3% deflation, and 2% extrusion rates.⁵ When specifically looking at time from placement of internal expanders to definitive reconstruction, Steenfos et al found an average of 82 days.⁶ By contrast, external expanders significantly reduce the time to definitive reconstruction compared with internal expanders.⁷ In addition, there is a very low risk of infection, with none observed in our study, and no risk of extrusion.

In pediatrics, CETE devices have been used to assist other types of reconstruction, and there are several types in the market. Mountziaris et al achieved delayed primary closure of an ALT donor site on a 6-year-old after a motor vehicle accident that resulted in a distal leg injury and large soft-tissue defect with the application of the DermaClose device for 1 week.⁸ Topaz et al achieved a staged excision of a giant forehead congenital nevus in an infant after applying CETE devices for six cycles, from the age of 3 months to 2 years.⁹ The device allowed for an early start and conclusion of the reconstructive process.⁹ An internal expander would have to be done later due to concerns of permanent cranial deformation from the immature cranial bones.⁹ Baird et al successfully closed a giant omphalocele through gradual bedside reduction using a different device over 3 weeks.¹⁰ These examples, including our series, demonstrate CETE devices' versatility that can be applied to wounds of various etiologies.

There are limitations to the CETE device. Foremost, given the limited amount of time it can be applied, only a fraction of the expansion achievable by an internal tissue expander can be obtained. Moreover, CETE should

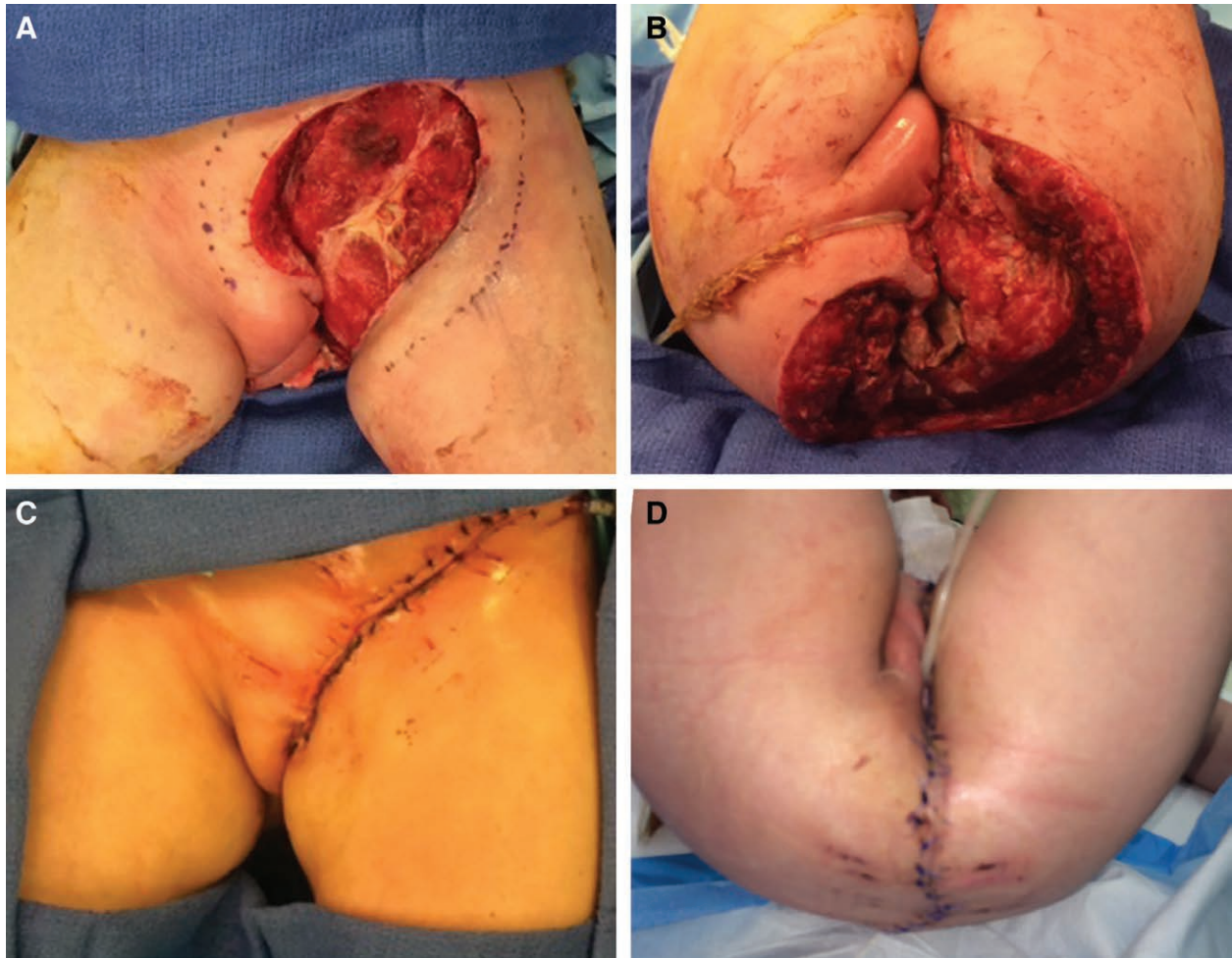


Fig. 1. Large groin and perineal wound closed by CETE. A, Anterior perineal wound after debridement for necrotizing fasciitis. B, Posterior perineal and gluteal wound after debridement. C, Postoperative appearance of anterior perineal wound. D, Postoperative appearance of posterior perineal and gluteal wound.

be avoided if the dermis on the periphery of the wound is compromised, as complete devascularization of those tissues can occur.¹¹ Lastly, CETE is not approved by all insurance companies; so reimbursement may be difficult.

CONCLUSION

CETE device use in the reconstruction of large pediatric wounds of various etiologies ranging from trauma to congenital defects can allow for timely wound closure with a favorable complication profile and should be in the armamentarium of reconstructive plastic surgeons.

Jessica Luo, MD

30 North 1900 East, Suite 3B400

Salt Lake City, UT 84132

E-mail: Jessica.Luo@hsc.utah.edu

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