

# Progressive Tightening of Pulley Sutures for Primary Repair of Large Scalp Wounds

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**Summary:** Scalp defects greater than 2 cm in diameter are not usually amenable to primary closure and require local tissue rearrangement, grafting, tissue expansion, or prolonged second intention healing. Scalp flap reconstruction is a significant undertaking that requires elevation of a total flap surface area that is 3–6 times the size of the defect, often involves profuse bleeding, and can be challenging to perform without conscious sedation or general anesthesia. Anticoagulated and medically complex patients pose additional challenges and limit options for treatment. The pulley suture uses the mechanical advantage of the pulley to distribute tension across a wound and is useful in areas of high tension such as scalp wounds. For scalp wounds greater than 2 cm, pulley sutures are placed along the length of the wound. An assistant exerts equal tension on the pulley sutures, and the surgeon sequentially ties the sutures. The sutures are tightened and retied weekly until complete scalp closure is achieved. The pulley sutures can be used for rapid primary closure of scalp wounds up to 2.5–3.0 cm in diameter under local anesthesia. For scalp wounds larger than 3 cm, we have also found that pulley sutures can be progressively tightened yielding additional tissue expansion every week. Scalp wounds greater than 3.0 cm can be easily closed via primary repair and weekly tightening of pulley sutures without the need for flap reconstruction, traditional tissue expander placement, or second intention healing. (*Plast Reconstr Surg Glob Open* 2017;5:e1592; doi: 10.1097/GOX.0000000000001592; Published online 12 December 2017.)

Defects larger than 2 cm on the scalp generally require local flaps, staged repair with grafting followed by tissue expansion, or second intention healing. The scalp poses numerous challenges in the setting of reconstructive surgery. Local tissue rearrangement is hindered by thick, inelastic skin overlying a convex surface and requires relatively large flaps to compensate. The abundant vascularity of the scalp decreases the risk of flap necrosis but may require a large time commitment devoted to hemostasis especially in the setting of anticoagulation.<sup>1,2</sup> Tissue expanders require a healed wound and involve multiple stages for reconstruction; cosmesis is poor during the tissue expansion process, and there is a high incidence of complications.<sup>2,3</sup>

Pulley sutures are highly effective in areas of high tension and poor local tissue mobility. Advantages of the pulley technique in scalp reconstruction include reduction in tension, improved hemostasis, decreased intraoperative time, and decreased cost.<sup>1</sup> Pulley sutures function as external intraoperative and postoperative tissue expanders, via creep and stress relaxation. In this case report, we present a technique that we use at our institution, which employs pulley sutures and progressive suture tightening to achieve primary closure of scalp defects greater than 3 cm.

## METHODS

For wounds greater than 2 cm in diameter, extensive undermining is performed bluntly in the subgaleal plane. Pulley suture placement is a “far-near-near-far” technique and is performed as follows (Fig. 1; also see video, **Supplemental Digital Content 1**, which displays placement of pulley sutures on fake skin. This video is available in the “Related Videos” section of the Full-Text article on PRSGlobalOpen.com or at <http://links.lww.com/PRSGO/A618>):

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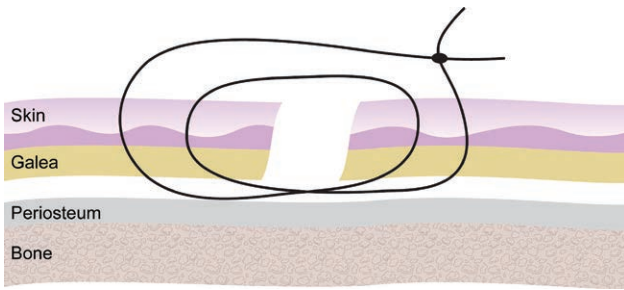
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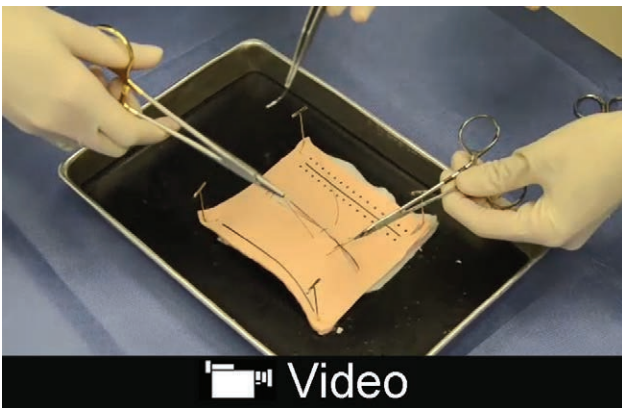
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**Fig. 1.** Pulley suture technique “far-near-near-far.” The needle is placed “far” from the wound edge. The needle is placed “near” starting deep to the galea on the opposite wound edge. The needle is placed “near” on the opposite wound edge. The needle is placed “far” starting deep to the galea on the opposite wound edge.

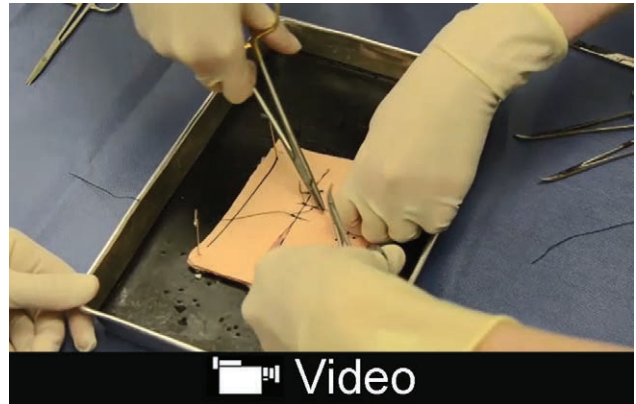


**Video Graphic 1.** See video, Supplemental Digital Content 1, which displays placement of pulley sutures on fake skin. This video is available in the “Related Videos” section of the Full-Text article on PRSGlobalOpen.com or at <http://links.lww.com/PRSGO/A618>.

- (1) The needle is placed “far” from the wound edge and includes galea at the base.
- (2) The needle is placed “near” starting deep to the galea on the opposite wound edge.
- (3) The needle is placed “near” on the opposite wound edge and includes galea at the base.
- (4) The needle is placed “far” starting deep to the galea on the opposite wound edge.
- (5) The two ends of the suture are secured with a hemostat.

Pulley sutures are placed along the length of the wound but are not tied until they have all been placed. An assistant exerts tension on the hemostats holding the pulley sutures while the surgeon sequentially ties the pulley sutures. Suture tails are left long to allow for future suture advancement. We inject bupivacaine at the end of the procedure and provide a two- to three-day supply of a schedule III or IV narcotic pain medication.

A week after the initial pulley suture placement, suture tightening is performed. The wound edges are sharply debrided. A hemostat is attached to the loop connecting the “far” bites of the pulley suture, and the suture is cut between the hemostat and the knot. Next, the suture is



**Video Graphic 2.** See video, Supplemental Digital Content 2, which displays tightening of pulley sutures on fake skin. This video is available in the “Related Videos” section of the Full-Text article on PRSGlobalOpen.com or at <http://links.lww.com/PRSGO/A619>.



**Fig. 2.** Scalp wound status after staged surgical excision for a recurrent basal cell carcinoma. The wound measures 3.4×3.0 cm and has exposed bone at the base.

advanced and retied using a square knot to the suture’s free end, and additional wound closure is achieved (see video, Supplemental Digital Content 2, which displays tightening of pulley sutures on fake skin. This video is available in the “Related Videos” section of the Full-Text article on PRSGlobalOpen.com or at <http://links.lww.com/PRSGO/A619>).

### CASE REPORT

The patient is an 84-year-old man who presented with a recurrent basal cell carcinoma of the scalp. After clear margins were achieved, the final defect size was 3.4×3.0 cm with exposed bone devoid of periosteum at the wound base (Fig. 2). Subgaleal undermining was performed bluntly. Pulley sutures were utilized to obtain partial wound closure (Fig. 3). The previously placed pulley sutures were advanced a week later, and the wound was completely closed. Sutures were removed 4 weeks after the initial closure (Fig. 4).



**Fig. 3.** Pulley suture partial scalp wound closure. The wound was completely closed a week later by tightening the original sutures.



**Fig. 4.** Progressively advanced pulley suture closure at 4-week follow-up after suture removal.

## DISCUSSION

Pulley sutures facilitate wound closure in areas of high tension due to the mechanical advantage inherent in the design of a pulley and the principles of stress relaxation and creep.<sup>1,2,4,5</sup> Multiple loops increase distance and decrease force in a reciprocal fashion.<sup>4,6,7</sup> Friction created by the extra suture material helps maintain wound closure tension before knot placement.<sup>4</sup> In contrast to the pulley suture, figure-of-eight, horizontal mattress and vertical mattress sutures techniques are typically not used in areas of high tension. Although figure-of-eight sutures are often placed in a pulley configuration, the forces are directed both across the wound and parallel to the wound. The parallel component increases the risk of wound necrosis as is seen with horizontal mattress sutures. Vertical mattress sutures eliminate dead space, but the mechanical advantage of the pulley design is not present. In addition, 2 of the tissue passes are taken superficially and do not contribute significantly to the strength of the wound closure.

Scalp wounds less than 2 cm can often be closed with pulley sutures without the need for undermining or galeal

scoring.<sup>1</sup> In addition, pulley sutures function as simple, inexpensive external tissue expanders leading to biological creep and allow for subsequent wound reduction.<sup>2,5,8</sup> Similarly, the DermaClose RC (Wound Care Technologies, Inc.; Chanhassen, MN) is an external tissue expansion device that has shown promising results for the closure of large wounds, but its use may be limited secondary to cost and availability, and the elevated profile of the device makes it prone to external insult resulting in tissue trauma.<sup>9,10</sup>

Previous reports have not shown a risk of necrosis with pulley sutures with primary scalp closure of wounds 2 cm or less.<sup>1</sup> Unfortunately, this does not hold true in the setting of large scalp wounds. We have seen minor wound edge necrosis with excessive pulley suture tension. We are unable to assess capillary refill as an end point for skin tension because of the use of epinephrine in our local anesthesia. We are careful to use minimal force when tying down pulley sutures during the initial repair.

An additional consideration is the risk of suture track marks as we commonly leave our original pulley sutures in place for 3–4 weeks. A recent prospective randomized study found equivalent scar cosmesis between bilayer and single-layer pulley suture scalp closure 6 months after surgery.<sup>1</sup> We have also seen excellent cosmetic outcomes after pulley suture closure on the scalp.

Progressive tightening of pulley sutures has numerous advantages over traditional flap closure for scalp wounds. Primary closure with pulley sutures creates little bleeding, takes less than 30 minutes to perform, requires far less tissue movement, and is easily achieved under local anesthesia. Pulley suture advancement at subsequent clinic visits requires minimal equipment and is performed in less than 10 minutes. Pulley suture closure of large scalp defects is especially useful in anticoagulated patients and patients who cannot tolerate a prolonged procedure under local anesthesia. At many institutions, patients who are not candidates for flap closure often spend 2–6 months healing by second intention. Pulley suture closure of scalp wounds with progressive tightening provides an attractive alternative option for patients.

## CONCLUSIONS

Classic teaching dictates that scalp defects greater than 2 cm in diameter cannot be closed primarily. Fortunately, this is no longer true. Scalp wounds up to 2.5–3.0 cm in diameter can be rapidly approximated with a single-layer pulley suture closure. In addition, pulley sutures act as external tissue expanders allowing up to an additional 5 mm of weekly scalp closure. Progressive tightening of pulley sutures allows for simple, fast, and inexpensive primary closure of scalp wounds greater than 3 cm in lieu of large scalp flaps.

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