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Evaluation of Soft Tissue in Rabbit Utilizing Suture and Tissue Glue

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Abstract

In this work, we sought to determine the efficacy of tissue glue and sutures in soft tissue incisions in rabbits. The comparison of tissue glue and suture for closure of excisional wounds in rabbits showed that the quality of wound healing of cutaneous excisional wounds closed with standard suturing was superior to that of wounds closed with tissue glue.

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Introduction

Sutures have been the backbone of surgical treatment over the past few decades [1]. Fibers or strands called sutures are used to join tissues or blood vessels [2]. In addition to sutures, many additional materials such as clips, staples, and microporous surgical tapes were also employed in surgical procedures. Few sutures are absorbed by the body after performing their intended function, these treatments are simple to do, have a high tensile strength, and have no possibility for allergies or cancer [3]. Notwithstanding these benefits, this process is extremely time consuming, and there is a higher risk of infection during its removal as well as leaks, tissue scarring, and wound separation [4].

Suture-less approaches must therefore be developed to meet the requirement for less invasive, quicker, and simpler surgical procedures [5].

Trends shift, and the art of dressing wounds has undergone a revolution in the twenty-first century thanks to advancements in synthetic polymer technology that produced tissue glue [6].

Adhesives for tissues

Surgical glues are a type of biomaterial that closes wounds or tissues by adhering to them after application. Additionally, they aid in the postoperative sealing of air or gas leaks through an incision and the adherence of medical devices to tissues [7,8]. Tissue glues offer a wonderful opportunity to enhance traditional methods of wound closure. Unlike sutures, they can stop fluid or air leakage and allow almost instant hemostasis [9].

Requirement of Tissue Glues

These adhesives must be quick to prepare, easy to handle, cure rapidly, spread appropriately due to a well-adjusted viscosity, have sufficient bonding strength in wet environments and have a modulus-like tissue. Ideally, the material should allow design flexibility for different indications, be cost-effective, cause minimal to no tissue damage, allow wound healing and primarily be biocompatible and biodegradable [10,11].

Bioadhesion Principles

The foundation of surgical adhesives is the concept of bioadhesion, which is the capacity to attach to biological materials and remain on the biological substrate for a predetermined amount of time [12]. Chemical and physiological interactions form the foundation of the adhesion mechanism. Because of the interaction of the various functional groups contained in adhesives, a chemical bond—either ionic or chemical—is formed between the surfaces of adhesives and biological substrates. Chemical contact involves three primary steps: the polymer is soaked and swells; the polymer chain diffuses into the mucosal membrane; and last, chemical bonds are formed between the entangled chains. Conversely, physiological contact entails adhesion via physiologically connected mechanisms such as the blood clotting process [13].

Advantages

Tissue glues are commonly used in the setting of traumatic lacerations. Their benefits

in this environment include reduced application time and reduced pain compared with standard wound-closure methods [9]. Patients also avoid the need to return for removal of stitches or skin clips. This can be especially useful in pediatric patients, who might find the application of tissue glue more acceptable than standard methods. However, cosmetic improvement [14].

Categorization Basis of Their Work

Hemostats are glues that clot blood and do not work in the absence of blood. A sealant creates a layer of defense to stop fluid or gas leaks.

The purpose of an adhesive is to securely join and maintain two surfaces. While hemostats work well in the presence of blood, adhesives and sealants don't always work well in damp environments [14,15].

Basis of Their Origin

1. Biologic such as fibrin glues and animal derived hemostatic agents.
2. Synthetic such as cyanoacrylate and noncyanoacrylate products, such as polymeric sealant.
3. Genetically engineered polymeric proteins.

Fibrin glues are widely used biologic tissue adhesive in surgical practice do not provide significant tensile and adhesive strength and require to be applied on dry substrates.

Cyanoacrylates are a class of synthetic glues that rapidly solidify upon contact with weak bases, such as water or blood compared with other tissue adhesives are easier to use, have quicker polymerization [16] and guarantee higher bonding strength.

Glubran2 (GEM s.r.l., Viareggio, Italy), a tissue adhesive with high adhesive and haemostatic properties, is a class III (f0r internal and external surgical use). Furthermore, it is diffusely applied on skin, eliminating the need for suture removal and providing good cosmertic results [17].

Sutures

Surgical sutures are one type of long-established and necessary medical device, and they play a pivotal role in closing damaged tissues and organs and assisting wound healing postoperatively. Although some products, like biomedical glues [18], adhesives, and nails, have been developed as alternatives to sutures, it is undisputed that there are still no perfect and fully-fledged alternatives to surgical sutures, due to their high stability, feasibility, and applicability.

Material Selection for Suture Fabrication

Materials originating from both natural and synthetic sources have been employed for the design and fabrication of surgical sutures [19]. Based on the absorbability of the material, the surgical sutures are further divided into absorbable and non-absorbable types. In general, natural suture materials possess poor tensile strength and unstable performances [20], while synthetic suture materials perform better in this regard, and their degradation properties can be controlled by adjusting the material structures and properties [21].

Natural Absorbable Suture Materials

Surgical Catgut

Surgical catgut was officially utilized as natural absorbable suture material in the 19th century and was commonly divided into plain surgical catgut and chromic surgical catgut. Since it contains collagen as the main component, surgical catgut could be absorbed in vivo. For instance, the strength of plain surgical catgut could be maintained for at least 7 days and degraded completely after 90 days [22].

Collagen

A collagen suture is mainly composed of Type I collagen, which is a fibrous protein with a rod-like helix structure. It has strong physical and mechanical properties and possesses the ability to bind and aggregate with platelets for the formation of a thrombus. Collagen sutures are biocompatible and absorptive, effectively promoting hemostasis and wound healing and relieving postoperative pain [23].

Chitin and Chitosan

Chitin is an environmentally friendly polymer derived from the cell walls of crustacean or fungal cells and is biologically inert and can effectively inhibit postoperative complications or tissue reactions. Generally, chitin fibers can be generated through dry or wet spinning [24].

Synthetic Absorbable Suture

It includes:

1- Polyglycolic acid
2- Polylactic acid
3- Poly-lactic-co-glycolic acid
4- Poly(p-dioxanone)

Natural Non-Absorbable Suture

It includes:

1- Silk
2- Cellulose

Synthetic Non-Absorbable Suture

It includes:

1- Polyamide
2- Polypropylene
3- Polyethylene terephthalate

Healing and Repair of injured Tissues

Healing and repair of injured tissues follows several steps in the healthy individual. Following birth, the process is initiated by the inflammatory response and subsequent steps are based on this initial response [25]. Whereas wound healing generally leads to a repair of the injured site, it does not lead to tissue regeneration. This difference between repair and regeneration has influence on tissues such as ligaments and tendons that function in a mechanically active environment. Thus, the dynamic interface between mechanics and biology influences the effectiveness of the healing response. The biology of the host is also influenced by a variety of factors including age, gender, genetics, and tissue history, factors that impact the outcome of the healing response [26].

Defined Steps in the Repair or Healing of a Tissue According to Following Overt Injury [27]

(1) **Hemostasis and a rapid inflammatory phase**. Acutely following overt injury in an otherwise healthy adult, there is usually pain and bleeding into the area of injury that may be variable depending on the site of injury.

(2) **The matrix deposition phase**. Following consolidation of the fibrin clot and the temporally regulated influx, proliferation and activation of a subset of cells' deposition of matrix molecules designed to bridge the damaged area with the residual endogenous ligament tissue begins.

(3) The remodeling phase. The remodeling phase is a slow process and is accompanied by alterations not only in matrix remodeling, but also gene expression, cellularity,

vascularity and innervation [27].

Factors that Influence on Soft Healing Process [28]

Age

It is obvious from everyday life and research that wounds incurred at an early age appear to heal rapidly and without residual scar. Because humans age, the same process following a similar injury leads to obvious scars.

Gender and Hormones

It is known in a variety of species that there is a sexual dimorphism in many responses. Females tend to have a more vigorous inflammatory response than males and as the inflammatory response to injury is a central initial step in the healing process, this is a consistent pattern of observation. It is also known that healing responses in post-menopausal women decline separate from the decline associated with aging. Application of estrogen can reverse some of these deficiencies and it is believed to work at the level of macrophages. Macrophages are inflammatory cells that can mediate multiple functions in a wound site, including serving as an important source of growth factors and mediators key for effective wound healing.

Genetics

Genetic factors play a role in some pathologic scarring or wound healing such as keloid formation. However, there is a paucity of information regarding a definitive role for genetic factors in subtle or not so subtle variations in "normal" healing. Whereas keloid formation is more common in some races than others there is no identifiable link between race and wound healing in other tissues [28].

Materials and Methods

Ten sisteen weeks mature, white rabbits were used for this study with a healthy appearance and weight ranging from 1500 to 2500 g. The study was approved by the Tikrit University College of Veterinary Medicine Laboratory Animal Care. All care and surgery were performed in the WSU Laboratory Animal Resources Center under the supervision of doctor Ahmed Khalid. All rabbits were observed for 4 days before surgery to verify that they were healthy. The animals were anesthetized with an intramuscular combination of 5 mg/kg xylazine and 35 mg/kg ketamine Envelope skin flabs 2cm long were performed on shaved right and left legs. One of incision closed with interrupted 0/3 silk sutures and another one closed with fibrin glue. On postoperative day 7, wound closure was scored and evaluated clinically. Parameters for clinical assessment of wound healing were summarized in table 1 of numbers was used to evaluate the healing process from (0_10) when 10 score mean complete healing of flab and every 1mm of wound length failure to healing and complete closure will reduce 1 score from evaluation (Figure 1). Data were analyzed using the SPSS program, using the Paired T-test.

Results

Based on clinical examinations all flaps which closed by suture shows complete healing without complications while using fibrin glue to close skin incision showed unsatisfactory results and incomplete closing of flaps.

Discussion

Suturing has been the most widely used method for wound closure because of high reliability of suture materials. However, alternative techniques have long been sought, since suturing technique requires skill and experience, a relatively longer time and the need for its removal. Due to these reasons, surgeons are increasingly using tissue adhesives over sutures for wound closure.

Although most facial wounds heal without complications, owing to the abundant blood supply of the region, mismanagement may result in infection, wound dehiscence, and unsightly and dysfunctional scar [29].

Tissue glue have several advantages over conventional sutures like their fast and painless application, rapid setting, which reduces the total operating time and their antibacterial properties. Tissue glue itself acts as a waterproof dressing and helps in reduction in the number of follow-up visits. As they do not require any needles, accidental needle stick injuries are prevented. However, there are certain disadvantages of tissue glue like their less tensile strength and chances of adhesive seepage, if edges are not properly approximated [30].

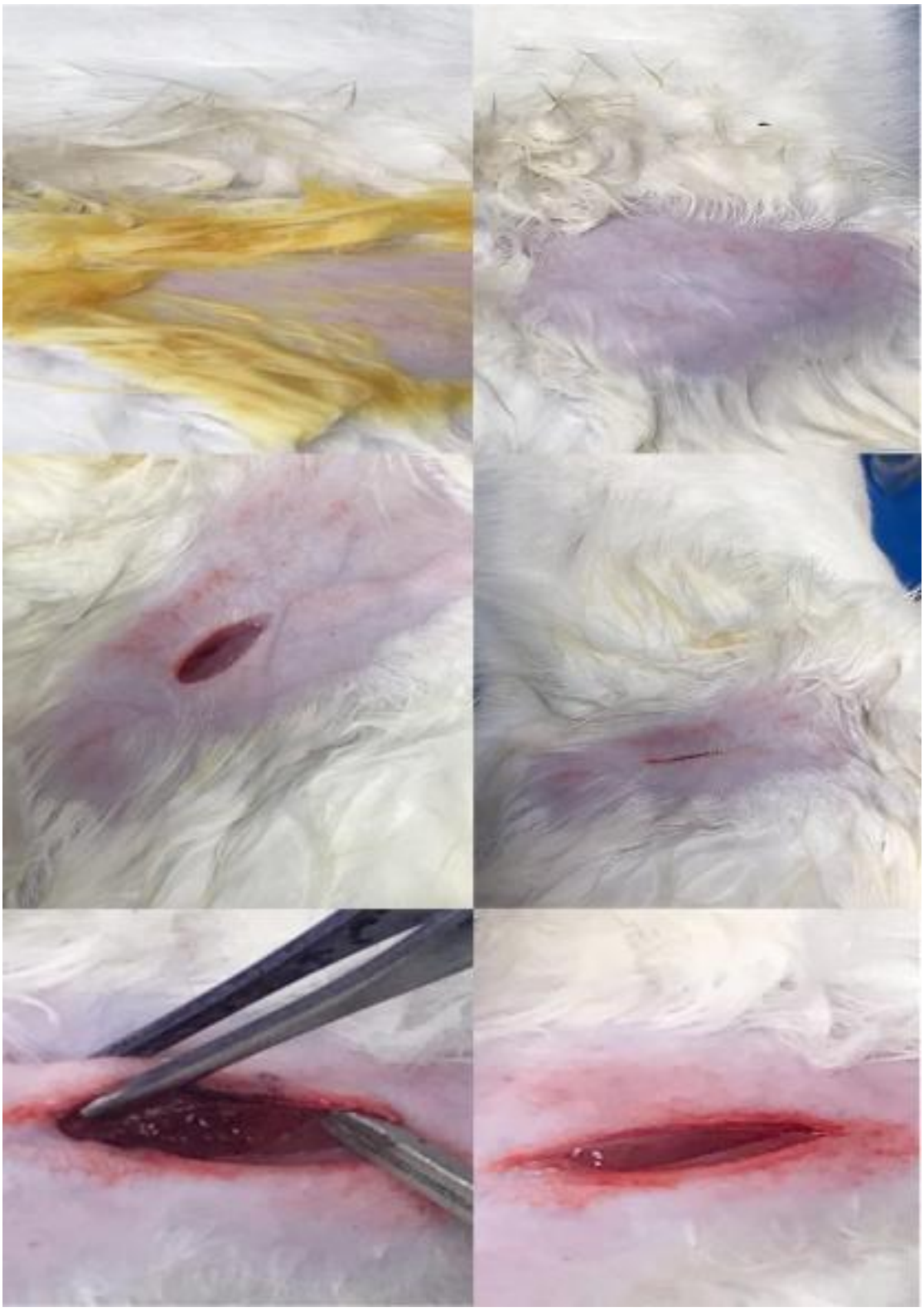
Conclusion

The comparison between tissue glue and suture for the closure of excisional wounds in rabbits found that the quality of wounds healing of cutaneous excisional wounds closed with standard suturing was found superior to that of wounds closed with tissue glue.

References

1. [B.J. Tighe et al. Adhesives and interfacial phenomena in wound healing Adv. Wound Repair Ther. (2011).
2. N. Annabi et al. Elastic sealants for surgical applications Eur. J. Pharm. Biopharm. (2015).
3. N. Annabi et al. Surgical materials: current challenges and nano-enabled solutions Nano Today (2014).
4. M. Kazemzadeh-Narbat et al. Surgical sealants and high strength adhesives Mater. Today (2015).
5. S.R. Mobley et al. Surgical tissue adhesives Facial Plast. Surg. Clin (2002).
6. J. Armitage et al. Skin incisions and wound closure Surgery (2011).
7. Kamil, Saif Saad; Khaudhair, Aseel Taha; Hamid, Hind Thyab. Association of Dental Caries with Different ABO Blood Groups. Dentistry 3000, 2024, 12.1.
8. Y. Okamoto et al. Effects of chitin and chitosan on blood coagulation Carbohydr. Polym. (2003).
9. Scognamiglio, F.; Travan, A.; Rustighi, I.; Tarchi, P.; Palmisano, S.; Marsich, E.; Borgogna, M.; Donati, I.; de Manzini, N.; Paoletti, S. Adhesive and sealant interfaces for general surgery applications. J. Biomed. Mater. Res. B. Appl. Biomater. 2016, 104, 626-639.
10. Bhagat, V.; Becker, M.L. Degradable Adhesives for Surgery and Tissue Engineering. Biomacromolecules 2017, 18, 3009-3039.
11. Taboada, G.M.; Yang, K.; Pereira, M.J.N.; Liu, S.S.; Hu, Y.; Karp, J.M.; Artzi, N.; Lee, Y. Overcoming the translational barriers of tissue adhesives. Nat. Rev. Mater. 2020, 5, 310-329.
12. M. Kazemzadeh-Narbat et al. Surgical sealants and high strength adhesives Mater. Today (2015).
13. A. Assmann. A highly adhesive and naturally derived sealant Biomaterials (2017).
14. A.J. Singer et al. Closure of lacerations and incisions with octylcyanoacrylate: a multicenter randomized controlled trial Surgery (2002).
15. B. Petersen et al. Technology status evaluation report: Tissue adhesives and fibrin glues Gastrointest Endosc (2004).
16. J.M.G. Paez et al. Comparative study of the mechanical behavior of a cyanoacrylate and a bioadhesive J Mater Sci Mater Med (2004).
17. D.H. Sierra et al. Failure characteristics of multiple-component fibrin-based adhesives J Biomed Mater Res (2002).
18. C. Ma, J. Sun, B. Li, Y. Feng, Y. Sun, L. Xiang, B. Wu, L. Xiao, B. Liu, V.S. Petrovskii, B. Liu, J. Zhang, Z. Wang, H. Li, L. Zhang, J. Li, F. Wang, R. Goestl, I.I. Potemkin, D. Chen, H. Zeng, H. Zhang, K. Liu, A. Herrmann Ultra-strong bio-glue from genetically engineered polypeptides Nat. 12 (1) (2021), p. 3613 .
19. Ahmed, Ali Saad, et al. Influence of Some Plant Extracts on Antifungal Properties, Hardness, and Peel Bond Strength of Heat-Cured Denture Soft Liner. Diyala Journal of Medicine, 2024, 26.2: 14-28.
20. R.H.H. Tan, R.J.W. Bell, B.A. Dowling, A.J. Dart. Suture materials: composition and applications in veterinary wound repair. Aust. Vet. J., 81 (3)

(2003), pp. 140-145.
21. E.J. Lee, B.K. Huh, S.N. Kim, J.Y. Lee, C.G. Park, A.G. Mikos, Y. Bin Choy. Application of materials as medical devices with localized drug delivery capabilities for enhanced wound repair. Prog. Mater. Sci., 89 (2017), pp. 392-410.
22. H. Kim, K. Hwang, S.M. Yun. Catgut and its use in plastic surgery. J. Craniofac. Surg., 31 (3) (2020), pp. 876-878.
23. Ahmed, Ali Saad; Ahmed, Rusal Saad; ARAB, Luma Nasrat. The antifungal potential of cinnamon oil incorporated into a heat-polymerized soft liner. Journal of Dental Materials & Techniques, 2024, 13.3.
24. J.L. Sharnshina, P. Berton, R.D. Rogers. Advances in functional chitin materials: a review. ACS Sustain. Chem. Eng., 7 (7) (2019), pp. 6444-6457.
25. Witte MB, Brabul A. General principles of wound healing. Surg Clin North Am. 1997;77:509-528 .
26. Diegelmann RF, Evans MC. Wound healing: an overview of acute, fibrotic and delayed healing. Front Biosci. 2004;9:283-289.
27. Kareen, Ahmed Abdul, et al. The influence of antibiotics administration subsequent to dental extraction. *Universal Publication Index e-Library*, 2024, 72-85.
28. Hildebrand, K.A. et al. "The basics of soft tissue healing and general factors that influence such healing," Sports Medicine and Arthroscopy (2005).
29. Shivamurthy DM, Singh S, Reddy S. Comparison of octyl-2-cyanoacrylate and conventional sutures in facial skin closure Natl J Maxillofac Surg. 2010;1:15-9.
30. Bernard L, Doyle J, Friedlander SF, Eichenfield LF, Gibbs NF, Cunningham BB. A prospective comparison of octyl cyanoacrylate tissue adhesive (dermabond) and suture for the closure of excisional wounds in children and adolescents Arch Dermatol. 2001;137:1177-80.



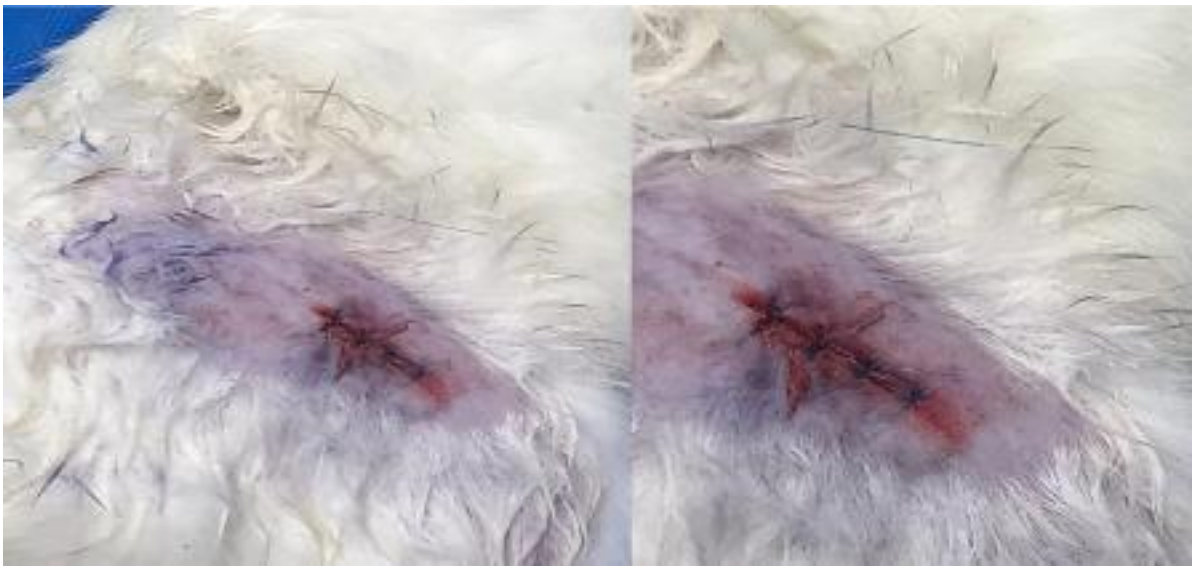


Figure 1. Representative example of the surgical intervention.