

# Use of BioGlue Surgical Adhesive for Brow Fixation in Endoscopic Browplasty

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**Objective:** To determine the efficacy, longevity, and safety of BioGlue Surgical Adhesive for periosteal fixation in endoscopic browlifts.

**Methods:** Retrospective review of 80 patients who underwent endoscopic browlift using BioGlue as the primary means of periosteal fixation. Visits were categorized as preoperative, 1 to 2 months, 3 to 6 months, and 7 to 12 months, and photographs of the first 15 patients were evaluated for change in brow position at each of these visits. Brow position was measured at the lowest brow hairs at the midpupillary and lateral canthus positions. Follow-up was 3 months to 3 years.

**Results:** All of the first 15 patients were included in the

1- to 2-month postoperative grouping, 13 in the 3- to 6-month grouping, and 10 in the 7- to 12-month grouping. At all postoperative visits, brow elevation was significantly maintained during 12-month follow-up. Revision has been required in only 1 of 80 patients to date.

**Conclusions:** BioGlue is an effective and safe method of maintaining brow position in endoscopic browplasty. Brow elevation achieved using BioGlue was significantly maintained during the 7- to 12-month postoperative period. Tissue adhesives such as BioGlue have the potential to become significant adjuncts in facial plastic surgery and warrant more critical evaluation.

*Arch Facial Plast Surg.* 2005;7:393-397

**E**NDOSCOPIC BROWPLASTY HAS become a standard method of forehead rejuvenation since its introduction in the 1990s. Endoscopic rejuvenation provides predictable results and uses a less invasive approach, making it attractive to patients and surgeons. The ideal optical pocket for the endoscopic approach is subperiosteal owing to reduced bleeding, ease of dissection, and identification of neurovascular landmarks. The success of the endoscopic approach, therefore, depends on fixation of the periosteum to the underlying bone once these forces have been released. Readherence of the periosteum to the underlying cortex will occur by the natural wound-healing response; however, it is critical to provide proper fixation of the periosteum–soft tissue complex in the desired position until this fibrosis has occurred.

Great interest exists in determining the time required for periosteal reattachment and the most effective means of fixation during this critical period. Although animal studies<sup>1-4</sup> suggest that 1 to 12 weeks is required for periosteal reattachment, recent evidence<sup>2,5</sup> suggests that at least 6 weeks of fixation may be necessary to allow the periosteum adequate time to re-

adhere to its new location on the frontal bone cortex. Although direct studies in humans have not been performed, clinical studies corroborate the findings from the animal studies.

For fixation, a plethora of options have been described, including exterior bolster sutures, spanning fixation sutures, transcutaneous screws, cortical bone tunnels, and absorbable subcutaneous cleats (Endotines; Coapt Systems Inc, Palo Alto, Calif).<sup>6-15</sup> Although each fixation option has variable effectiveness, they all have downsides from the perspective of patient acceptance and surgical difficulty. Included are the need for drilling into the skull (which many patients find unfavorable), the potential for intracranial complications, the risk of foreign body complications, and the lack of duration of effectiveness due to “cheese wiring” through soft tissue when suture suspension techniques are used. Consequently, there has been interest in the use of tissue adhesives that can be easily inserted into the optical cavity to fixate the periosteum–soft tissue complex in the desired position. Historically, Tisseel (Baxter Inc, Deerfield, Ill) has been reported as an alternative to rigid fixation techniques. However, with low bonding strength

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and duration of effectiveness, one of us (C.M.S.) and others have found limited reproducible results using this (primarily hemostatic) agent for brow fixation.

BioGlue Surgical Adhesive (CryoLife Inc, Kennesaw, Ga) is primarily a complex of purified serum albumin and glutaraldehyde and is approved by the Food and Drug Administration for hemostasis in cardiac procedures such as aortic dissection repair and valve replacement.<sup>16-20</sup> Significant tissue adhesion is achieved by the polymerization of lysine molecules from the albumin, the glutaraldehyde, and any juxtaposed protein-containing tissue. This bond has a strength potential of up to 1500 kilopascals (kPa), which can be contrasted with fibrin glue's bond of approximately 150 kPa.<sup>21</sup> It is, therefore, capable of creating a bond that is effective for tissue fixation. In addition, the material elicits a limited foreign body reaction, as seen on histologic studies, and is reabsorbed within 2 years.<sup>21</sup> As a result, BioGlue has been the primary method of periosteal fixation in endoscopic browplasty used by one of us (C.M.S.) for the past 2 years. In this study, we retrospectively evaluate our experience with 80 patients who underwent endoscopic browplasty using BioGlue as the primary means of brow fixation. The first 15 consecutive patients of the 80 were then used to measure the preoperative and postoperative brow position to objectively determine the long-term efficacy of BioGlue in maintaining brow position.

## METHODS

Between July 1, 2002, and December 1, 2004, 80 patients with brow ptosis underwent endoscopic browplasty with BioGlue fixation by 1 of us (C.M.S.) in university and private practice settings. Institutional review board approval from the University of California at San Francisco was obtained for reviewing medical records and facial photographs. Patients were evaluated before and after surgery on days 1, 3, 10, and 14 for any complications, such as hematoma, fluid collections, infection, and recidivism. Subsequently, patients were followed up at 3- to 4-month intervals for up to 1 year. Only the first 15 consecutive patients of 80 were used to objectively determine change in brow position. For this evaluation, postoperative periods were grouped into a 1- to 2-month category, a 3- to 6-month category, and a 7- to 12-month category.

Standardized photographs were taken before and after surgery using a dedicated photography lane with a mounted FinePix S2 Pro Digital SLR (Fuji, Tokyo, Japan) and clinical imaging software (Mirror; Canfield Scientific Inc, Fairfield, NJ). Photographs were obtained by 2 trained staff members to help reduce variability between photographs, and all the photographs were taken with the patients positioned appropriately using the Frankfurt horizontal plane. The standard views for browplasty were obtained, including a single anteroposterior view, bilateral three-quarter views, and bilateral lateral views.

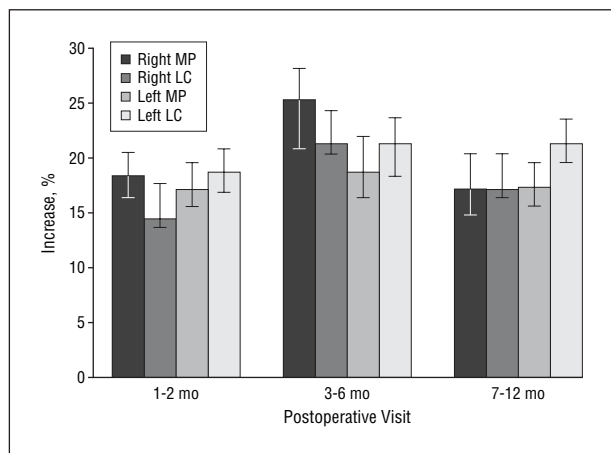
From the digital images, measurements were taken from the patients' anteroposterior views using the measuring tool included in the Mirror imaging software. Because the interpupillary distance for a given individual is constant throughout adult life, it was used to calibrate all that patient's photographs. If variability existed between photographs from a single patient owing to a slight variation in the distance at which the patients were photographed, calibrating the interpupillary distance to match the preoperative photograph's value minimized photographic inconsistencies. After calibration of the measuring tool, brow position

was assessed by taking bilateral measurements from 2 different sites. The first measurement was the vertical distance from the midpupillary point to the lowest row of eyebrow hairs (MP). The second measurement was the vertical distance from the lateral canthus to the lowest row of eyebrow hairs (LC). Five individual values, including the interpupillary distance, were recorded for each patient photograph.

Data were then compiled into a spreadsheet program (MS Excel; Microsoft Corp, Redmond, Wash), and the values of the preoperative and postoperative photographs were compared. Because the interpupillary distance is a constant in each individual and the photographs are calibrated to all have constant interpupillary distances, the preoperative and postoperative MP and LC values can be directly compared. Data are reported as a percentage increase from the baseline preoperative MP and LC values. Mean values for each postoperative grouping were then calculated, and a paired *t* test was used to determine whether differences in means were statistically significant. Ninety-five percent confidence intervals were calculated to determine the significance of the increase in distances at the MP and LC locations. Patients were monitored for any potential adverse effects associated with either the surgery or the use of BioGlue.

After appropriate anesthesia, the patient is prepared and draped in the typical sterile manner for facial and brow surgery. The eyes are protected with small transparent patches (Tegaderm; 3M, St Paul, Minn) cut in half and affixed so as not to pull the brows downward.

Incisions are made in the usual manner 5 to 10 mm behind the anterior hairline in the midline and over each lateral canthus. Temporal incisions are also made where the plane of dissection is directly on the superficial layer of the deep temporal fascia. The conjoined tendon is taken down from the temporal pockets. Subgaleal dissection is performed in a sweeping manner posteriorly from the hairline incisions to the crown, and then a subperiosteal dissection is performed caudally toward the brow. The endoscope is used once the dissection is within 1 to 2 cm of the brow. Careful attention is given so that there is good release of the periosteum along the whole orbital rim, especially laterally. Suction cautery is used to achieve hemostasis and to create myotomies of the procerus and corrugator muscles. Periostotomies are also performed using the suction cautery device approximately 1 cm above the orbital rims. Without this maneuver, the periosteum may be too rigid and may limit complete mobilization of the brows cephalically. The cavity is then irrigated and suctioned. Next, the forehead skin is dried and 1-in sterile skin closure strips (Steri-Strips; 3M) are applied to the middle of the forehead over the lateral canthi to provide upward traction on the brow during BioGlue application and for further support of the brow during the early healing period. The BioGlue applicator tip is primed immediately before use. The user has approximately 60 seconds after priming to apply the adhesive over the bone. Using skin hooks, the brow and the periosteum are elevated from the cortical bone and retracted superolaterally, creating a pocket, and 2 mL of BioGlue is inserted through the central scalp incision, staying at least 2 cm above the orbital rim. Pulling cephalad and then downward, the brow is repositioned appropriately. It is held here for 2 minutes. Because the polymerization of BioGlue is rapid, it is best to determine the proper position of the brow before fixation. The wounds are now closed in a single-layer manner using surgical clips, and the 1-inch closure strips already attached to the forehead are secured to the hair-bearing scalp using surgical clips to help support the new brow position. A standard face-lift-browlift dressing with rolled cotton, an antimicrobial gauze dressing (Kerlix; Kendall Company, Mansfield, Mass), and self-adherent plastic wrap (Coban; 3M) is applied to support the brows in an elevated position and to put gentle pressure across the supraorbital rim (not across the middle of the forehead).



**Figure 1.** Postoperative brow elevation. Increase from preoperative baseline measured as a percentage of the interpupillary distance, a constant. MP indicates the vertical distance from the midpupillary point to the lowest row of eyebrow hairs; LC, the vertical distance from the lateral canthus to the lowest row of eyebrow hairs. Error bars represent SD.  $P < .05$  at all data points.

## RESULTS

Eighty patients underwent endoscopic browplasty using BioGlue as the primary method of fixation between July 1, 2002, and December 1, 2004. The first 15 patients, whose preoperative and postoperative photographs were studied for long-term maintenance of brow position, ranged in age from 46 to 72 years; 80% were women ( $n=12$ ) and 20% were men ( $n=3$ ). Most patients had the endoscopic browplasty in conjunction with another cosmetic procedure, rhytidectomy being the most common. All of the 15 patients were included in the 1- to 2-month postoperative grouping, 13 in the 3- to 6-month grouping, and 10 in the 7- to 12-month grouping.

At the 1- to 2-month postoperative visit, mean brow elevation at the MP was 17.0% on the left and 18.3% on the right ( $P < .001$  for both). The mean LC at the 1- to 2-month postoperative visit was 18.6% on the left ( $P < .001$ ) and 14.3% on the right ( $P = .001$ ) (**Figure 1**). The elevation in the brows compared with the preoperative status was maintained at the 3- to 6-month postoperative period. The MP at 3 to 6 months was 18.6% on the left ( $P = .01$ ) and 25.2% on the right ( $P = .005$ ), and the mean brow elevation at the LC was 21.2% on the left ( $P = .007$ ) and 21.3% on the right ( $P = .003$ ) (**Figure 1**). The elevated brow position was maintained across time; in the 7- to 12-month group, the mean brow elevation at the MP was 17.3% on the left ( $P = .009$ ) and 17.1% on the right ( $P = .02$ ). The mean brow elevation at the LC at the 7- to 12-month postoperative visit was 21.3% on the left ( $P = .001$ ) and 17.1% on the right ( $P = .03$ ) (**Figure 1**). These findings corroborated the subjective improvement in brow position by the surgeons and the patients. **Figure 2** and **Figure 3** demonstrate the longevity of postoperative results.

Overall, the patients tolerated the procedure well with minimal discomfort. Patients returned to social functions within 7 to 10 days. In terms of complications, 6



**Figure 2.** Preoperative (A) and 3-month postoperative (B) views of a patient who had an endoscopic browlift, a face-lift, and upper and lower eyelid blepharoplasties.



**Figure 3.** Preoperative (A) and 9-month postoperative (B) views of a patient who had an endoscopic browlift, upper eyelid blepharoplasties, and submental liposuction.

of our first 80 patients developed small but palpable collections of BioGlue in the hair-bearing scalp. These “BioGlueomas” were small and were managed conservatively with reassurance. In most cases, the patients were comfortable with conservative management, allowing resorption with time (up to 18 months). Two of the 6 patients developed local unilateral sterile abscesses near the lateral scalp incisions. Both resolved with incision and drainage in the clinic under local anesthesia, local wound care, and a 7-day course of oral antibiotic agents. Finally, 1 patient (1%) required a revision browplasty to address asymmetrical postoperative brow position. This was performed without difficulty; the surgical planes were easily identified, elevated, and refixed with BioGlue. This patient had no further complications and was pleased with the final postoperative brow position. No patients required revision because of failure of fixation or loss of brow repositioning.

## COMMENT

Fixation of the brows during the critical period of periosteal readherence is essential for the success of the en-

doscopy browplasty technique. A stable and secure fixation will allow a predictable result in brow rejuvenation and will ensure that there will not be loss of brow position in the early postoperative period. A variety of animal studies have been performed evaluating what the critical period of brow fixation is to allow adequate periosteal readherence. Although animal studies<sup>1-4</sup> suggest that 1 to 12 weeks are required for periosteal reattachment, recent evidence<sup>2,5</sup> suggests that at least 6 weeks of fixation may be necessary to allow the periosteum adequate time to re-adhere to its new location on the frontal bone cortex.

With this knowledge, surgeons can properly evaluate which method of brow fixation best suits their practice and will provide adequate fixation during the critical period of periosteal readherence. Numerous options exist, many of which extend operative times because of complicated or labor-intensive techniques. Many popular methods require additional equipment, have protracted learning curves, and add substantial operative risk to the procedure. The bone tunnel and the Endotine techniques are 2 of the more popular methods of securing the periosteum-soft tissue complex. Both require drilling into the outer cortex of the skull. In the bone tunnel technique, a drill is used to create a passage through the bone to secure a fixation suture over a bridge of calvarium. This technique has an inherent potential to violate the underlying vessels, meninges, and brain parenchyma. One of us (D.M.S.) is aware of at least 1 case of epidural hematoma. Other complications, such as subdural hematoma, cerebral spinal fluid leak, and brain injury, are realistic possibilities that must be discussed with the patient.

When using the Endotine, a well is created in the outer cortex into which the peg on the backside of the absorbable cleat or Endotine is secured. This allows the Endotine to resist the downward pull of the periosteum-soft tissue complex. The outer surface of the Endotine is lined with spikes, which pierce the periosteum and soft tissue. Its adjustability makes it an attractive choice. Along with the risks of drilling the well, the Endotine can slip or displace, and it is frequently palpable through the scalp. This may, in part, be because the hardware is flat but it is juxtaposed onto a curved bony surface. In fact, patients in our experience complain of tenderness with palpation or during activities such as washing, combing, or styling their hair. Finally, although the cleat is absorbable, we found that it often persists for a protracted period, making its palpability a constant source of patient concern.

Transcutaneous screws have also been used to fixate the brows after endoscopic browplasty. These screws are placed high into the calvarium through the frontal scalp and are used as anchors to which sutures or skin clips can be secured. Although these screws are only temporary, being removed in approximately 2 weeks, they are indwelling hardware that is visible and palpable during this period. Furthermore, they are potential sources of infection for the surrounding soft tissue and the underlying bone. Patients are often reluctant to have these transcutaneous screws in place, even temporarily, for an elective procedure.

As an alternative to these more invasive and involved fixation techniques, investigations have explored the use

of tissue adhesives that can be easily and rapidly inserted into the optical cavity to secure the periosteum until physiologic reattachment has occurred. Ellis and Shaikh<sup>22</sup> and Marchac et al<sup>23</sup> explored the use of fibrin glue as the primary means of brow fixation in endoscopic browplasty. Consisting of thrombin and fibrinogen, fibrin glue is unique in that it has hemostatic and adhesive properties. In rhytidectomies, for example, a reduction in postoperative hematomas and ecchymoses in the absence of drains has been reported with the application of fibrin glue.<sup>24</sup> Marchac et al<sup>23</sup> reported a series of 206 cases of endoscopic browlifts using fibrin glue fixation. They noted a satisfactory elevation in brow position in 94% of patients with a revision rate of 6% (10 of 163 patients). The experience of one of us (D.M.S.) with fibrin glue has not yielded similar satisfactory results, and the relapse rate was unacceptably high. The relapse rate is likely to be secondary to the low adhesive properties of fibrin glue given that it has a low bonding strength (up to 150 kPa) and can be significantly resorbed as early as 2 weeks.

BioGlue creates adhesion through polymerization between lysine molecules in its bovine serum albumin, glutaraldehyde, and any adjacent tissue proteins. It is another tissue sealant that can be easily used for fixation in endoscopic browlift without the use of indwelling hardware, such as absorbable cleats, screws, or plates. Although fibrin glue can be resorbed as early as 2 weeks, BioGlue is resorbed in 2 years, well beyond the critical 6 weeks needed to allow proper periosteal re-adherence. Moreover, it creates a bond strength of up to 1500 kPa, 10 times the potential of fibrin glue.<sup>21</sup> Safety from disease transmission is ensured by purification in a proven 3-step process, including 2 heat precipitations and 1 chromatography.

In the present series of patients, the surgical brow position, while using BioGlue as the primary method of fixation, was maintained during the critical period of periosteal reattachment and remained elevated for 12 months compared with the preoperative state (Figure 1). Indeed, brow position continued to improve after the initial 1- to 2-month postoperative position at some measurement locations. This observation may be related to resolving nonclinical postoperative edema, possible continued wound contraction with wound maturation, or myotomy of the brow depressors. The percentage increase in brow position from baseline can be different between the 2 sides. Although a difference in percentage increase at the midpupillary position to the lowest hairs of the brow between the left and right sides may seem large at 6.6%, this actually translates into only a 2-mm difference in elevation between the 2 sides. Also, the disparity between the 2 sides could be due to an attempt to correct preoperative asymmetries inherent in most patients.

Patient satisfaction was high. Only 1 (1%) of our first 80 patients required revision owing to postoperative asymmetry in brow position. This is, of course, consistent with revision rates previously reported in the literature.<sup>23</sup> Also, the revision case was one of the first 15 patients operated on using this technique. No serious adverse outcomes were noted. The 2 local abscesses seen in the study resolved with exploration and drainage without further

sequelae. Their development may be related to the persistence of BioGlue in the surgical site.

BioGlue application is efficient and effective, significantly reducing procedure time (by as much as 30 minutes). In general, it takes 1 minute to apply the BioGlue and an additional 2 minutes to allow for complete polymerization and tissue fixation. The original reusable applicator has been refined to just 1 loaded disposable syringe and a few applicator tips, limiting additional equipment costs. One 2-mL syringe of BioGlue costs approximately \$200, much less than some of the alternatives. BioGlue is also conveniently stored at room temperature, and no time-consuming or complicated preparation is required. Overall, the results with BioGlue brow fixation in endoscopic browplasty are encouraging, and a prospective evaluation of patients in the long term is warranted.

## CONCLUSIONS

BioGlue is an effective and safe method of maintaining proper brow position in endoscopic browplasty. The present study shows that brow elevation achieved using BioGlue as the primary method of fixation was significantly maintained during the 7- to 12-month postoperative study period, beyond the critical period in which periosteum readheres to the bone. The application of BioGlue is fast and straightforward, thereby simplifying the overall procedure. No adverse events were seen, and complications were minimal and easily treated. Revision was required in only 1 of 80 procedures to date. BioGlue demonstrates tissue-bonding-strength orders of magnitude greater than any available tissue adhesive and has the potential to become a significant adjunct in facial plastic surgery. More thoughtful evaluation of this and other applications in our field is warranted.

Accepted for Publication: May 11, 2005.

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