Novel Devices for Wound Closure in Interventional Radiology

Sidney Regalado, M.D.,^{1,2} and Brian Funaki, M.D.^{1,2}

ABSTRACT

Wound closure issues are not as common in the field of interventional radiology when compared with other surgical fields, such as plastic surgery or dermatology. A common exception to this rule involves the placement and removal of chest wall vascular ports. This article reviews newer wound closure devices such as skin adhesives and closure film.

KEYWORDS: Wound closure, Dermabond, Indermil, chest port, tissue adhesives

Objectives: Upon completion of this article, the reader should be familiar with common wound closure techniques used in the field of interventional radiology.

Accreditation: Tufts University School of Medicine (TUSM) is accredited by the Accreditation Council for Continuing Medical Education to provide continuing medical education for physicians.

Credit: TUSM designates this educational activity for a maximum of 1 *AMA PRA Category 1 Credit*TM. Physicians should only claim credit commensurate with the extent of their participation in the activity.

Wound closure issues are relatively rare in interventional radiology, and most procedures are performed through skin nicks routinely closed with a small bandage. An exception is the placement and removal of chest wall vascular ports. Interventional radiologists commonly place chest wall ports as a form of long-term vascular access, particularly for chemotherapy administration.¹ Chest wall ports are placed using strict sterile precautions, and wound closure is essential in this process.¹ When chest wall ports are removed after treatment is completed, the incision is closed in a similar sterile manner.

Many different forms of traditional wound closure have been available to the interventional radiologist including sutures, skin staples, and adhesive strips. The optimal method is controversial because many studies show no significant difference in terms of cosmetic

appearance or complication rates among various types of closure methods.²⁻⁸ Over the past few years, novel wound closure devices such as skin adhesives and newer versions of adhesive strips have been developed, and some studies suggest these are superior to traditional wound closure methods, such as suturing. For instance, many case reports have described less pain during placement and better cosmesis with closure strips when compared with traditional suturing.⁹

Currently, our section is comprised of seven interventional radiologists, and each physician closes incisions differently. All would agree that at least a two-layer closure is needed. The first layer is a deep subcutaneous layer of absorbable sutures that are placed to decrease the tension on the wound. A second layer of closure is performed that is usually a running subcuticular stitch with absorbable suture to appose the dermal

¹Section of Vascular and Interventional Radiology, University of Chicago Medical Center, Chicago, Illinois; ²Department of Radiology, Weiss Memorial Hospital, Chicago, Illinois.

Address for correspondence and reprint requests: Sidney Regalado, M.D., Section of Vascular and Interventional Radiology, University of Chicago Medical Center, 5840 S. Maryland Avenue, MC 2026, Chicago, IL 60637 (e-mail: sidreg3@yahoo.com).

New Tools and Techniques in Interventional Radiology; Guest Editor, Martin G. Radvany, M.D.

Semin Intervent Radiol 2008;25:58-64. Copyright © 2008 by Thieme Medical Publishers, Inc., 333 Seventh Avenue, New York, NY 10001, USA. Tel: +1(212) 584-4662.
DOI 10.1055/s-2008-1052307. ISSN 0739-9529.

layer. Others perform a hybrid technique, placing multiple interrupted vertical mattress sutures to decrease tension in the wound and appose the dermal layer. For some physicians in our group, these skin closure devices have completely replaced a running subcuticular stitch, serving as the sole second layer of closure for chest wall ports. A few physicians in the group apply these skin closure devices to reinforce the subcuticular row of sutures, serving as a third layer of closure.

Bypassing additional suturing has certain advantageous aspects in busy interventional radiology practices, including potentially decreasing the risk of infection, improving room turnover time, and minimizing the risk of needlestick injuries. This article briefly reviews two common topical skin adhesives and a new topical adhesive strip, which our group has integrated into our clinical practice.

SKIN ADHESIVES

Topical skin adhesives are in such widespread use that suturing the dermal layer may soon become obsolete. Skin glues have been described in the medical literature and applied to everything from traumatic lacerations to trocar port incisions to surgical incisions.⁷⁻⁹ In addition to the advantages described earlier, *in vitro* studies have shown that tissue adhesives seal out bacteria, which should theoretically decrease the risk of wound infection.^{10,11}

Applying topical skin adhesives is fairly straightforward, and the manufacturers recommend only a few guidelines. The adhesive glue is meant to close only the dermal layer, similar to the function of subcuticular sutures or simple running sutures. The topical skin adhesive should only be used on the dermal layer and not in deeper subcutaneous tissues because the material is not absorbed by the body and can elicit a foreign body reaction. The skin should be dried thoroughly before the product is applied. The wound should be clean and sterile as possible; the product should not be used over infected sites. Two commonly used topical skin adhesives are Dermabond Topical Skin Adhesive (Ethicon, Somerville, NJ) and Indermil (U.S. Surgical, Norwalk, CT).

Dermabond

Dermabond Topical Skin Adhesive is a monomeric formulation (2-octyl-cyanoacrylate). The product comes as a single-use packet with a crushable glass ampule within a plastic vial and an applicator tip (Fig. 1). The product has already been modified, and a high-viscosity formulation has already replaced the original low-viscosity formulation. The manufacturer recommends placing three layers with a 30-second waiting interval between each application to allow

time for the glue to dry. The skin is held in apposition for an additional 60 seconds after the final layer. Full apposition strength is achieved ~2.5 minutes after the final layer is placed, although the top adhesive layer may remain tacky for up to 5 minutes.¹⁰ The product is not considered fully polymerized until the glue is no longer tacky. The strength of the bond is reported to be analogous to skin that has been allowed to heal for 7 days.^{10,11} Dermabond sloughs on its own in 7 to 10 days.¹⁰

Indermil

Indermil is a skin adhesive composed of a monomer (n-butyl-2-cyanoacrylate) that remains as a liquid until it is exposed to water or water-containing substances and polymerizes. The product also comes in a single-use packet and is contained in a plastic vial with a cap (Fig. 2). After the Indermil is applied, the wound is held in apposition for 30 seconds to allow the adhesive to polymerize.¹² When Indermil is dried, the glue has the appearance of a hard clear scab. Indermil eventually sloughs off in 7 to 10 days.¹²

Although Dermabond and Indermil are similar in formulation, the latter has three specific advantages over the former. The major advantage is that only a single layer of glue is needed over the wound, and drying time is 30 seconds. Second, Indermil is dispensed in a plastic applicator ampule that can be recapped and redispensed later during the procedure. In contrast, once Dermabond is dispensed, the applicator tip hardens after a few minutes and additional adhesive cannot be dispensed.¹¹ Lastly, Indermil does not directly touch the wound when it is dispensed, whereas Dermabond must touch the wound as it is dispensed through its applicator, which could potentially disrupt the wound apposition when it is dispensed.

Discharge instructions are very important to prevent premature or accidental removal of the skin adhesive before the underlying tissue has healed sufficiently to maintain apposition. Patients are instructed not to bathe, shower, or swim for 48 hours. The wound should not be scrubbed or soaked in water for 7 to 10 days. The glue should not be picked at, and medications or lotions should not be applied on the glue because these products may break down the adhesive prematurely.¹⁰⁻¹² Anecdotally, a few patients have complained of significant pain and erythema when lotions have been applied on the topical skin glue, which has required premature removal of the adhesive.

The manufacturers have described a few contraindications to skin adhesives. Topical skin glues should not be used over potentially infected sites. The product should not be used across mucocutaneous junctions such as the lips and oral cavity or skin that is regularly exposed to body fluids. The product should not be used across

Figure 1 (A) Dermabond Topical Skin Adhesive is dispensed by a disposable ampule. (B) Open incision after vascular port is placed in subcutaneous pocket. (C) Subcutaneous layer is closed with deep absorbable sutures. (D) Wound edges are held gently in apposition while Dermabond is applied to close the dermal layer. Three layers are placed with 30 seconds between layers. Wound is held in approximation for an additional 60 seconds. (E) Appearance after application of topical adhesive.

Figure 2 Indermil topical adhesive. (A) Single-use ampule with cap on. (B) Single-use ampule with cap off. (C) Open wound after vascular port removal. (D) Appearance after closure with deep interrupted absorbable sutures and Indermil (arrow).

joints or to close wounds under high tension. The product should be used with extreme caution around the eyes. As a precautionary measure, if the glue is to be used near an eye, the patient should be positioned such that the glue drips away from the eye. The manufacturers also caution against heavy application of the product, which may lead to thermal damage of underlying tissues and thus to delayed healing.^{10–12}

Even though the skin glue dries fast, as described earlier, the most common technical error is placing a bandage over the glue before it has completely dried. During attempted removal of the bandage, the glue adhering to the wound can be removed accidentally. For a more comprehensive review of these products, we recommend reviewing the product information that is

available with the product or visiting the manufacturer's Web site.

CLOSURE FILM

The Steri-Strip brand of wound closure adhesive tape has on the market for many years. A newer version of the product, the 3M Steri-Strip S Skin Closure (3M Health Care, St. Paul, MN), provides quick skin closures with good cosmetic results (Fig. 3). Similar to the skin adhesives, the adhesive strips are intended to close the dermal layer. The manufacturer has described their use in a variety of applications, including the closure of lengthy skin incisions from sternotomy incisions. The strips are available in various sizes and composed of

Figure 3 3M Steri-Strip S Skin Closure. (A,B) Color coding and numeric system on both sides of closure film facilitate proper application. (C) Wound after vascular port has been removed and deep absorbable sutures have been placed. (D) Adhesive film is placed on both sides of incision. (E,F) Backing is removed and wound edges are apposed together. The design of the filament strips aid in dispersing wound tension. (G) Appearance of successfully closed wound.

interlaced adhesive filaments engineered to approximate the wound while dispersing skin tension.^{9,13} The adhesive film is marketed in a single-use packet and a variety of sizes. The strips are color coded and have a numbering system to aid in the proper sequence for applying the adhesive strips. Similar to skin adhesives, the product is suggested for use in low-tension skin lacerations or surgical incisions, as an adjunct to suture closures for wounds under higher tension, or to reinforce wounds after early suture removal.¹³ An obvious advantage to these closure devices is that they can be deployed very quickly and a wound can be closed in <1 minute, depending on the size of the original incision.

According to manufacturer recommendations, after 48 hours the patient may take brief showers but the wound site should not be soaked. The length of time that the adhesive strips remain in place varies, but a range of 7 to 14 days is common.¹³ Similar to the skin adhesives, this product should not be used on incisions under high tension or areas that undergo repetitive motion, such as joints, or overinfected wounds. One disadvantage that can lead to premature accidental removal is the closure film does not adhere over areas with excessive skin oils, moisture, exudates, or hair.¹³ A second disadvantage in terms of chest port insertion is that the film may interfere with port access if not positioned properly. We tend to use this product more commonly to close incisions after port removal rather than at the time of placement.

DISCUSSION

Skin adhesives and adhesive strips are desirable closure devices for the dermal layer because they are easy to apply, require minimal training, and result in a good cosmesis with low risk for wound dehiscence, infection, or both.^{2,8,9} Additionally, these new closure methods have further advantages that have motivated us to integrate their use into our daily practice.

In many academic hospitals, the placement of chest wall ports is a routine daily procedure, and most attending physicians can close the wound in ≤ 10 minutes. However, wound closure is the most time-consuming portion of the procedure for physicians in training, and the same incision may take a junior resident ≥ 45 minutes to close. Delayed wound closure increases the risk of infection, which can have significant morbidity.¹⁴ This delay also has an impact on section productivity and room turnover time. For instance, if five chest wall ports are placed and each one takes an extra 50 minutes to finish, > 4 hours of room time is lost per day. Anecdotally, the use of skin adhesives has definitely decreased procedure time and has helped expedite room turnover times in our institution. Additionally, the patients and physicians are not burdened with follow-up appointments to remove sutures.

The skin glue and adhesive strips have a definite safety advantage over traditional suturing, eliminating the risk of needlestick injury. In the United States, ~600,000 to 800,000 needlestick injuries occur per year, and suturing needles cause ~50% of them.^{2,15,16} By using these alternative closure devices, physicians decrease their risk of an occupational injury, which has not only an obvious medical and psychological impact but also is associated with dramatic health-care costs.^{2,15,16}

Probably the biggest downside to skin glue and adhesive strips is the added cost to the procedure. The tissue adhesives can be priced 2.5 to 5 times more than the cost of a pack of sutures.¹¹ Unfortunately, many departments run on tight budgets, and factors such as improved room turnover time and improved physician safety may not translate into a tangible financial savings for the institution. Thus, from a pure financial standpoint, a hospital administrator may not deem the added expense to be justifiable.

In conclusion, skin adhesives and adhesive closure strips offer many advantages when dealing with wound closure issues in interventional radiology. Anecdotally, in our experience with the products described here over the past few years, no significant change in terms of complication rates has been noticed. In the future, prospective studies showing the safety profile of these products may help validate their use throughout all interventional radiology departments.

REFERENCES

1. Funaki B. Chest port insertion. *Semin Intervent Radiol* 2005;22:242-244
2. Kuo F, Lee D, Rogers GS. Prospective, randomized, blinded study of a new wound closure film versus cutaneous suture for surgical wound closure. *Dermatol Surg* 2006;32:676-681
3. Karounis H, Gouin S, Eisman H, et al. A randomized, controlled trial comparing long-term cosmetic outcomes of traumatic pediatric lacerations repaired with absorbable plain gut versus nonabsorbable nylon sutures. *Acad Emerg Med* 2004;11:730-735
4. Selo-Ojeme DO, Lim KB. Randomised clinical trial of suture compared with adhesive strip for skin closure after HRT implant. *BJOG* 2002;109:1178-1180
5. Pedersen VM, Struckmann JR, Kjaergard HK, et al. Late cosmetic results of wound closure, strips versus suture. *Neth J Surg* 1987;39:149-150
6. Atkinson P. Tissue adhesive with adhesive strips for wound closure. *Emerg Med J* 2003;20:498
7. Farion KJ, Osmond MH, Hartling L, et al. Tissue adhesives for traumatic lacerations: a systematic review of randomized controlled trials. *Acad Emerg Med* 2003;10:110-118
8. Handschel JGK, Depprich RA, Dirksen D, et al. A prospective comparison of octyl-2-cyanoacrylate and suture in standardized facial wounds. *Int J Oral Maxillofac Surg* 2006;35:318-323
9. Zempsky WT, Parrotti D, Grem C, et al. Randomized controlled comparison of cosmetic outcomes of simple facial

- lacerations closed with Steri Strip Skin Closures or Dermabond tissue adhesive. *Pediatr Emerg Care* 2004;20:519-524
10. Dermabond Topical Skin Adhesive [product insert]. Somerville, NJ: Ethicon Inc; 2003
 11. Iqbal Y. What's new in wound closures. *Outpatient Surgery Magazine*; October 2002
 12. Indermil Tissue Adhesive [product insert]. Norwalk, CT: United States Surgical; 2006
 13. 3M Steri-Strip S Surgical Skin Closure [product insert]. MN: St. Paul, MN: 3M Health Care; 2006
 14. Funaki B. Subcutaneous chest port infection. *Semin Intervent Radiol* 2005;22:245-247
 15. Henry K, Campbell S. Needlestick/sharps injuries and HIV exposures among health care workers: national estimates based on survey of U.S. hospitals. *Minn Med* 1995;78:41-44
 16. Tokars JI, Bell DM, Culver DH. Percutaneous injuries during surgical procedures. *JAMA* 1992;267:2899-2904