Comparison of long-term abdominal scarring after DIEP flap reconstruction: conventional dermal sutures versus INSORB dermal staples

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Background The importance of adequate wound closure in plastic surgery cannot be overstated. With the goals of shortening the operative time and improving outcomes, various methods and devices have been introduced to enhance the speed and quality of wound closure. To simplify dermal closure with favorable outcomes, several studies have compared results between the INSORB dermal stapler and conventional dermal sutures. We hypothesized that the dermal stapler would yield satisfactory scar formation without increasing complication rates over the long term.

Methods This retrospective study included patients who had undergone breast reconstruction with a deep inferior epigastric perforator (DIEP) free flap between October 2019 and May 2020 at a single center. Postoperative photographs of the patients’ abdominal scars were assessed at a minimum of 248 days by three blinded attending plastic surgeons using the Vancouver Scar Scale.

Results A total of 108 patients who underwent DIEP-free flap reconstruction after mastectomy were included in this study. Among them, 68 patients (group 1) underwent dermal closure with the INSORB dermal stapler, while 40 patients (group 2) underwent conventional dermal sutures. No significant differences were observed between the two groups in terms of vascularity, pigmentation, pliability, scar height, or overall scar assessment. Additionally, there was no significant difference in complication rates between the two groups.

Conclusions The INSORB dermal stapler is a valuable tool that can reduce operative time while delivering satisfactory outcomes. When used appropriately with proper training, it can mitigate perioperative complications and alleviate the surgical burden for the surgeon.

Keywords Cicatrix / Suture / Staple

INTRODUCTION

In the field of plastic surgery, the significance of proper wound closure cannot be overstated. Achieving adequate skin edge eversion and meticulous layer-by-layer closure is pivotal in both ensuring satisfactory scar formation and minimizing the rate of complications. However, achieving these goals can be challenging in certain scenarios, particularly in procedures involving extended incisions such as abdominoplasty. Prolonged closure procedures necessitate the use of multiple hand-sewn sutures, which in turn increase the risk of infection and inflammation, as well as needle stick injuries.
to surgeons. Furthermore, the extended operative time exposes the patient to longer anesthesia and its associated risks. The final outcome can be inconsistent, depending on the surgeon’s expertise.

With the goals of shortening the operative time and improving outcomes, various methods and devices have been developed to expedite wound closure and enhance its quality. Notably, 2-octyl cyanoacrylate (Dermabond; Ethicon, Inc.) has been available as a skin closure alternative since 1997 [1]. The use of this adhesive has been shown to reduce procedural time, expedite wound healing, lower the risk of infections, and minimize scarring in diverse clinical contexts. In addition to innovations in skin closure, there has been a focus on simplifying dermal closure to attain cost-effective outcomes. The INSORB dermal stapler (Incisive Surgical) is a United States Food and Drug Administration-approved device designed for dermal closure. This device positions U-shaped absorbable staples within the dermal layer of tissue. Cross et al. [2] conducted a randomized controlled study, comparing the outcomes of INSORB and conventional dermal sutures in breast cancer patients who underwent expander insertion after mastectomy. Their findings indicated that patients who underwent INSORB-based closure had higher Vancouver Scar Scale scores in the early postoperative period. Similarly, Han et al. [3] conducted a study comparing scar scale scores between INSORB and conventional dermal suture groups, finding no significant difference between the two groups when evaluated at 6 months postoperatively.

While numerous articles have provided evidence of the effectiveness and safety of various skin closure materials, the long-term results of dermal closure devices have yet to be reported in the literature. Moreover, previous studies have been limited by small sample sizes, with fewer than 30 patients included.

In this study, we hypothesized that the use of a dermal stapler would result in satisfactory scar formation without an increased complication rate in the long term. We evaluated long-term outcomes using the Vancouver Scar Scale in two groups, one comprising patients who received the INSORB dermal stapler and the other using conventional sutures. Each group consisted of more than 30 patients.

**METHODS**

This retrospective study was conducted with the approval of the Seoul Asan Medical Center Institutional Review Board. The study included patients who underwent breast reconstruction with a deep inferior epigastric perforator (DIEP)-free flap between October 2019 and May 2020 at a single medical center. The patients were divided into two groups: in group 1, dermal closure was performed using the INSORB dermal stapler, and in group 2, dermal closure was performed using absorbable dermal sutures.

**Operative technique**

All procedures were performed by two well-trained residents. In both groups, the superficial fascia was closed with polyglactin 1-0 sutures at 5-cm intervals. In group 1, one surgeon everted the abdominal skin using two vital forceps, while another surgeon positioned the INSORB dermal stapler within the dermal tissue layer. In group 2, two surgeons performed standard dermal sutures using absorbable polydioxanone 3-0 and 4-0 sutures from each side, with the dermal layer closed at 2- to 3-cm intervals. The Dermabond Prineo skin closure system (Ethicon) was applied in both groups. The length of the abdominal incision and the closure time were recorded intraoperatively.

**Postoperative assessment**

Patients were discharged on postoperative day 6 if no surgical complications occurred. Postoperative follow-up visits were scheduled at approximately 2 weeks, 1 month, 6 months, and 1 year. At least 248 days after the operation, clinical photos of each patient’s abdomen were taken by a single photographer.

**Scar assessment**

Assessment of the abdominal scars was conducted by three blinded attending plastic surgeons who evaluated the clinical photos using the Vancouver Scar Scale. This scale categorizes scars based on vascularity, pigmentation, pliability, and height, with rating scores recorded for each patient.

**Statistical analysis**

Data were analyzed using the chi-square or Wilcoxon signed-rank test. Comparisons resulting in a P-value of ≤ 0.05 were considered statistically significant.

**RESULTS**

A total of 108 patients who underwent DIEP-free flap reconstruction after mastectomy were included in this study, with 68 patients (group 1) undergoing dermal closure with the INSORB dermal stapler and 40 patients receiving conventional dermal sutures (group 2). In group 1, 23 patients without long-term data were excluded, and five patients were excluded for the same reason in group 2.

The patients’ demographic factors are summarized in Table 1. The mean patient age was $46.64 ± 8.19$ years in group 1 and $47.86 ± 9.23$ years in group 2. The mean body mass index (BMI) was $23.76 ± 3.04$ kg/m$^2$ in group 1 and $24.55 ± 3.80$ kg/m$^2$ in group 2. Three patients (6.7%) in group 1 and six patients in group 2 (17.1%) underwent delayed reconstruction. The mean flap weight was $702.39 ± 350.19$ g in group 1 and $772.85 ± 396.04$ g in group 2. There were no significant differences in age, BMI, flap weight, and follow-up period between the two groups.
The abdominal scars were assessed by three blinded attending residents using the Vancouver Scar Scale (Table 2). No significant differences were observed in any of the categories (vascularity, pigmentation, pliability, and height) or in the overall scar assessment between both groups.

The mean abdominal closure time was 38.33 ± 5.90 minutes in group 1 and 39.62 ± 5.46 minutes in group 2 (Table 3). Although there was no significant difference in abdominal length, the abdominal closure time and the ratio of closure time to abdominal length were significantly shorter in group 1.

Hypertrophic scar formation was noted in four patients in group 1 and five patients in group 2. Two patients and three patients in groups 1 and 2, respectively, complained of abdominal bulging. There was no significant difference in complication rates between the two groups (Table 4).

### DISCUSSION

The DIEP flap technique was popularized by Allen and Treece in 1994 [4]. This technique has become the gold standard for mastectomy reconstruction. However, the resulting scar at the donor site can be a concern for patients when making their decision. In practice, the primary focus of the main operator is often on microanastomosis and inserting the flap following the DIEP flap elevation. However, in some cases, less experienced surgeons may perform the donor site closure, and if working hastily, potentially overlook the quality of the wound. It is important to emphasize that donor site scar formation is a critical aspect of this surgical procedure.

Prior research has demonstrated the safety and effectiveness of absorbable dermal staples when compared to conventional dermal sutures. At 1 year postoperatively, Dutteille et al. [5] evaluated the scar quality of 95 patients from multiple centers who had undergone dermolipectomy or breast surgery. They found no significant difference between the two methods. The evaluation tool used in this study was a simple scale ranging from 0 to 10 points. Similarly, Chung et al. [6] compared the outcomes of 30 DIEP free flap reconstruction cases, evaluating them at 1 month, 3 months, and 6 months postoperatively using the modified Manchester Scar Scale, and reported superior results in some categories for the absorbable dermal stapler group. Nevertheless, while several studies have reported acceptable surgical outcomes after dermal stapler application, long-term results in larger patient populations are needed for further verification.

In this study, we conducted a comparative analysis of long-term results between the INSORB dermal stapler group and the conventional dermal suture group, based on clinical photos taken at least 6 months postoperatively (Figs. 1, 2). The results indicated no significant differences in Vancouver Scar Scale sub-criteria or overall scores between the two groups. Notably, the INSORB group demonstrated significantly reduced closure time and closure time relative to abdominal length, with P-values of 0.010 and 0.018, respectively (both ≤ 0.05). These findings align with the trends observed in previous studies.

The INSORB dermal stapler offers the advantage of dramatically reducing operative time, thereby lowering associated risks, while
still yielding acceptable long-term outcomes. Importantly, even surgeons with less experience can consistently achieve favorable results. However, in some cases, stitch mark scars resembling dots were observed in the INSORB group. This appearance may result from dermal staples being placed too deeply, preventing proper margin approximation, or if placed too superficially, they may lead to a characteristic scar shape. To mitigate the risk of unsatisfactory scar formation, a careful approach is necessary, with one surgeon ensuring adequate skin eversion using toothed forceps and the other surgeon precisely placing the dermal staple at the correct location.

This study had a few limitations. First, this was not a prospective study, as it employed a retrospective design. In addition, the outcome evaluations were based on clinical photos that might differ from the actual appearance of the scars. To minimize these differences, multiple photos from various angles, all captured by a single photographer, were utilized.

In conclusion, the INSORB is a valuable tool that can reduce operative time while consistently delivering satisfactory outcomes. Moreover, its application can contribute to the reduction of perioperative complications and alleviate the surgeon’s burden, particularly when employed with appropriate training.

NOTES

Conflict of interest
Jin Sup Eom is an editorial board member of the journal but was not involved in the peer reviewer selection, evaluation, or decision process of this article. No other potential conflicts of interest relevant to this article were reported.

Ethical approval
Ethical approval The study was exempted from approval by the Institutional Review Board of Asan Medical Center (approval number: 2024-0561).

Patient consent
The patients provided written informed consent for the publication and use of their images.

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