The use of a suture retention device with punctureless technique for rapid tissue expansion in facial and lower extremity wounds

Allison Stoecker, DO,[a] Stephanie Howerter, DO,[b] John Young, MD,[a] and William Lear, MD[b]
Salem, Oregon

Key Words: dermatologic surgery; Mohs micrographic surgery; reconstruction; suture retention device; tissue creep.

INTRODUCTION

Surgical defects of the face and lower extremity provide unique reconstructive challenges because of the highly visible site and limited local tissue supply.[1] Aesthetic reconstructive options are scarce when a patient declines a flap or graft. As previously published, the use of a novel suture retention device (SRD) (SUTUREGARD; SUTUREGARD Medical, Portland, OR) may provide stress-relaxation of wounds and tissue expansion in a timely manner using percutaneous simple interrupted sutures.[2] Using subcuticular sutures along with the SRD may circumvent factors that lead to the formation of suture marks, which include high wound tension and epidermal puncture wounds.[3] We present 2 cases of facial defects and 1 case of a lower extremity defect after Mohs micrographic surgery (MMS) that were closed with a completely punctureless technique using the novel SRD.

Abbreviations used:

MMS:	Mohs micrographic surgery
PDS:	polydioxanone suture
SRD:	suture retention device
USP:	United States Pharmacopedia

CASE ONE

A 70-year-old woman presented with an invasive squamous cell carcinoma of the left lower leg. Treatment required a single-stage of MMS, which resulted in a 2.8-cm-wide by 3.8-cm-long defect with minimal tissue laxity of the surrounding skin. The patient declined options including skin graft and healing by secondary intention. The decision was made to use a SRD for tissue relaxation. A single United States Pharmacopedia (USP) 1 polydioxanone suture (PDS; Ethicon, Bridgewater, NJ) was used with the device. The suture was placed in a buried fashion, and the ends were threaded through central holes in the SRD (Fig 1). The suture was tied and secured using a surgical clamp (Fig 2). The retention suture was incrementally tightened in 5- to 10-minute intervals over 45 minutes, after which the tissue exhibited a much greater degree of laxity. This was demonstrated by a 64.3% reduction in the width of the wound to 1.0 cm. The SRD was then removed, leaving the suture in place to be tied in a buried fashion for third-space closure (Fig 3). To reduce risk of hematoma formation, no undermining was performed. USP 3-0 PDS was used to close the remainder of the deep dermal space followed by USP 4-0 poliglecaprone-25 (Monocryl; Ethicon) in running subcuticular fashion. This was further reinforced with topical skin adhesives (Dermabond; Ethicon) and skin closure strips (Steri-Strip; Nexcare, Maplewood, MN). The patient tolerated the procedure well, reporting minimal pain and bleeding from

From the Department of Dermatology[a] and the Department of Dermatology and Dermatologic Surgery,[b] Good Samaritan Regional Medical Center/Silver Falls Dermatology.

Funding sources: None.

Conflicts of interest: Dr Lear is a cofounder and shareholder in SUTUREGARD Medical. The remaining authors have no conflicts of interest to disclose.

Correspondence to: Allison Stoecker, DO, 1793 13th St SE, Salem, OR 97330. E-mail: melkoni1@gmail.com.

JAAD Case Reports 2018;4:910-4.
2352-5126

https://doi.org/10.1016/j.jdcr.2018.09.005

Fig 1. Buried absorbable USP 1 violet PDS suture placed with ends threaded through central holes of the SUTUREGARD device to close 2.8-cm-wide × 3.8-cm-long defect after MMS. USP 1 violet suture was used in this case to highlight the suture path.

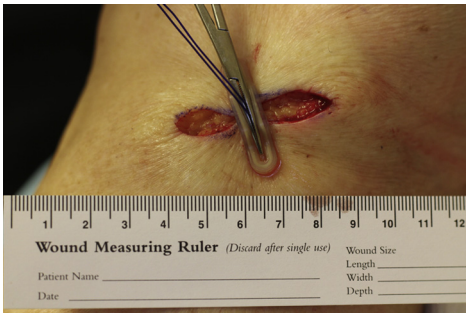

Fig 2. Suture ends tightened to achieve stress-relaxation and clamped to hold in place on top of SUTUREGARD device. It was tightened incrementally over 45 minutes to allow for direct epidermal approximation.

the wound site. There was no dehiscence, necrosis, or wound infection over the following 14 days of healing.

CASE TWO

A 58-year-old woman presented with a squamous cell carcinoma in situ of the right cheek. Removal with 1 stage of MMS resulted in a large defect measuring 3.3 cm wide by 5.1 cm long (Fig 4). The surrounding skin exhibited minimal laxity, and the patient did not wish to proceed with a large flap repair. The decision was made to use 2 SRDs with 2 USP 3-0 PDS and incrementally clamp for 45 minutes to enhance tissue creep and allow for primary closure. The decision to use 2 SRDs was based on surgeon preference, to reduce pressure at multiple points of a long excision wound. The procedure was well tolerated and resulted in 66.7% reduction of the wound width to 1.1 cm. No undermining was performed. The two USP 3-0 polydioxanone retention sutures were tied with buried knots. To avoid standing cone deformity, the incision was lengthened to 5.9 cm. The wound was closed using USP 4-0

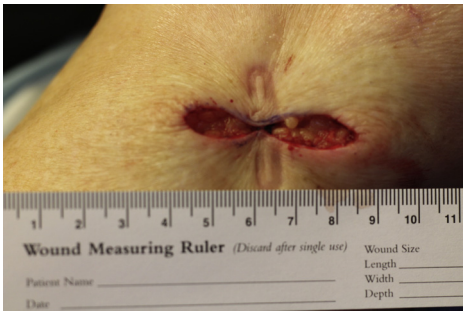

Fig 3. The suture retention device was removed. The buried suture stayed in place and was tied. Transient indentation and maceration of the skin resolved by the time the repair was complete.

Fig 4. SUTUREGARD device with 3-0 PDS and puncture-less technique initiated on 3.3-cm-wide × 5.1-cm-long skin defect of the right cheek.

poliglecaprone-25 with running subcuticular technique followed by reinforcement with topical skin adhesives and skin closure strips. There was no dehiscence, necrosis, or wound infection over the following 14 days of healing (Fig 5).

CASE THREE

An 82-year-old man presented with a basal cell carcinoma of the left preauricular cheek. The tumor was cleared with one stage of MMS, leaving a 2.4-cm-wide by 2.7-cm-long defect with poor tissue laxity in which the edges of the wound could not be directly opposed (Fig 6). The patient declined repair with a flap or graft as well as second intent healing. Two SRDs were placed using USP 3-0 PDS as in prior cases (Fig 7). The sutures were gradually tightened over the next 45 minutes, leading to a new relaxed defect width of 0.6 cm (75.0% decrease). No undermining was performed. The SRDs were removed, leaving the USP 3-0 PDS in place to be tied with buried knots. A running subcuticular stitch was placed using USP 4-0 poliglecaprone-25 suture (Fig 8). The wound was

Fig 5. Right cheek wound after 14 days of healing with minimal erythema and no pressure effect from SUTUREGARD devices.

Fig 6. The surgeons were unable to approximate the edges of this nearly circular wound.

further supported with topical skin adhesive and skin closure strips. The patient tolerated the procedure well, and there were no healing complications over the following 14 days.

DISCUSSION

MMS allows for definitive removal of cutaneous malignancies while conserving normal tissue. It is particularly useful in cosmetically sensitive areas, like the face, or areas with minimal spare tissue and poor healing capability, like the lower leg. Aesthetic reconstruction of these defects can be difficult depending on the wound size, orientation, and tension of surrounding skin. Repair options include primary linear closure, healing by second intent, flaps, and grafts. Flap or graft procedures may result in large surgical incisions, postoperative pain, and long-term anesthesia.[4] Direct linear closure involves less tissue destruction and may allow for superior aesthetic results.[5] However, its use is limited in high-tension sites because this force increases the chance of tissue ischemia, necrosis, and wound dehiscence.[5]

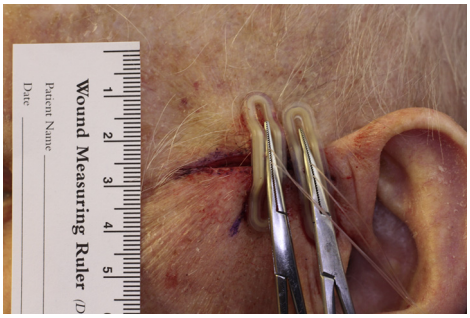

Fig 7. Two SUTUREGARD devices placed with 3-0 PDS and punctureless technique to allow for tissue expansion on a 2.4-cm-wide × 2.7-cm-long MMS defect of the left temple.

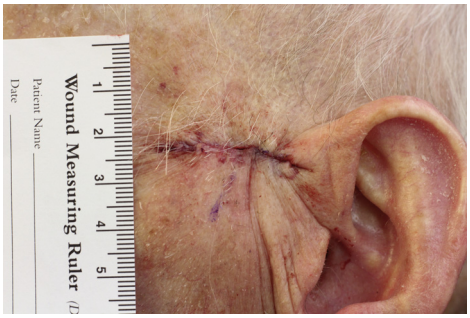

Fig 8. Aesthetic linear closure of the surgical defect with 4-0 Monocryl leaves no epidermal puncture wounds.

Tension may be reduced through skin stress-relaxation. Skin is a viscoelastic organ which exhibits a load-dependent behavior.[6] With repeated cycles of stress and relaxation, the dermal collagen fibers reorient while delicate elastic fibers break and lose elasticity.[7] This allows for skin elongation over time (mechanical creep) and loss of tendency to recoil when load is removed (stress-relaxation).[7] We are not aware of long-term adverse consequences of stress-relaxation.

Mechanoreceptors may play a primary role in keloid generation.[8] Decreasing tension during wound repair by using zig-zag sutures or z-plasty has previously demonstrated more efficient scar maturation and reduced formation of keloids.[9] Thus, there may be potential benefits of stress-relaxation for patients at risk of keloids.

Some intraoperative tissue expansion methods cause visible tissue damage and therefore have limited utility for cosmetically sensitive areas. Stress-relaxation can be accomplished with simple suturing techniques and towel clamps or more complex devices like Dermaclose RC (Wound Care Technologies, Chanhassen, MN), Easapprox (BIOWIM Ltd, Dalian City, China), and TopClosure (IVT Medical Ltd, Ra'anana, Israel). Suturing

techniques include the traditional pulley, interrupted retention, and purse string. In high-tension sites, excess pressure from suture filaments can lead to superficial erosion and ulceration.[2] Simple interrupted buried sutures can be intermittently taken out and replaced with a suture under greater tension. However, this technique would cause repeated skin damage with each suture placement. The device also protects the skin from damage from the clamp that is used to secure the suture. Towel clamps may be readily available, but they can cause traumatic puncture wounds.[10] Easapprox consists of hook needle units placed on either side of the wound, which are gradually pushed together along a rod to allow for skin stretching.[11] This requires a minimum of 12 puncture wounds. Dermaclose is applied through skin anchors connected to a controller, which provides a continuous 12 N of force to slowly expand tissue.[12] Each anchor penetrates into the subcutaneous tissue and is stabilized with two staples. Owing to limited force, tissue expansion may require multiple days. TopClosure involves 2 attachment plates that are advanced together along a flexible strap by an incremental lock and release mechanism.[13] The plates may be anchored with staples, suture, or a biocompatible hypoallergenic tape.[13] The noninvasive option is limited by local skin irritation and blistering from shear forces and may be difficult to place on hair-bearing areas.

Some superficial wound closure devices are punctureless, but their use is limited in high-tension wounds. These include barbed suture, ZipLine (Zipline Medical Inc, Campbell, CA), and DermaClip (DermaClip US, LLC, Houston, TX). Barbed sutures evenly distribute tension and allow knot-free suture placement, decreasing the risk of dehiscence from knot breaking or slipping.[14] When placed in the papillary dermis, these sutures are associated with increased rates of minor wound complications including erythema, suture extrusion, and wound separation.[14] The ZipLine and DermaClip devices are similar in that they comprise 2 strips with adhesive coating attached by a strap bridge over the wound. Both devices are needle free, easy to apply, and circumvent wound edge trauma.[15,16] They may be difficult to use in hair-bearing or oily areas. If combined with the punctureless SUTUREGARD SRD device tissue expansion method, these latter devices may allow for superficial epidermal approximation without running subcuticular suture.

The SUTUREGARD device was used in this case series to demonstrate punctureless intraoperative rapid tissue expansion. This single-piece SRD has a semirigid insert covered with a softer shell. The core bridgelike structure allows it to withstand the forces of wound closure while protecting wound edges and dissipating pressure on the skin. The retention suture used with each device may be placed either percutaneously, as previously reported,[2] or subcutaneously, as in the cases in this report. Using a clamp, surgeons can incrementally place stress on the closure with up to 25 N (2.5 kg) of force without apparent pressure injury to the skin.[2]

When placed using the punctureless technique shown in this case series, this novel SRD may be used for intraoperative rapid tissue expansion in cosmetically sensitive areas. This allows adjacent skin with matching color and tissue texture to be used for an aesthetically appealing direct linear buried subcuticular closure. The use of an antibacterial monofilament suture reduces risk of infection when the retention suture remains in place for third-space closure. No patients in this case series experienced dehiscence, necrosis, pressure injury, or wound infection. Further research is necessary to quantify the rate of tissue expansion and limits of force allowed for various body locations. Nevertheless, this is a promising method that may minimize the need for flap and graft repair of wounds in cosmetically sensitive areas after MMS.

REFERENCES

1. Heller L, Cole P, Kaufman Y. Cheek reconstruction: current concepts in managing facial soft tissue loss. *Sem Plast Surg*. 2008;22(4):294-305.
2. Blattner CM, Perry B, Young J, Lear W. The use of a suture retention device to enhance tissue creep and healing in the repair of scalp and lower leg wounds. *JAAD Case Rep*. 2018;4(7):655-661.
3. Field L. Suture marks: factors of causation and prevention. *Dermatol Surg*. 2006;32(11):1425-1426.
4. Leedy JE, Janis JE, Rohrich RJ. Reconstruction of acquired scalp defects: an algorithmic approach. *Plast Reconstr Surg*. 2005;116(4):54e-72e.
5. Soliman S, Hatef DA, Hollier LH Jr, Thornton JF. The rationale for direct linear closure of facial Mohs' defects. *Plast Reconstr Surg*. 2011;127(1):142-149.
6. Hsu S, Jamieson AM, Blackwell J. Viscoelastic studies of extracellular matrix interactions in a model native collagen gel system. *Biorheology*. 1994;31(1):21-36.
7. Liu Z, Yeung K. The preconditioning and stress relaxation of skin tissue. *J Biomed Pharm Eng*. 2008;2(1):22-28.
8. Ogawa R. Keloid and hypertrophic scarring may result from a mechanoreceptor or mechanosensitive nociceptor disorder. *Med Hypotheses*. 2008;71(4):493-500.
9. Ogawa R. Keloid and hypertrophic scars are the result of chronic inflammation in the reticular dermis. *Int J Mol Sci*. 2017;18(3):606.
10. Liu CM, McKenna J, Griess A. Surgical pearl: the use of towel clamps to reapproximate wound edges under tension. *J Am Acad Dermatol*. 2004 Feb 1;50(2):273-274.
11. Song M, Zhang Z, Liu T, et al. EASApprox® skin-stretching system: A secure and effective method to achieve wound closure. *Exp Therapeut Med*. 2017;14(1):531-538.

12. Bajoghli AA, Yoo JY, Faria DT. Utilization of a new tissue expander in the closure of a large Mohs surgical defect. *J Drugs Dermatol*. 2010;9(2):149-151.
13. Topaz M, Carmel NN, Topaz G, Li M, Li YZ. Stress—relaxation and tension relief system for immediate primary closure of large and huge soft tissue defects: an old—new concept: new concept for direct closure of large defects. Gaines. R, ed. Medicine. 2014;93(28):e234. doi:10.1097/MD.0000000000000234.
14. Cortez R, Lazcano E, Miller T, et al. Barbed sutures and wound complications in plastic surgery: an analysis of outcomes. *Aesthet Surg J*. 2015;35(2):178-188.
15. Gorsulowsky DC, Talmor G. A novel noninvasive wound closure device as the final layer in skin closure. *Dermatol Surg*. 2015;41(8):987-989.
16. Freed JS, Ko J. An innovative advance in non-invasive wound closure: a new paradigm. *Mil Med*. 2018;183(suppl_1):472-480.