A novel suture retention device for intraoperative tissue support

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INTRODUCTION

Large surgical defects of the scalp and lower leg are often challenging to reconstruct due to limited tissue mobility.[1] If linear closure is attempted, the tension required of the initial central suture often tears the tissue. In such cases, surgeons often use flaps or grafts for closure or leave the wound open to heal secondarily. Options are limited if a patient requests closure but declines a larger flap or graft procedure. Towel clamps and pulley sutures can be used to stretch the skin and redistribute tension but can be very damaging to tissue.[2,3] We previously described a promising technique of intraoperative tissue expansion using a suture retention device (SRD) (SUTUREGARD, SUTUREGARD Medical, Portland, OR).[4,5] Here we present a new, time-saving technique using the same SRD as a temporary scaffold at the site of the central suture. Using the SRD with a large-bite simple interrupted suture allows wound edges to be approximated while redistributing tension to decrease the risk of the suture tearing the skin edge. With the wound successfully apposed, the surgeon may place several deep and superficial sutures under minimal tension on either side of the SRD. Next, the device and temporary suture can be removed and final central suture placed (Fig 1) We present 2 lower extremity defects and one scalp defect that were successfully closed using this temporary scaffold technique with the SRD.

Abbreviations used:

SRD: suture retention device
USP: United States Pharmacopeia

CASE 1

A 64-year-old obese woman with a medical history of hypercholesterolemia and varicose veins presented with malignant melanoma in situ of the left lower leg. The tumor required surgical excision with 0.5-cm margins, resulting in a 2.0- × 4.5-cm defect. The surrounding skin exhibited minimal tissue laxity. The patient declined flap, graft, and healing by secondary intention. The decision was made to use the SRD for temporary support of the wound closure. A single United States Pharmacopeia (USP) 2-0 nylon suture was placed percutaneously with 1-cm bite sizes at the center of the wound (Fig 2). The ends of the suture were placed through the peripheral slots of the SRD. The suture was then tightened over the SRD until the wound edges were approximated. Then the suture was secured with a surgical clamp (Fig 3). The wound edges flanking the SRD exhibited very little tension, allowing easy placement of USP 3-0 Polysorb suture in buried fashion. This action was followed by percutaneous placement of simple interrupted USP 4-0 nylon suture on either side of the SRD (Fig 4). The SRD was then removed, and the remainder of the superficial sutures were placed (Fig 5). The patient tolerated the procedure well, reporting minimal pain and bleeding from the wound site. There was no dehiscence, necrosis, or wound infection over the following 14 days of healing.

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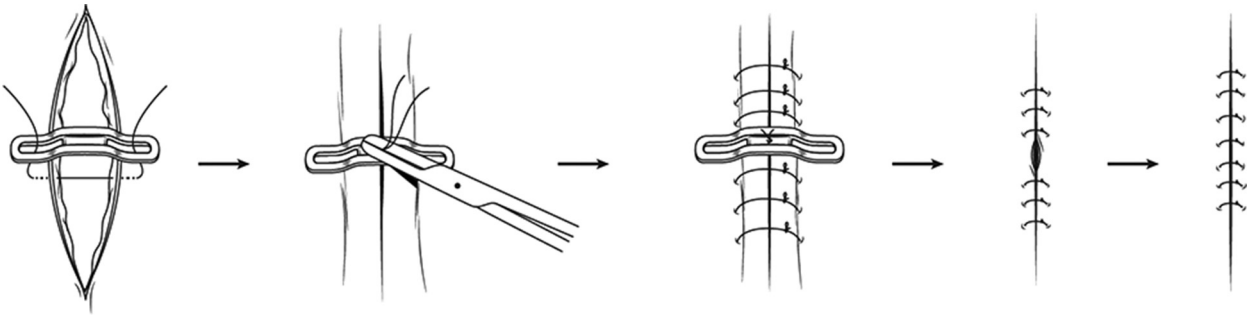

Fig 1. The SUTUREGARD is placed at the center of the wound using a simple interrupted suture and secured with a surgical clamp. Layered closure is continued normally, with deep and percutaneous sutures on each side of the SRD under minimal tension. Next, the device and temporary suture can be removed and final central suture placed.

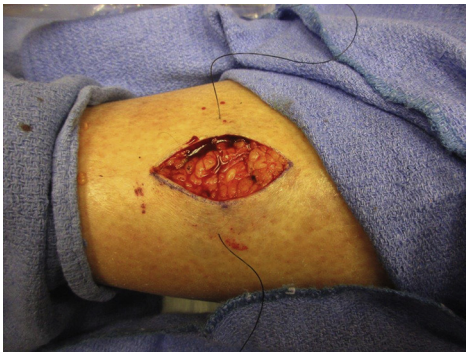

Fig 2. Large surgical wound of the left lower leg. A USP 2-0 nylon retention suture was placed with large bite sizes on either side of the wound.

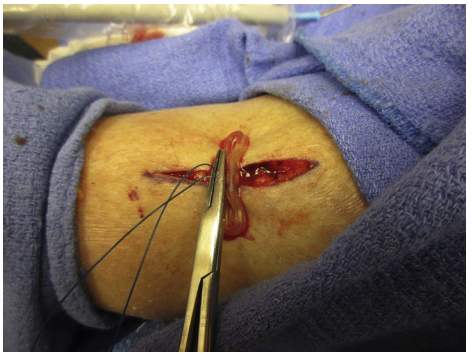

Fig 3. The ends of the retention suture were placed through the SUTUREGARD suture retention device and then secured using a surgical clamp.

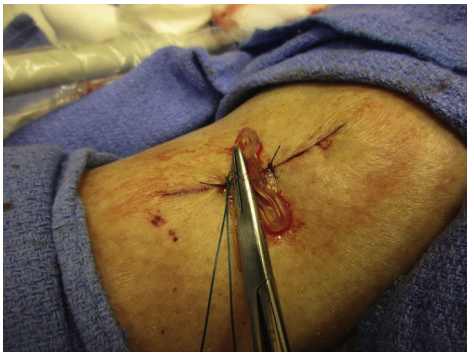

Fig 4. By acting as a temporary support, the SUTUREGARD allowed the surgeon to continue layered linear closure under minimal tension with buried simple interrupted sutures followed by percutaneous simple interrupted sutures.

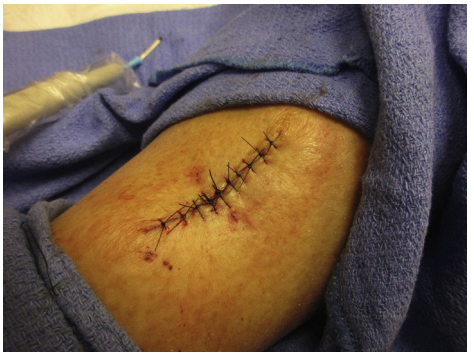

Fig 5. After removal of the suture retention device, the final top sutures were placed under minimal tension.

CASE 2

A 67-year-old man with a history of hypertension, non–insulin-dependent diabetes mellitus, and peripheral vascular disease presented with a dysplastic compound nevus on his left lateral calf, which required re-excision with 0.5-cm margins. The resultant defect measured 1.5 cm by 3.0 cm with minimal laxity of the surrounding skin. The patient did not wish to proceed with flap, graft, or healing by second intent, so the decision was made to use an SRD as a temporary scaffold. The SRD was placed with percutaneous USP 2-0 nylon at the center of the wound. USP 3-0 Polysorb sutures were placed in buried fashion on either side of the SRD. Then USP 3-0 nylon sutures were placed superficially on either

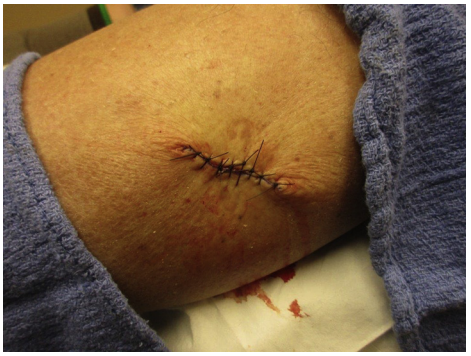

Fig 6. Large surgical wound of the lower extremity that was closed using the SUTUREGARD as a temporary bridge device.

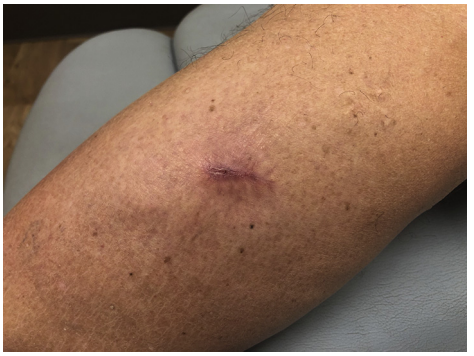

Fig 7. Follow-up 11 weeks postoperative. Overall, the wound is well healed.

side of the SRD. The SRD was then removed, and the final nylon sutures were placed centrally (Fig 6). There was no necrosis, dehiscence, or wound infection over the next 2 weeks of healing. At 11-week follow-up, the wound was well healed (Fig 7).

CASE 3

A 72-year-old woman presented with an invasive squamous cell carcinoma of the fronto-parietal scalp which was cleared with one stage of Mohs micrographic surgery, leaving a 2.7- x 3.7-cm defect. She was a tobacco user with an extensive medical history including insulin-dependent type 2 diabetes mellitus, hemodialysis-dependent end-stage renal disease, hypertension, hyperlipidemia, congestive heart failure, and history of nonhealing diabetic foot ulcers. The surrounding tissue exhibited minimal laxity and the wound edges could not be easily approximated. The patient did not wish to proceed with galeotomy, flap, or graft repair. The decision was made to use the SRD as a temporary support to approximate wound edges. The SRD was secured at the center of the wound using USP 2-0 nylon suture with 1-cm bite size. USP 2-0 Polysorb sutures were placed in buried fashion on either side of the SRD (Fig 8). The SRD was removed, and the wound was further reinforced with staples (Fig 9). The patient tolerated the procedure well. Over the next 2 weeks of healing, there was no necrosis, dehiscence, or wound infection.

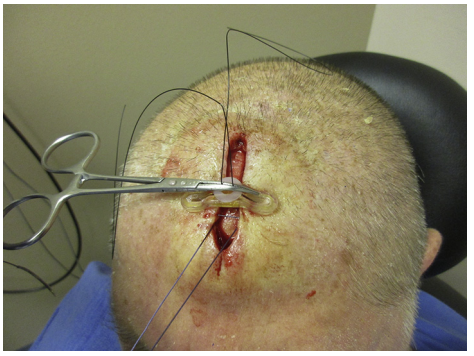

Fig 8. Placement of a USP 2-0 nylon retention suture using the SUTUREGARD as a temporary support structure for closure of a large scalp wound. The surgeon was able to perform direct linear closure by placing buried 2-0 Polysorb sutures under reduced tension.

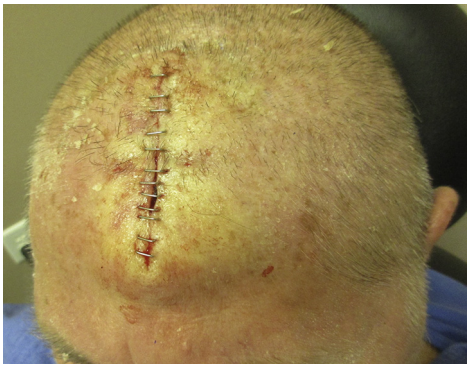

Fig 9. Final closure with staples after removal of the retention suture.

DISCUSSION

Surgical wounds of the scalp and lower leg are often difficult to repair. Scalp skin requires greater forces than other body areas to stretch and approximate wound edges.[6] In addition to minimal tissue laxity, lower-extremity skin also exhibits slower wound healing.[7] Direct linear closure may not be possible in these areas because of excessive tension on the wound edges. If a surgeon attempts linear closure, the force on the central suture often exceeds the strength of the dermis and the suture tears through the tissue. Towel clamps and pulley sutures may be used, but these techniques can be damaging to tissue.[2,3]

Towel clamps have 2 sharp prongs at 60° angles, which lock together when closed. For tissue expansion they may be placed 6 mm from the wound edge with the prongs piercing through the dermis into the subcutis.[3] The pressure required to puncture the thick dermis of the scalp and back may be uncomfortable for patients who are awake. Additionally, if not used gently, they may cause tissue laceration or crush injuries.[3] This technique requires a minimum of 2 full-thickness puncture wounds, which may increase risk of infection, especially on the lower extremity.

Similarly, pulley sutures have been used for intraoperative tissue expansion in high-tension areas. The traditional pulley stitch is placed in a near-far-far-near fashion, ending with 2 loops over the wound surface. This increases the mechanical advantage of the suture and can be gradually tightened to allow for intraoperative tissue expansion.[8] Unfortunately, this technique requires 4 puncture wounds and places tension on the epidermis, which can result in excessive scarring.[2,8,9]

This suturing technique has been modified in several ways. Buried pulley sutures circumvent the epidermal damage; however, they are difficult to place and often result in vertical misalignment of the wound edge.[9] A modified pulley suture, called the *winch stitch* has been described in the literature.[8] It is a temporary stitch comprising multiple loops or pulleys that can be gradually pulled to provide tissue expansion.[8] The simplest winch stitch is a continuous running suture with the initial end left free. After placement, the surgeon may periodically place tension on both ends to approximate the wound. This technique requires extra puncture wounds, and as with any running suture, surgeons must be careful to avoid tissue strangulation.[8]

The SUTUREGARD device is a bridge-like structure composed of a semirigid core and a soft outer shell. It is placed with a retention suture, which may be either percutaneous or subcutaneous. As force is applied to close the wound, the SRD deforms and redistributes the pressure away from the wound edges. It has been shown that up to 25N of force may be applied to the SRD for intraoperative tissue expansion without erosion or pressure injury to the skin.[4,5]

This case series demonstrates a novel use of the SRD as a temporary support structure for wound apposition of high-tension sites. With this temporary structure in place, the surgeon can continue the layered linear closure as normal, with placement of deep dermal sutures flanking the central SRD followed by superficial sutures for reinforcement. Once layered closure is complete, the surgeon can remove the SRD and place the final central sutures (Fig 1). This efficiency is an advantage over intraoperative tissue expansion techniques, including those using towel clamps and pulley sutures.

This simple technique may be a viable option for patients with large scalp or lower extremity wounds who desire wound closure but decline flap or graft repair. Advantages of direct linear closure include simplicity, decreased bleeding risk, and increased cosmesis given color and texture match from adjacent tissue. The SRD may be used in hair-bearing areas. Additionally, the wound can be secured with dermal sutures instead of epidermal sutures in cosmetically sensitive areas in which the surgeon plans to avoid epidermal puncture via subcuticular closure.[5] In this case series, despite their multiple comorbidities, none of the patients experienced pressure injury, dehiscence, necrosis, or wound infection at 2-week follow up.

Further research is necessary to quantify the rate of tissue expansion and the amount force reduction when using the SRD as a temporary scaffold. Moreover, future research will be needed to assess the limits of force reduction allowed in various body areas. Nevertheless, this is a promising method that may minimize the need for flap and graft repair of wounds in high-tension sites including the scalp and lower leg.

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