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**A REVIEW ON WOUND CLOSURE MATERIALS USED FOR SURGICAL INCISION
CLOSURE**

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ABSTRACT

Aim

The aim of this study is to present the selection of wound closure materials (sutures, needles, staples, and skin tapes). The characteristics of commonly used suture materials and needles are discussed as a background for their rational selection and usage. The attributes of staples and sutureless skin closures (skin tapes) are also mentioned.

The goals of wound management are to avoid infection and also to achieve a functionally and aesthetically pleasing scar. The scope of this article is to review the various wound closure materials available.

Keywords: sutures, needles, staples, tapes, tissue adhesives, tissue healing, absorbable sutures, non-absorbable suture, surgical zipper

INTRODUCTION

Proper wound closure is a part of successful overall wound care after the assessment of patient and sustained wound, anaesthesia, debridement and irrigation of wound. Wound closure biomaterials and devices concern every surgeon. Every operation requires the use of biomaterials to close the wound for subsequent successful healing. The proper closure of wounds can influence the success of surgery. The wound closure biomaterials required, depend to some extent on the type of wound to be closed.

All the wound closure materials should retain adequate tensile strength during the critical period of healing. They should also induce minimal tissue reaction that might interfere with the healing process.

The complexity involved in wound healing calls for different types of wound closure materials. The choice of the biomaterials is based largely on the type of wound and surgeon's preference.

Ideally, a wound closure method should be cost-effective, time-efficient, easy to perform, and produce the optimal cosmetic result. The primary goals of treating wounds in general and the skin incisions in particular is rapid closure of the surgical wound with the creation of a functional and esthetic scar [1]. Although sutures are used frequently in

surgery, there are few reviews available in the literature that compare or review the attributes and qualities of sutures. Over the years, research on acute wound healing has resulted in the development of technologies such as staples and adhesives (e.g., glues and adhesive tapes) to allow surgeons to replace their tedious suturing techniques with simple, non-operator-dependent, safe, and rapid techniques, resulting in the optimal cosmetic appearance of the scar and avoiding infections by immediately sealing the wounds by using wide varieties of skin closure materials.

REVIEW OF LITERATURE

During the past 2 decades, alternative approaches have been described in the literature. Topical skin adhesives, including butylcyanoacrylate and octylcyanoacrylate, have been shown to be faster and less painful when used to close superficial facial lacerations [2-5]. In addition, adhesive strips also seem to have excellent cosmetic results in superficial lacerations [4, 6]. However, lacerations that are deeper, gaping, or occurring along lines of high tension still require sutures for repair. Plastic surgeons, ophthalmologists, otolaryngologists, and neurosurgeons have used absorbable sutures with good cosmetic results. La Bagnara [7] in

his review of absorbable suture materials used in head and neck surgery, noted that absorbable sutures are easy to handle, have low reactivity and excellent tensile strength, and costs less than the nonabsorbable sutures. Several other studies, involving mostly adult patients, have shown no significant differences with respect to wound appearance and infection rates between absorbable and nonabsorbable sutures [8-11].

Sutures

From time to time in surgical literature, there have been discussions of the ideal suture material. For skin repair, the ideal material should be inert in the tissue, induce no foreign body reaction, have a fine calibre and a smooth surface, and be strong and easy to handle. In addition, it should possess secure knotting characteristics and minimal trauma should result from its insertion. Furthermore, suturing material must have certain handling qualities to be effectively used [8]. Suture strength, infection risk, tissue-holding power, incision type and suturing technique are important factors for deciding the type of suture for wound closure [8]. Sutures or staples are used most commonly because they provide the needed mechanical support [8]. A wide choice of suture materials is available to surgeons today. The choice of suture for a particular procedure should be

based on the known physical and biological properties of the suture material, suturing technique and the healing properties of the sutured tissues. However, the availability of the suture material and the personal preference of the surgeon play important roles.

In general, braided sutures potentiate more infections than non-braided sutures. Contaminated wounds closed by a braided Vicryl™ suture resulted in a 100% wound infection rate. By contrast, contaminated wounds closed by non-braided sutures showed a significantly reduced incidence of wound infection [12]. Many surgeons prefer non-absorbable monofilament sutures for their easy gliding through tissue, easy handling, minimal inflammatory response and unlikeliness to break prematurely [13]. Other surgeons prefer absorbable sutures because there is no need for suture removal, and they save time and decrease patient anxiety and discomfort [13]. The main disadvantage of non-absorbable sutures is the need for their removal between 5 and 10 days after being placed.

Absorbable sutures are characterised by the loss of most of their tensile strength within 60 days after placement. They should be absorbed with little or no tissue reaction at a predictable rate appropriate for the duration

of the needed tissue support. They are used primarily as buried sutures to close the dermis and subcutaneous tissue and to reduce wound tension. Absorbable sutures traditionally have not been recommended for skin closure, primarily due to unsightly railroad track formation. The only natural absorbable suture available is surgical gut or catgut sutures. Synthetic multi-filamentous materials include polyglycolic acid (Dexon; Synture) and polyglactin 910 (Vicryl; Ethicon). Monofilamentous suture forms include polydioxanone (PDS; Ethicon), polytrimethylene carbonate (Maxon; Synture), poliglecaprone (Monocryl; Ethicon), glycomer 631 (Biosyn; Synture) and polyglytone 6211 (Caprosyn; Synture). Vicryl, a synthetic absorbable suture, is composed of a polymer of glycolide and lactide coated with a mixture of glycolide, lactide and calcium stearate [14]. There is a new formulation of Vicryl called VicrylRapide, which consists of smaller molecules of the same components as Vicryl [15]. VicrylRapide is produced by gamma irradiation of polyglactin 910, which degrades more rapidly than Vicryl [15]. Its tensile strength is reduced by 50% after 5 days, in comparison to Vicryl, which has a 35% reduction at 14 days; furthermore, there is no traction left after 14 days [15].

Vicryl Rapide is fully absorbed after 42 days, whereas Vicryl takes around 56-70 days [16]. Irradiated polyglactin 910 is advantageous for its low inflammatory properties and rapid degradation in 7-10 days, thus precluding the need for suture removal. The characteristics of irradiated polyglactin 910 make it ideal for full-thickness skin grafts. Linberg found an equal efficacy of Vicryl and nylon sutures in preventing wound dehiscence in an in vivo rat model of oculoplastic surgery [17].

Staplers

Skin staples are useful as a time-saving device for long incisions or to position a skin closure or flap temporarily before suturing. There are two types of staples — non-absorbable and absorbable. The nonabsorbable staple (Proximate®; Ethicon, Inc.) is made of stainless steel and has the highest tensile strength of any wound closure material. In addition, staples have a low tissue reactivity [18]. Staples come in a regular and wide size and are dispensed from lightweight cartridges [3]. Prior to stapling, it is useful to grasp the wound edges with forceps to evert the tissue so as to prevent inverted skin edge

Skin staples were compared with two conventional suture methods for speed, convenience, effectiveness and cost. The use

of staples was associated with significantly more pain compared with sutures [19].

Disposable mechanical skin staplers are a rapid and effective method for closing long skin incisions. There was reduction in the time for skin closure was observed with staple use for wound closure; however, more time is required for their removal post-operatively [20]. The Inisorb™ (Incisive Surgical, Inc., Plymouth, MN) dermal stapler is a U.S. Food and Drug Administration-approved device for wound closure. The absorbable subcuticular staples provides rapid, uniform and secure, interrupted subcuticular skin closure that improves the patient comfort. And also the wound appearance when compared to percutaneous metal skin staples that patients associated with increased and unnecessary trauma, discomfort, disquieting appearance, and inconvenient and sometimes painful metal staple removal [21].

Absorbable staples were designed as an alternative to sutures for closure of surgical wounds. These devices are U-shaped absorbable staples composed of a polylactic / polyglycolic copolymer, which maintains 40% of its strength at 14 days and is completely absorbed over a period of months (tissue half-life of 10 weeks) [22]. The device deploys U-shaped absorbable staples

into the dermal layer of tissue. A double-headed forceps is used in conjunction with the stapler to ensure proper positioning. In a study by Pineros-Fernandez and colleagues, the closure of contaminated wounds with Inisorb staples was found to be superior to closure with Vicryl sutures. The Inisorb staples also had a significantly lower incidence of infection [23]. These skin staplers are placed in the sub-cuticular tissue to hold the wound together without puncturing the epidermis and are designed to combine the cosmetic result of absorbable sutures with the rapid closure times in addition to eliminating the need for metal staple removal post-operatively.

Tellis studied the use of absorbable subcuticular staples in renal transplant incision, concluding that they are secure and effective and therefore preferable to metal staple closures even in renal transplant recipients receiving immunosuppressants [21].

Tissue adhesives

The glue 2-octylcyanoacrylate (Dermabond) is being increasingly used for traumatic lacerations [23]. The cyanoacrylates polymerize into long chains upon contact with blood, forming a solid film that bridges the wounds and holds the apposed wound edges together [26]. The skin of wounds also can be closed by tissue adhesives. They

should be applied only topically. Tissue adhesives cannot be used intra-orally and cannot replace deep suture. Modern tissue adhesives contain cyanoacrylates. more stable, has greater flexibility, and maintains a stronger bond. It degrades much more slowly, which leads to its classification as nontoxic. The wound edges are manually approximated with fingers or forceps while care is taken not to apply the adhesive between the edges. Interposing the glue into the wound results in greater scarring. The wound is held in position for 30 seconds to complete polymerization. The adhesive holds well on the face, and it usually stays on for 7 to 14 days then sloughs off with the epidermis.

Bozkurt and Saydam [25] found that cyanoacrylates provide a faster wound closure as compared with an interrupted suture closure; in fact, closure time duration with the adhesive glue was 15 times faster than the standard suture closure. A disadvantage of cyanoacrylate is the higher cost of the raw material as compared to standard sutures.

Adhesive tapes

Suture-less skin closure was first evaluated by Gillman [26]. Can be used to approximate wound edges after buried sutures are placed or with superficial wounds. They maintain

the integrity of the epidermis which results in less tension to the wound [18]. The advantages of tape include that they are fast, simple, inexpensive, comfortable, provide minimal reactivity, and there is no need for removal. Some surgeons favor replacement of cutaneous sutures with tape at postoperative day 3 to 6, as retention of sutures beyond a few days may lead to slower development of tensile strength than if sutures are removed earlier. Adhesive strips may also be used in conjunction with liquid adhesives. When placed over sutures at the end of a closure, adhesive strips may relieve tension at the wound edges, improve the aesthetics of the wound and reduce wound care. Disadvantages include that tape will not adhere to moist areas or to mobile areas under tension. In addition, tapes provide for less precise wound margin approximation, the least tensile strength of all wound closure devices, no moisture resistance, no antimicrobial properties and have the highest risk of dehiscence when used alone [24].

Surgical zipper

A new form of non-invasive skin closure system, the Medizip surgical zipper, was introduced to the field [27]. Rookler reported no significant differences in the cosmetic results or complications of the scar

in comparison with sutures [22]. The zipper could be a safe alternative to conventional suture material for skin closure [27]. The zipper is useless in high-tension or wet wounds, wounds with substantial curves of more than 20 degrees and in obese patients [27]. The advantages of using Medzip, is that it can be opened for wound inspection. In addition, this technique is comfortable for the patient, reduces the time for skin closure in the operating room and does not need removal, and therefore potentially enhancing the cosmetic outcome. This method is very useful in paediatric patients and adults affected by neoplastic disease

Roolker and co-authors concluded that Medzip presents a safe option for surgical wound treatment as a non-invasive skin-closure system [22].

CONCLUSION

Depending on the length of the incision closure, the surgeon can choose either staples, sutures, adhesive tapes, tissue adhesives or surgical zipper.

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