Comparison of Incision Closures With Subcuticular and Percutaneous Staples

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Objective: Incision closures should yield safe, effective healing with excellent cosmesis. Subcuticular absorbable staples may combine the advantages of subcuticular suturing with the efficiency of percutaneous stapling. This study compares absorbable subcuticular staples with percutaneous metal staples as a means of incision closure in facial rejuvenation surgery.

Methods: Sixteen patients undergoing endoscopic eyebrow-lift and/or rhytidectomy were studied. Each patient had 50% of their temporal and postauricular skin incisions closed with subcuticular staples oversewn with 5-0 plain gut and the remaining 50% closed with percutaneous metal staples. Incisions were evaluated intraoperatively and at regular intervals for 1 year postoperatively. Intraoperative assessments included device handling, bleeding, tension, and cosmesis. Postoperative assessments included incision integrity, inflammation, and cosmesis. Patients were also interviewed regarding incision appearance and comfort.

Results: During the early postoperative period, metal staples produced greater incisional erythema and crusting. Subcuticular staples produced better tissue eversion, less erythema, equivalent if not superior comfort, and shorter office visits. These differences faded over time. The need to properly engage the subcuticular stapler in the dermis was the principal impediment to optimal stapler use.

Conclusions: Subcuticular staples represent a safe, comfortable, and potentially more rapid alternative to percutaneous staples. Modifications of the subcuticular stapler device are required before its full potential can be realized.

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sociated with and time required for cutaneous staple removal. Potential advantages over subcuticular suturing include shorter incision closure time and reduced risk of infection.\(^1\)

The purpose of this study was to evaluate the safety, efficacy, and cosmesis of wound closure with a novel absorbable subcuticular stapling system (INSORB\(^2\)0 Subcuticular Skin Stapler; Incisive Surgical Inc, Plymouth, Minnesota) and to compare these results with those obtained with conventional percutaneous metal staples in esthetic facial rejuvenation surgery. Primary outcome measures were quality of incision closure and the acute and chronic effects on incision healing. Secondary outcome measures were the comfort level and cosmesis of subcuticular staples compared with percutaneous metal staples.

**METHODS**

**MATERIALS**

The INSORB\(^2\)0 Subcuticular Skin Stapler system is composed of synthetic poly(l-lactide-co-glycolide) copolymer staples, a staple applicator, and a proprietary forceps. The U-shaped staples are rigid and barbed. These staples lose 60% of their holding strength within 14 days of placement.\(^5\) Poly(l-lactide-co-glycolide) is primarily degraded via hydrolytic chain scission into lactic acid and glycolic acid. Lactic and glycolic acids are then metabolized via the Krebs cycle to carbon dioxide, which is ultimately expelled by respiration.\(^4,5\)

The INSORB\(^2\)0 Subcuticular Skin Stapler applicator is a sterile, multiple-fire, single-patient-use device containing 20 staples (Figure 1). The proprietary fused double Adson forceps (INSORB\(^1\) Forceps) feature preferential spring forces. During proper forceps use, 2 mm of one tissue edge is grasped with the weaker spring arm, and 2 mm of the opposite edge is then grasped with the stronger spring arm (Figure 2).\(^6\) The forceps are seated into shelves in the applicator’s nose. As the applicator fires, 2 needles advance into a tissue capture zone that precisely “bites” the dermis on both sides of the incision. A staple simultaneously deploys horizontally into the subcuticular tissue to provide a secure, well-approximated, everted closure.\(^6\) This process is repeated at approximately 7-mm intervals until the incision is closed.

Conventional metal staples were percutaneously placed with a sterile, multiple-fire, single-patient-use Proximate RH Rotating Head Skin Stapler (Ethicon Endo-Surgery Inc, Cincinnati, Ohio). Standard percutaneous stapling techniques were used to achieve complete interrupted incision closures, also at 7-mm intervals.

**PATIENTS**

All patients were seen at the private practice of one of us (P.A.H.) requesting aesthetic facial rejuvenation, including rhytidec-
Rhytidectomy were performed on each patient according to the
of each procedure. A single 1-g dose of intravenous cefazolin or clindamycin, in the event of a penicillin or cephalosporin allergy) was administered at the start of each procedure.

Informed consent was then obtained from all patients. Written informed consent was then obtained from all patients. Written informed consent was then obtained from all patients. Written informed consent was then obtained from all patients.

Exclusion criteria included (1) active infection; (2) concurrent enrollment in a similar study; (3) history of hypertrophic scars and/or keloids; (4) history of radiation therapy to the head and neck; (5) dermatologic comorbid disease (eg, cutis laxa or collagen vascular disease); and (6) immunosuppression (eg, human immunodeficiency virus and/or AIDS). Ultimately, 16 consecutive adult female patients were enrolled.

Prior to study inception, approval was obtained from the University of Minnesota institutional review board. All patients范围内双侧皮肤及皮下组织切口，并使用Salvatore’s superficial muscular aponeurotic system（SMAS）技术进行提升。术前患者均接受1次1g剂量的静脉注射青霉素类抗生素治疗。所有患者均在术后1周、2周、6周、3个月、6个月和12个月时进行随访。在每次随访时，所有切口将被肉眼观察、手动触诊和拍摄照片。

在第一次术后复查时，所有额部提升术均使用敷料去除。所有患者均在术后第1周、2周、6周、3个月、6个月和12个月时进行随访。在每次随访时，所有切口均被肉眼观察、手动触诊和拍摄照片。最终，16名连续的成年女性患者被纳入研究。

在术前研究开始之前，已从明尼苏达大学研究所获得伦理委员会批准。所有患者均接受1次1g剂量的静脉注射青霉素类抗生素治疗。所有患者均被纳入研究范围内双侧皮肤及皮下组织切口，并使用Salvatore’s superficial muscular aponeurotic system（SMAS）技术进行提升。术前患者均接受1次1g剂量的静脉注射青霉素类抗生素治疗。所有患者均在术后1周、2周、6周、3个月、6个月和12个月时进行随访。在每次随访时，所有切口将被肉眼观察、手动触诊和拍摄照片。

Surgical Procedures Performed

Patient No./Age, y* Surgical Procedures

1/52 Rhinoplasty, submental liposuction, endoscopic eyebrow-lift, subnasal lip-lift, SMAS graft upper lip augmentation

2/58 Rhinoplasty, submental liposuction, ptosisplasty, endoscopic eyebrow-lift, upper and lower eyelid blepharoplasty

3/48 Rhinoplasty, subcutoplasty, endoscopic eyebrow-lift, alloplastic chin implantation, open septorhinoplasty

4/54 Rhinoplasty, platysmaplasty, endoscopic eyebrow-lift, upper and lower eyelid blepharoplasty

5/72 Rhinoplasty, platysmaplasty, periorbital dermabrasion

6/52 Rhinoplasty, submental liposuction, platysmaplasty, endoscopic brow-lift

7/49 Rhinoplasty, submental liposuction, platysmaplasty, endoscopic brow-lift, lower eyelid blepharoplasty

8/59 Rhinoplasty, submental liposuction, spot dermabrasion

9/52 Rhinoplasty, endoscopic brow-lift, revision endonasal rhinoplasty, hyaluronic acid injection bilateral nasolabial folds

10/67 Rhinoplasty, endoscopic brow-lift, revision nasal scar, hyaluronic acid injection bilateral nasolabial folds

11/58 Rhinoplasty, submental liposuction, endoscopic brow-lift, lower eyelid blepharoplasty

12/76 Endoscopic brow-lift, upper and lower eyelid blepharoplasty, lateral canthoplasty

13/59 Endoscopic brow-lift, upper eyelid blepharoplasty

14/59 Rhinoplasty, submental liposuction, upper and lower eyelid blepharoplasty

15/57 Rhinoplasty, submental liposuction, upper and lower eyelid blepharoplasty

16/66 Rhinoplasty, platysmaplasty, endoscopic brow-lift, periorbital dermabrasion

Abbreviation: SMAS, superficial muscular aponeurotic system.

*All patients were women.

Patients ranged in age from 48 to 76 years (mean age, 59 years). All patients underwent additional facial rejuvenation procedures in conjunction with endoscopic brow-lift and/or rhytidectomy surgery (Table). The surgical procedure was tolerated well in all patients. One intraoperative hematoma, attributed to surgical drain malfunction, occurred in patient 3 on the right side of the face. This area had been previously closed with subcuticular absorbable staples. The hematoma was evacuated, and the incision was then identically closed after

RESULTS

All patients were discharged home on the day of surgery and prescribed a 1-week course of cephalexin antibiotic treatment (or clindamycin, in the event of a penicillin or cephalosporin allergy). All postoperative visits were conducted in the private practice of one of us (P.A.H.). During these postoperative sessions, patients were interviewed, and the closed incisions were visually inspected, manually palpated, and photographed.

During the first postoperative day, all endoscopic brow-lift pressure dressings were removed. All rhytidectomy patients underwent bilateral suction drain removal; pressure dressings were then reapplied for an additional 24 hours. Additional visits occurred at 1 week, 2 weeks, 6 weeks, 3 months, 6 months, and 12 months postoperatively. During each visit, all incisions were assessed for integrity, inflammation, edema, and cosmesis through direct observation and digital photographic documentation. In addition, patients were interviewed regarding the comfort and cosmetic appearance of the bilateral temporal and postauricular incisions.

Percutaneous metal staples were removed at postoperative week 1. Owing to the unilateral presence of metal staples and the contralateral presence of absorbable 5-0 plain gut suture, blinded wound assessments could only begin at the postoperative week 6 visit.
dram replacement. All patients were discharged home on the day of surgery.

PERCUTANEOUS METAL STAPLES

Intraoperatively, a single surgeon easily and rapidly placed the percutaneous metal staples. Incisions were uniformly closed with good edge apposition and without undue tension. No untoward bleeding accompanied metal staple placement. The rare malpositioned metal staple was easily removed. Peri-incisional erythema was mildly more pronounced in those incisions closed with metal staples. This erythema gradually resolved following metal staple removal; improvement was observed as early as postoperative week 2. Compared with subcuticular staples, metal staples exhibited a greater tendency toward crust accumulation, which required additional office time for debridement and removal. Crusts obscured the presence of metal staples in 2 patients; these staples were thus removed during subsequent office visits. Throughout the study duration, there was no dehiscence of any wound closed with percutaneous metal staples. Patient 15 developed a focal Staphylococcus aureus postauricular wound infection at postoperative week 2. This infection resolved following limited office debridement and 2 courses of culture-directed oral antibiotic treatment.

Patients reported minimal to mild discomfort during metal staple removal. Independent of the specific act of metal staple removal, the physical presence of these staples contributed to subjective patient discomfort. Overall postoperative discomfort improved following metal staple removal, with incisions feeling less “tight.” While patients were generally pleased with incision cosmesis, patients reported focal “bumps” or “lumps” more often along incisions closed with metal staples. These irregularities subjectively and objectively settled by postoperative week 12.

SUBCUTICULAR ABSORBABLE STAPLES

The INSORB system was similarly easy to manipulate intraoperatively. The ergonomic design of the applicator permitted rapid staple delivery into incisions. A minimal learning curve was required to become adept with system use. When the staple properly engaged the dermis, excellent to outstanding incision edge apposition and eversion resulted. Unfortunately, this situation occurred...
during only a minority of attempted subcuticular staple placements. More commonly, the subcuticular staples engaged the dermis edges asymmetrically or engaged insufficient amounts of dermis to confer adequate holding strength. At these times, subcuticular staple removal was made more arduous (though still possible) by the staple barb configuration. These circumstances, in conjunction with the 5-0 plain gut suture used to oversew these incisions, increased the total operative time required for incision closure. Ultimately, all incisions were closed with good edge apposition, without undue tension, and without significant bleeding.

Postoperatively, incisions closed with subcuticular staples exhibited no dehiscence. These incisions demonstrated less crust formation than metal staples (Figure 4). Patients were spared the discomfort and time associated with metal staple removal and crust debridement during the postoperative week 1 visit. The subcuticular staples produced less erythema and more uniform tissue eversion than metal staples during the first 2 weeks postoperatively (Figure 3). These observations corresponded with fewer patient reports of focal "bumps" or "lumps." However, 5 patients each required removal of 1 to 3 subcuticular staples found extruding through an incision edge. Staple extrusions were identified 2 weeks postoperatively in 3 patients and 1 month postoperatively in 2 patients. No patient complained of focal pain at these sites. No discreet wound infections were associated with the subcuticular staples. Patient 2 reported intermittent temporal incision inflammation 5 months postoperatively. A focal cyst containing scant mucopurulence was opened in the office, with subsequent complete resolution.

One year postoperatively, incisions closed with either stapling technique showed no significant objective differences in cosmesis or quality of healing (Figure 5 and Figure 6). Subjectively, all patients were highly satisfied with the cosmesis of all incisions closed with either stapling technique. Two patients (patients 7 and 15) reported greater comfort and improved cosmesis along incisions closed with subcuticular staples. The remainder experienced equivalent cosmesis and comfort with the 2 stapling techniques; no patient described increased discomfort over any incision closed with subcuticular staples. No scar revision procedures were anticipated.

**COMMENT**

Optimal incision closures produce excellent wound edge approximation with good eversion and without tension. Achieving this result consistently and efficiently re-
mains the ideal, especially given the increasing emphasis on productivity in both the operating room and outpatient setting. Toward that end, a technique that combines the merits of subcuticular closure with the speed and precision of percutaneous staple delivery is highly desirable.

To our knowledge, very few studies of surgical incision closure have used absorbable subcuticular staples. Using a porcine model, Fick et al. compared healing responses and tissue irritation in thoracic and abdominal wounds closed with percutaneous metal staples, subcuticular polyglactin 910 suture, and subcuticular absorbable staples. On postoperative days 7 and 21, incisions closed with subcuticular staples demonstrated significantly less histologic inflammation. By postoperative 42, however, wound healing scores and tissue irritation scores did not significantly differ across incision closure techniques. Incisions closed with metal staples showed the highest incidence of bacterial presence (3 of 8 incisions); incisions closed with absorbable subcuticular staples had the lowest incidence (1 of 16 incisions). These findings suggested that absorbable subcuticular staples may have less tendency to harbor bacteria.

Andrisevic and Guttormson applied the INSORB system in the subcuticular closure of more than 100 thoracotomy, mastectomy, cholecystectomy, and abdominal midline incisions over a 2-year period. The system proved simple and efficient to use by a single surgeon. Typical closures were closely approximated with good edge eversion and no clinically significant inflammation. In addition, the absorbable staples were perceived by patients to be more comfortable than percutaneous metal staples.

Prior to performing the present study, 2 brief practice sessions (each lasting 15-20 minutes) on abdominal panniculectomy skin afforded comfort with the proper use of the INSORB system. The relatively thick abdominal skin permitted rapid, consistent, single-operator incision closure with superb edge eversion and no misfirings.

In the present study, a number of intraoperative and postoperative observations were comparable across the 2 incision closure techniques. Untoward bleeding and dehiscence were uniformly absent with both techniques. Potential complications associated with the INSORB system were similar to those experienced with subcuticular running sutures or percutaneous metal staples: bleeding, pain, bruising, material extrusion, and infection. There were no complications specific to the INSORB system.

At postoperative week 1, metal staples incited mildly elevated levels of tissue reaction, with more firm, edematous, and erythematous tissue observed (Figure 3). These inflammatory characteristics gradually improved following metal staple removal. In contrast, minimal grossly visible inflammation characterized those wounds closed with absorbable subcuticular staples. Focal erythema and edema were absent even where the occasional subcuticular staple extruded. Beginning at postoperative week 12, and continuing through study conclusion at 1 year after the procedures, erythema and edema subsided to the extent that the specific closure technique used for a given incision could not be discerned.

Incisions closed with subcuticular staples exhibited reduced early postoperative crust formation; thus, less time was required for wound care (Figure 4). Subcuticular staples were uniformly perceived by patients as conferring equivalent if not superior comfort compared with metal staples. Furthermore, use of subcuticular staples avoided the patient discomfort and surgical time associated with metal staple removal. Both surgeon and patient satisfaction with incision cosmesis during the postoperative week 12 visit was similarly high with both stapling techniques. Similarly, at 6 and 12 months postoperatively, no significant differences in incision cosmesis were discernible to either surgeon or patient between the 2 stapling techniques (Figure 5 and Figure 6).

The thin skin of the scalp created considerable difficulty with accurate placement of subcuticular staples in this study. The subcuticular staple barbs failed to properly engage the dermis during most of the application attempts. Successful subcuticular staple delivery proved equally difficult in both the temporal and postauricular incision locations. However, excellent tissue eversion with acceptable holding strength was observed after successful staple application. Owing to the inconsistent accuracy of subcuticular staple placement, oversewing the incisions was deemed necessary to optimize wound edge eversion and minimize risk of postoperative wound dehiscence. Oversewing the incisions resulted in tension-free closures with excellent eversion and adequate holding strength in all cases. To our knowledge, no prior study of the INSORB system evaluated closure of scalp incisions; rather, thoracic and abdominal incisions were assessed. The relatively thicker skin of the thorax and abdomen afforded superb edge eversion and holding strength without device misfirings or postoperative wound dehiscence. Therefore, oversewing the incisions was not required in these prior studies of the INSORB system. It is anticipated that future modifications of the subcuticular stapler design will eliminate the need to oversew scalp incisions.

The current economic climate places considerable importance on cost containment. In this regard, each INSORB20 Subcuticular Skin Stapler costs $45.00. By comparison, each Proximate RH Rotating Head Skin stapler costs $25.25. While the absolute cost of the INSORB system is more expensive, this price differential can be surmounted with theoretically faster incision closure times and, therefore, reduced total operating room times with future device modifications.

In conclusion, the INSORB20 Subcuticular Skin Stapler is safe to use in facial rejuvenation surgery. The system is ergonomically designed and simple to use. When staples are properly deployed, closure times can be significantly faster than subcuticular suturing and comparable to percutaneous metal stapling. Proper staple placement results in a uniform, everted closure that eliminates the percutaneous insult associated with metal staples. The subjective short-term patient discomfort and cosmesis profiles of the INSORB system are at least equivalent, if not superior, to those seen with percutaneous metal staples. The principal shortcoming of the INSORB system relates to its rather infre-
quent ability to properly engage the dermis. As subsequent generations of this device emerge, technical improvements are anticipated that will accommodate differences in skin thickness found in the head and neck. These refinements can translate into improvements in intraoperative incision closure time, postoperative office visit time, patient comfort level, and scar visibility.

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REFERENCES