The use of a suture retention device to enhance tissue expansion and healing in the repair of scalp and lower leg wounds

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Key words: dermatologic surgery; Mohs micrographic surgery; reconstruction; second-intention healing; suture retention device; tissue creep.

INTRODUCTION

Dermatologic surgery defects on the scalp and lower leg present unique reconstruction challenges because of decreased skin laxity and excessive wound tension.[1] Several options avoid this adverse outcome, but when a patient declines flap or graft, there is a paucity of alternatives aside from second-intent healing. One promising method is the use of a suture retention device (SUTUREGARD, SUTUREGARD Medical, Portland, OR) that may allow for stress relaxation of wounds (Fig 1). After relaxation, the wound can then be closed under lower tension, avoiding flap or graft. The authors present 5 cases of large defects after Mohs micrographic surgery (MMS) that were closed successfully with this novel suture retention device method.

Abbreviations used:

MMS: Mohs micrographic surgery
BCC: basal cell carcinoma

CASE REPORTS

Case 1

A 91-year-old woman presented with a basal cell carcinoma (BCC) of the left temporal scalp. The tumor required 3 stages of MMS that resulted in a 2.0-cm-wide × 2.3-cm-long defect (Fig 2). The patient's scalp exhibited minimal laxity, and the patient did not wish to proceed with second-intention healing, flap, or graft. The decision was made to use a single suture retention device that was left in place overnight to enhance tissue creep in hopes of allowing for primary closure. A single USP 1 nylon retention suture with a 1.0-cm bites size was used in a simple interrupted fashion in conjunction with the device (Fig 3). A Xeroform dressing (Covidien, Dublin, Ireland) was applied under the device before use to absorb moisture. The suture was knotted and a dressing applied over the wound. The patient returned home with the retention suture in place. She tolerated the procedure well, and the device was removed the following day (approximately 23 hours). The defect was then reassessed, and the width was found to be significantly smaller (0.5 cm; 75% overall reduction [Fig 4]). There was no visible injury, and the skin under the device appeared normal. The wound was then cleansed and re-anesthetized, and a closure was performed with 4 simple interrupted 4-0 nylon sutures. The patient reported minimal pain and bleeding at the wound site. There was no dehiscence, necrosis, or wound infection throughout the 14 days of healing before suture removal.

Case 2

A 46-year-old man presented with a BCC of left side of the frontal scalp. The tumor required one stage of MMS that resulted in a 1.8-cm-wide × 1.8-cm-long defect (Fig 5). The patient's scalp exhibited minimal laxity, and the patient did not wish to proceed with second-intention healing or a large rotation flap. The decision was made to use 2 suture retention devices and 2 USP 2-0 nylon retention

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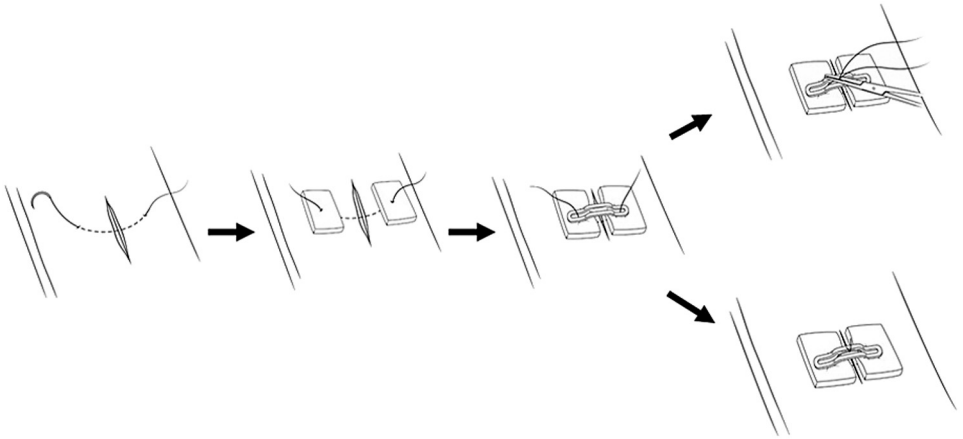

Fig 1. A large (1.0 cm or greater) bite-sized percutaneous retention suture is used on each side of wound with a large caliber suture (for example, USP 1 nylon). A dressing can optionally be placed under the device to absorb exudate. The retention suture is secured with either a clamp or knot to place the wound under tension. The device has flexible skin contact portions and a soft silicone covering to reduce the skin pressure of a high tension retention suture.

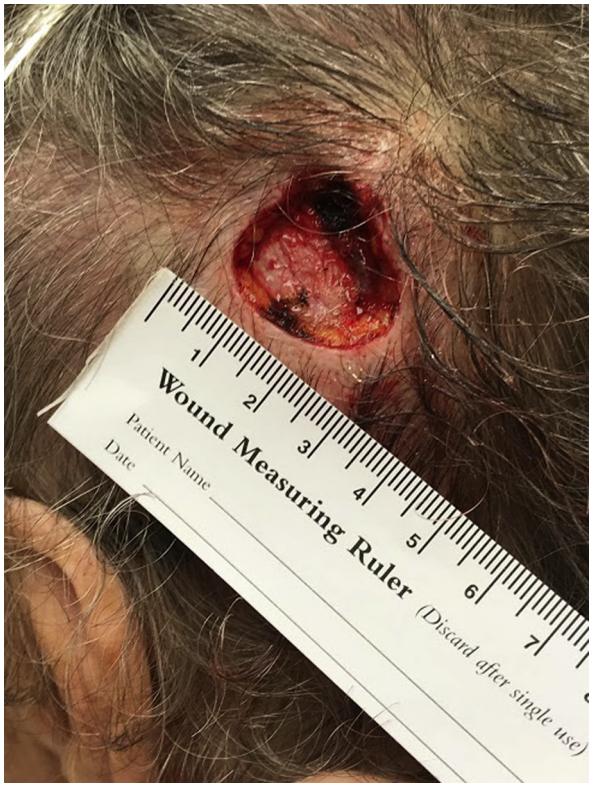

Fig 2. BCC on left temporal scalp. Defect was 2.3 cm × 2.0 cm.

Fig 3. Suture retention device secured with USP 1 nylon retention suture over Xeroform.

sutures with clamps for 45 minutes to enhance tissue creep in hopes of allowing for primary closure (Fig 6). A Xeroform dressing was applied under the device before use. The patient tolerated the device well, and the wound size decreased from 1.8 cm to 1.2 cm in diameter in 45 minutes (33% reduction). This decrease allowed the wound to be closed with 3-0 nylon simple interrupted sutures (Fig 7). The patient reported minimal pain and bleeding at the wound site. There was no dehiscence, necrosis, or wound infection during the 10 days of healing.

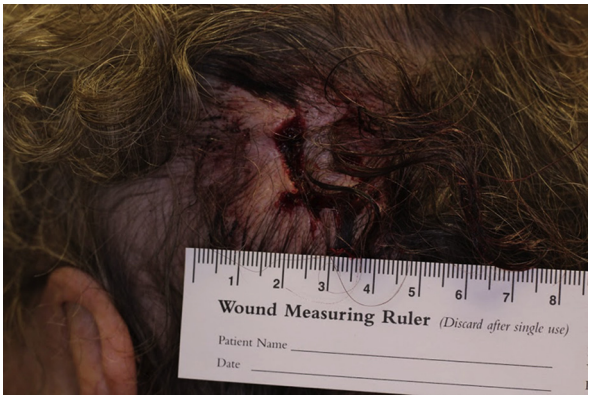

Fig 4. Wound measures 0.5 cm wide (75% reduction).

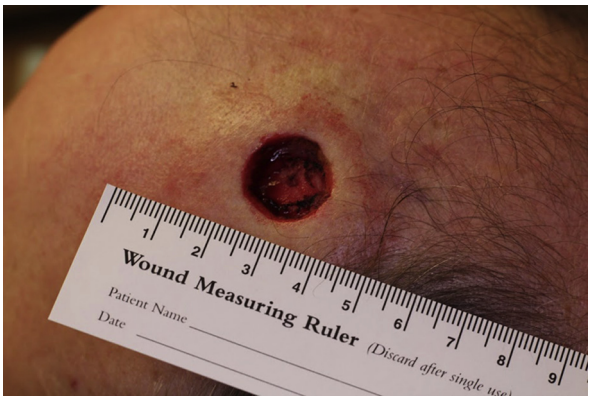

Fig 5. BCC on left frontal scalp. Defect was 1.8 cm × 1.8 cm.

Case 3

An 81-year-old man presented with a BCC on the left shin. The tumor required 1 stage of MMS that resulted in a 2.5-cm-wide × 3.7-cm-long defect (Fig 8). The edges of the defect could not be approximated, and the patient did not wish to proceed with second-intention healing or a large graft. The decision was made to use 2 suture retention devices with 2 USP 1 nylon retention sutures intraoperatively to enhance tissue relaxation in hopes of allowing for primary closure. The 2 devices were left in place for 90 minutes, after which the defect was reassessed and found to be to 1.5 cm wide (Fig 9; 32% reduction). There was no visible injury to the skin despite having no dressing under the device. The wound was then cleansed, re-anesthetized, and closed with 4-0 nylon sutures. The patient reported minimal pain and bleeding at the wound site. There was no dehiscence, necrosis, or wound infection throughout the 21 days of healing.

Case 4

A 67-year-old woman presented with a malignant melanoma in situ for re-excision on the left lower leg.

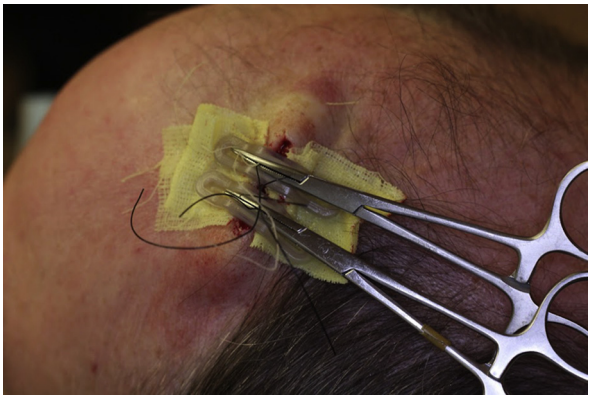

Fig 6. Two suture retention devices secured with two USP 1 nylon retention sutures over Xeroform.

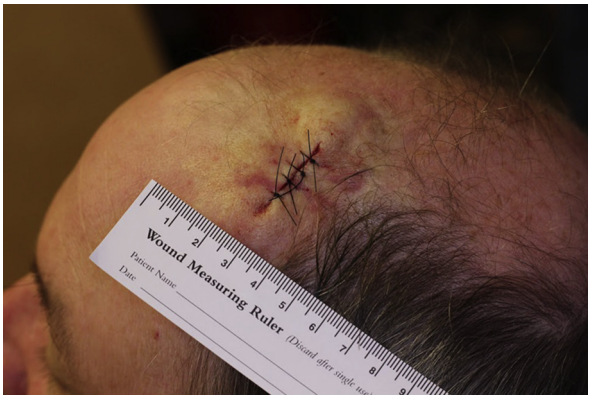

Fig 7. Final linear closure with 3-0 nylon sutures performed immediately after removal of suture retention device.

The specimen was removed with a 5-mm margin that resulted in a 2.5-cm-wide × 2.7-cm-long defect (Fig 10), and the tissue was sent to have margins assessed by permanent sections. The patient's left shin exhibited minimal laxity, and the patient did not wish to proceed with second-intention healing or a large graft. The decision was then made to proceed with placing 2 suture retention devices and 2 USP 1 nylon retention sutures to incrementally close the wound (Fig 11). A Xeroform dressing was applied under the device before use. The wound was closed partially with this method and then left for 5 minutes to allow for skin relaxation before final tightening. The hemostatic clamps were removed, the sutures were knotted, and the devices were left in place for 2 days (Fig 12). The patient was seen for follow-up at postoperative days 1 and 2 and exhibited minimal pain and bleeding. At postoperative day 2, devices were removed, as histologic margins were clear. The defect was reassessed and found to be 0.9 cm in width (64% reduction) (Fig 13). The wound was then cleansed, re-anesthetized, and closed completely in

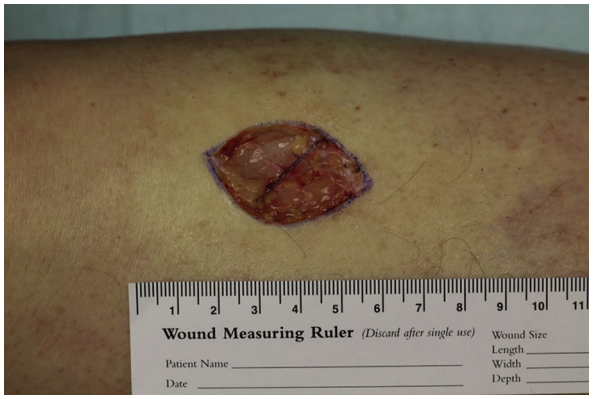

Fig 8. BCC on left shin. Defect was 2.5 cm wide × 3.7 cm long.

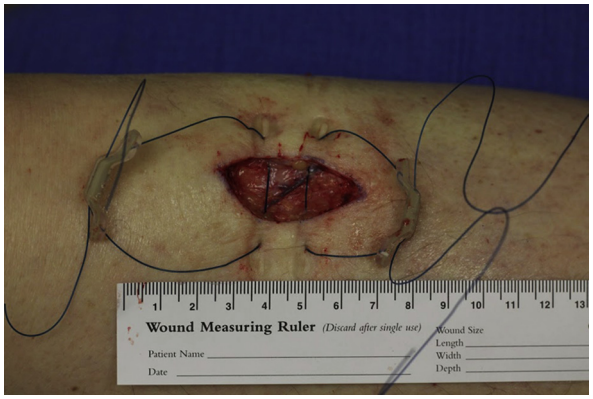

Fig 9. Two suture retention devices were used for 90 minutes with 2 USP 1 nylon retention sutures. The defect was reassessed and found to be 1.5 cm wide (32% reduction).

a linear fashion with 4-0 nylon simple interrupted sutures. There was no dehiscence, necrosis, or wound infection throughout the 21 days of healing.

Case 5

A 90-year-old man presented with a squamous cell carcinoma of the left posterior auricular area. The tumor required 2 stages of MMS that resulted in a 2.3-cm-wide × 3.0-cm-long defect. The patient's left posterior auricular area exhibited minimal laxity, and we were unable to approximate wound edges with lateral pressure. The decision was made to use the suture retention device between stages of MMS with a USP 1 nylon retention suture intraoperatively. A Xeroform dressing was applied under the device before use. The device was used for a total of 60 minutes during the 2 stages of MMS. The defect was reassessed and found to be 1.9 cm in width (17% reduction). There was no visible injury to the skin under the device (Fig 14). The wound was then cleansed, re-anesthetized, and closed with seven 4-0 nylon sutures. The patient reported minimal pain

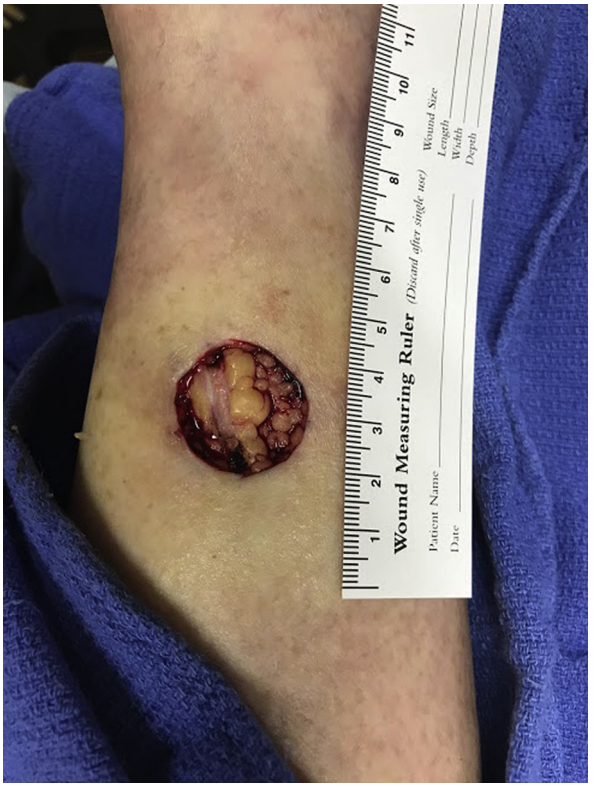

Fig 10. Malignant melanoma in situ of the left lower leg. Defect was 2.5 cm wide × 2.7 cm long.

and bleeding at the wound site. There was no dehiscence, necrosis, or wound infection throughout the 14 days of healing.

DISCUSSION

MMS is the most efficacious method for removing cutaneous malignancies with a cure rate of almost 99%.[2] The objective of the MMS is to remove as little tissue as possible, obtain clear margins, and preserve the most normal tissue to ensure optimal outcome.[2] Despite tissue preservation with MMS, some wounds present unique challenges to reconstruction owing to the size, amount of tension, and location of the defect. Reconstruction choices include primary closure, second-intention healing, and grafts or flaps.[3,4] Large surgical defects on the scalp and lower leg present unique challenges because of the amount of tension in these areas that may increase chance of tissue necrosis and wound dehiscence. Because of the risk of tissue ischemia that can lead to necrosis caused by excessive tension, surgical repair options are sometimes limited to second-intention healing, especially on the lower leg where infection rates are increased.[5] In our case series, we describe results of 5 patients with malignancies removed by MMS who did not wish to have flaps, grafts, or second-intention

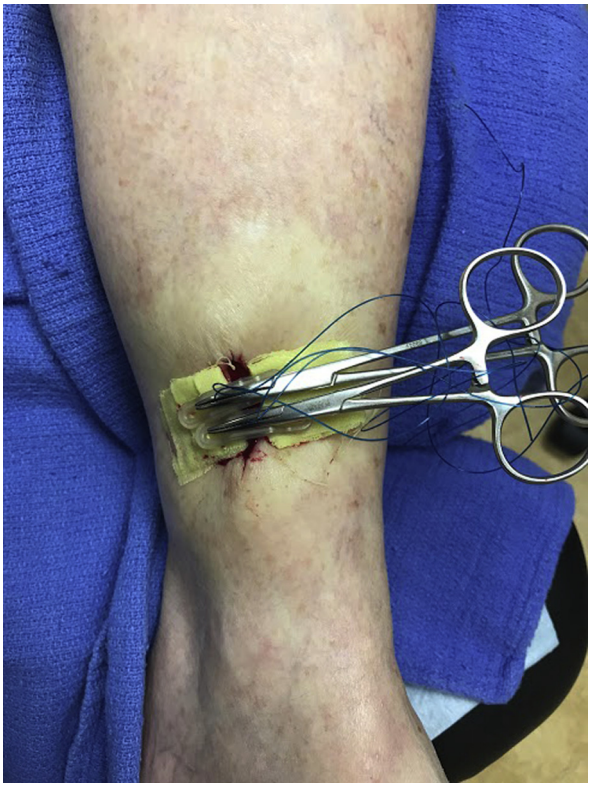

Fig 11. Two suture retention devices secured with two USP 1 nylon retention sutures over Xeroform and incrementally closed over 5 minutes.

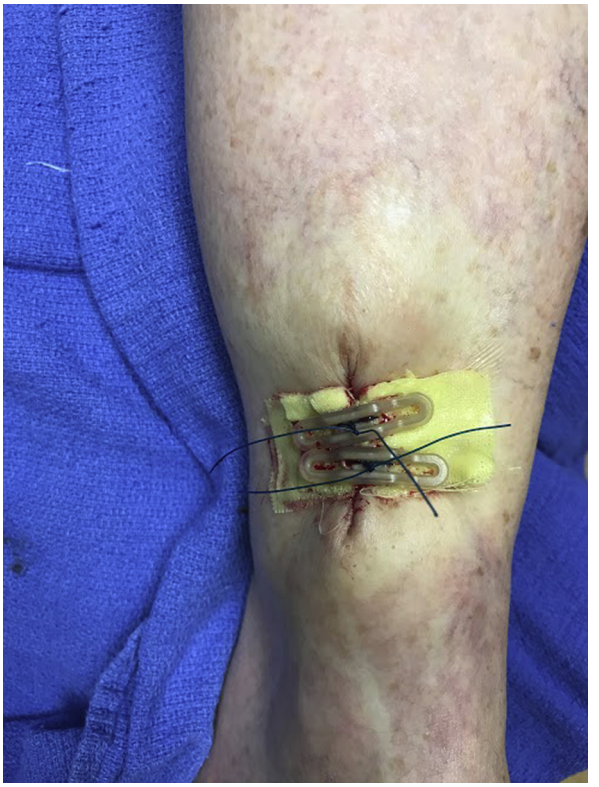

Fig 12. Two suture retention devices were left in place for two days while awaiting histological clearance of MMIS.

healing but instead had successful repairs with a suture retention device that allowed for primary closure that otherwise would have not been feasible.

Tension is the principal force experienced by the skin during excisional wound closure and is an important factor in wound healing.[6,7] If a device can minimize wound tension, then improved healing and earlier wound closure may be observed. The skin consists largely of collagen and elastin within the extracellular matrix that are affected during mechanical loading.[7] The skin has viscoelastic properties and exhibits load-dependent behavior.[8] There is a also dramatic effect of repeated cycles of stress rather than continuous stress.[9] The reorientation of collagen and elastin fibers enables the skin to stretch and expand, which is highlighted by the nonlinear stress strain curve of the skin.[10]

Stress-relaxation of wound edges to allow for easier closure is a commonly performed practice.[11] It has been used for a variety of different procedures but has pitfalls because stressing wound edges may create excessive tension that may lead to complication.[11,12] Other devices including anchors have been studied to address these complications, but these devices resulted in their own problems.[12] The devices also tended to be invasive, and some led to tearing, ischemia, and necrosis of skin wound edges.[11,13,14] Our case series highlights the efficacy of a noninvasive removable suture retention device that allows for tissue creep and relaxation of skin near the wound edges to promote primary closure for a variety of wound sizes. Although other devices have been used to facilitate mechanical creep, none have simultaneously addressed tissue creep and wound eversion.

The SUTUREGARD device has 2 lateral skin contact portions that are less stiff than its central, elevated portion. These skin contact portions can deform under a tensile load, while the central portion keeps the suture elevated above the wound. The skin contact portions are also covered with soft silicone to further dissipate pressure and improve comfort. The device results in significantly lower pressure on the skin when compared with traditional sutures and has been tested for up to 6 weeks of retention in a porcine full-thickness skin incisional model.[15]

Alternatively, a traditional pulley or interrupted retention suture may be used, but superficial erosion and ulceration may occur because of excess pressure of the thin suture filament on the skin. The suture retention device disperses the force over a much

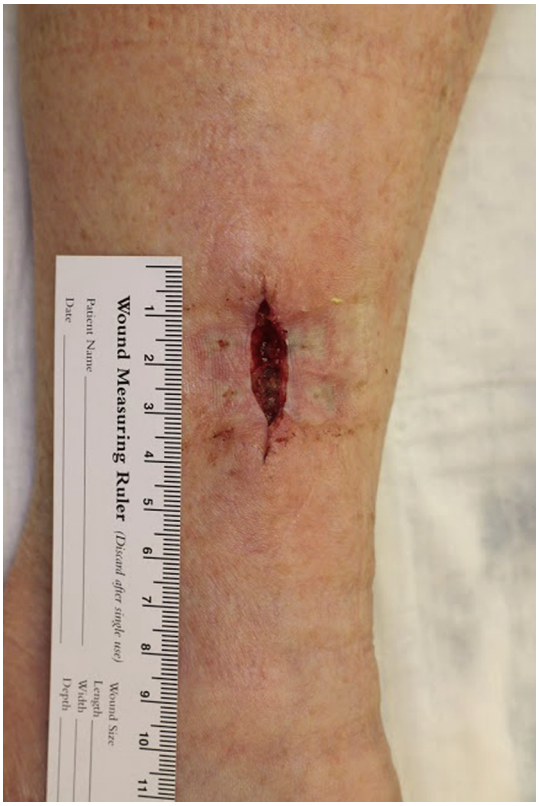

Fig 13. After removal of suture retention devices on postoperative day 2, the wound had reduced in size to 0.9 cm (64% reduction).

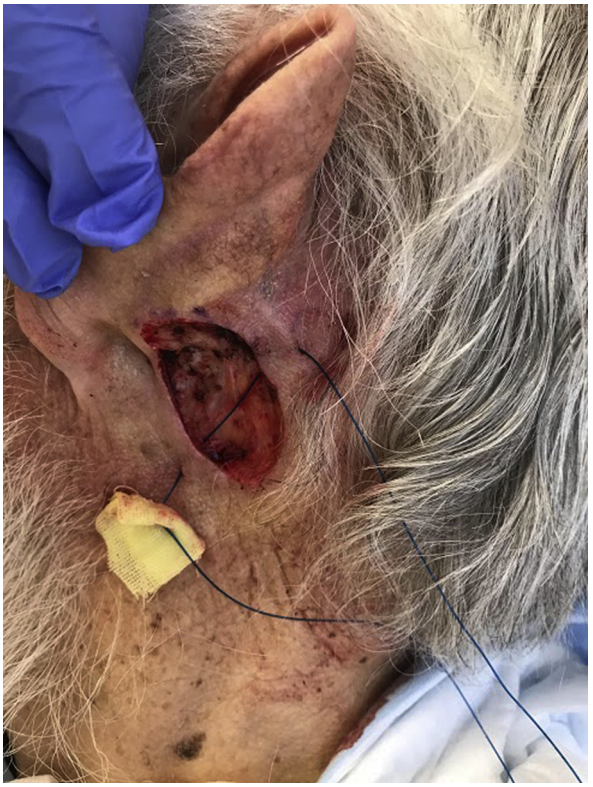

Fig 14. After 90 minutes of tissue expansion with the suture retention device on a left posterior auricular skin defect, there was no visible damage to underlying skin.

larger surface area, thus, reducing pressure. In practice, a 15% to 30% reduction in width of the wound has been observed with 60 to 90 minutes of application of the suture retention device; greater than 60% reduction is observed with overnight retention. Using up to 25N (2.5 kg) of force, there have been no erosions or pressure injuries when continuously retained up to 2 days postoperatively.

A common alternative to stress relaxation used in plastic surgery is tissue expansion, which involves expansion of the breast skin and muscle using a temporary expansion device. The expander is then removed later (typically 4 to 6 weeks), and the patient undergoes a flap or permanent breast implantation. This procedure requires advanced training, multiple operating stages, additional costs, and several weeks of preoperative planning. The suture retention device in this study can be deployed at the time of surgery, with minimal additional cost and with commonly used tools and techniques.

Although the exact protocol of the suture retention device and wound care was slightly different for each individual case, the recommended protocol involves a large bite size (eg, 1.0 cm or more) retention suture with the protocol as in Fig 1. The device is then left on for a period to be determined at the discretion of the physician that may allow for adequate tissue relaxation to occur. At various time points, the defect is reassessed to determine if it can be closed in a simple linear fashion. Once this endpoint is achieved, the wound is anesthetized and sutured.

No patients experienced dehiscence, necrosis, pressure injury, or wound infection with the use of the suture retention device. The device can be effectively used for skin stretching of postoperative wounds in preparation for linear wound closure after MMS. The device assisted in closure of large wounds under tension that would have otherwise required second-intention healing, flap, or graft, which are associated with increased morbidity.

CONCLUSION

When used as described in this case series, the SUTUREGARD device allows performance of retention sutures under very high tension without damage of underlying tissue. This device allowed for stress relaxation of large wounds that would normally require flap or graft closure. All of the wounds in this series initially required

at least 2-0 caliber nylon to be approximated. After high-tension stress relaxation with the device, lower-caliber sutures could be used, which is empirical evidence of lower tension in the closure. Furthermore, all wounds healed after linear closure, indicating adequate perfusion and lack of tissue trauma. No significant complications were observed in any subjects in our case series.

Further research is needed on the rate of tissue relaxation and limits of force that are tolerable in various body locations. However, this is a promising method to help avoid flap and graft repair of large wounds after MMS.

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