

Wound closure technique

Arifiana Wungu Kartika Dewi, Bagus Haryo Kusumaputra, M. Yulianto Listiawan, Maylita Sari, Irmadita Citrashanty

Department of Dermatology and Venereology, Faculty of Medicine, Universitas Airlangga/ Dr. Soetomo General Academic Hospital, Surabaya, Indonesia.

Abstract

Skin, which is the biggest organ in the human body, is vital to many aspects of our lives. Significant skin damage, such as a wound, can undoubtedly affect the skin's ability to protect the body and, in some cases, even endanger life. Understanding the importance of effective wound treatment is very important. The main goal of successful wound care is rapid wound healing with excellent functional and cosmetic results. A suture is any material thread that connects tissues or binds blood vessels together. In clinical settings, sutures of varying types, such as simple interrupted, vertical mattress, horizontal mattress, and sub-cuticular, are widely employed. When applying stainless steel staples, using staples is an excellent alternative to suture closure. The use of adhesive or sticky glue to seal the skin, close the margins of laceration wounds, or as an addition to various surgical operations are all examples of adhesive treatments. Each method has advantages and pitfalls of its own. There is no significant difference between the three wound closure procedures in terms of cosmetic concerns, potential secondary infections, discomfort, expenses, or time necessary for the wound closure process.

Key words

Wound closure; Suture; Stapler; Adhesive tapes.

Introduction

Skin is the largest organ in the human body and plays various important roles in life processes. There are five main functions of the skin in our body, including as protection, thermoregulation, serve to sense because it contains various nerve receptors that are sensitive to stimuli such as pain, temperature, pressure, and touch, plays a role in the body's metabolic processes and has an aesthetic function where the appearance of scar tissue on the skin can affect a person's self-confidence in relationships.^{1,2}

Severe skin damage such as injury can certainly

interfere with the protective function of the skin and in certain conditions can be life-threatening. Wound is a disruption of tissue continuity due to tissue damage. Wounds have a fairly large morbidity rate worldwide and are divided into acute wounds, that is heal within 8-12 weeks and chronic wounds with a healing time of more than 12 weeks.³⁻⁵

A fall, a car accident, a sharp impact injury, or a surgical procedure can all result in injuries. According to statistics from the Ministry of Health of the Republic of Indonesia, injuries or illnesses reached up to 8.2% of the population in 2013. The highest injury prevalence was in South Sulawesi (12.8%), while the lowest was in Jambi (4.5%). Abrasions, which are prevalent in the Indonesian population at 70.9%, and lacerations, which are prevalent at up to 23.2%, are the two most prevalent types of wounds.³

A wound healing process is the body's

Address for correspondence

Dr. Bagus Haryo Kusumaputra
Department of Dermatology and Venereology,
Faculty of Medicine, Universitas Airlangga/
Dr. Soetomo General Academic Hospital,
Surabaya, Indonesia.
Ph: +6281217277414
Email: bagushkputra@yahoo.com

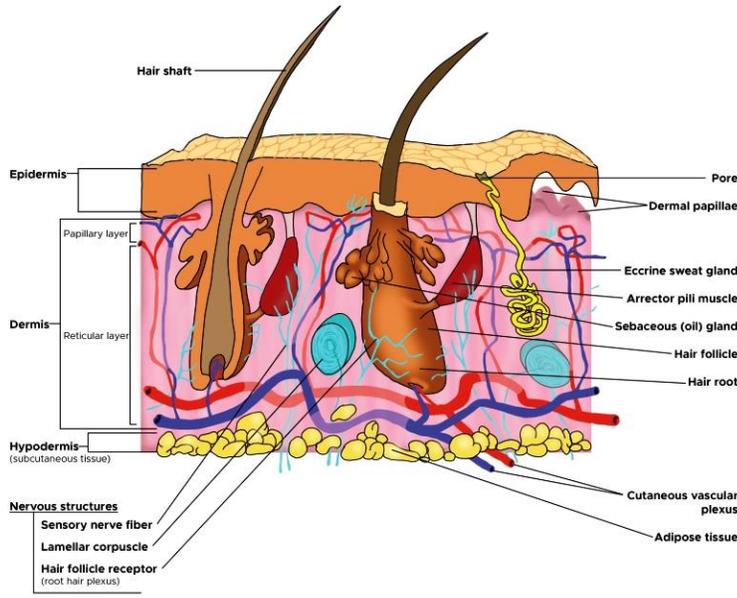


Figure 1 Skin anatomy.[8]

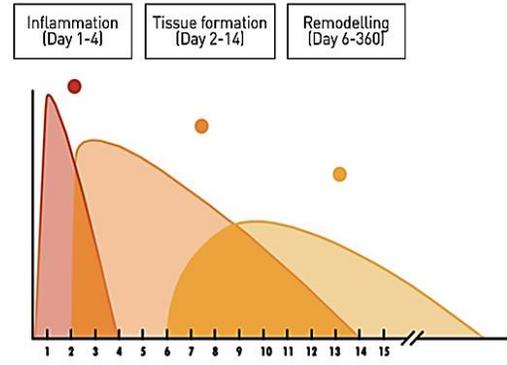


Figure 2 An illustration of the stages of wound healing.[10]

physiological reaction to injuries. The restoration of tissue integrity during the wound healing process involves a number of intricate mechanisms involving different cell types, cytokines, mediators, and the vascular system.⁶ This is the essential foundation for comprehending the significance of effective wound care. The major objective of effective wound care is to achieve rapid healing with the best possible functional and cosmetic outcomes. The best environment for wound healing can be created while avoiding infection and additional damage. This review specifically discusses wound closure techniques as a kind of wound treatment.

Skin anatomy and physiology

The epidermis and dermis are the two primary layers of the skin. The ectoderm, which is primarily made up of keratinocytes, is the source of the epidermis, an epithelial tissue. The basement membrane, a slender, multi-layered structure that connects the epidermis to the dermis, is the epidermis' lowest layer. The dermis, a layer of relatively dense connective

tissue produced from the mesoderm, is followed by subcutaneous tissue, a layer of loose connective tissue that, in some areas, is primarily made up of adipose tissue.^{3,7}

Wound healing process

There are three stages to the wound healing process: the inflammatory stage, the proliferative stage, and the maturation or remodeling stage. Eicosanoids, such as prostaglandins, prostacyclin, thromboxane, leukotrienes, and lipoxins, as well as cytokines like chemokines, lymphokines, interleukins, interferons, tumor necrosis factor, nitric oxide, and growth factors are among the inflammatory mediators involved in wound healing. The inflammatory phase, which lasts from the first day until the fifth day, begins with a process of blood vessel hemostasis in the form of platelet aggregation and the formation of a fibrin mesh to stop the bleeding. This is followed by a process of vasoconstriction from the blood vessel. Angiogenesis starts when new capillaries are formed by the endothelial cells of the blood arteries surrounding the wound.^{3,9}

The granulation tissue, which is made up of a network of new capillaries, fibroblasts, and macrophages, forms at the base of the wound during the proliferative phase, giving the wound a fresh, glossy appearance and a bright red appearance. Fibroblasts will multiply and produce collagen, which might join the margins of the wound. For up to three weeks, the proliferative phase can last. Before normal tissue begins to form, the maturation or remodeling period might last anywhere between a few weeks and two years. In this stage, the inflammation-related symptoms have vanished, fresh collagen has produced, and a far more robust tissue has emerged. Collagen synthesis and scar contraction are the key features of this maturation or remodeling stage. Scar tissue can form at the end of the wound healing process.^{3,9}

The Centers for Disease Control and Prevention (CDC) classifies wounds into four categories based on the degree of contamination: clean wounds, clean contaminated wounds, contaminated wounds, and wounds that only affect the epidermis. Based on the cause, wounds can be divided into three types: erosion wounds, abrasion wounds, and excoriation

wounds that only affect the epidermis, contusion wounds, and lacerations, which can be divided into incision, tension laceration, and crush laceration or compression laceration.^{11,12}

Based on the rate and pattern of healing, wounds are divided into three categories depending on the type of tissue involved and the process of wound closure. These categories include primary intention, secondary intention and tertiary intention.^{13,14}

Wound closure technique

Stitching technique

A suture can be defined as any strand of material used to bind blood vessels or bring tissue together. The technique of closing wounds with sutures has been used since 2000 BC (BC) by the Egyptians and Syrians. For centuries, a wide variety of materials including silk, linen, cotton, horsehair, veins, animal intestines, and wire made of precious metals have been used in surgical procedures. A good dermatologist has knowledge of basic suture technique, thread size and needle size to produce a good wound healing process in minimum time.^{13,16}

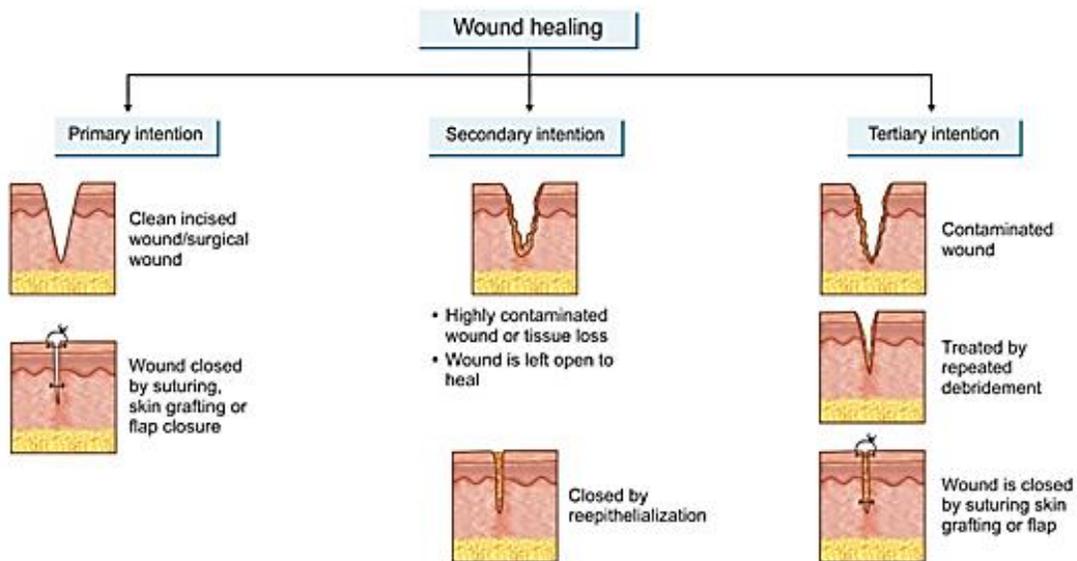


Figure 3 The description the type of wound healing.[15]

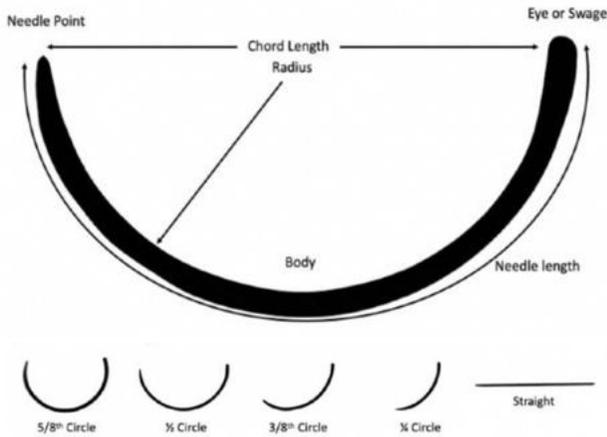


Figure 4 Anatomy and various needle curves.[17]

The needle consists of three main parts, namely the eye, body, and point. The eye of the needle is where the stitch attaches to the needle and this can become the actual eye of the needle, where the thread can pass through and be threaded onto the needle. The needle body is the most substantial part of the needle and connects the eye to the point and determines the shape of the needle. The needle body can be straight or curved. Needle circumferences can be of different lengths, with the most commonly used needle curves being 1/4, 1/2, 3/8, or 1/3 circle. The curve of the needle body is very important in helping the surgeon know where the needle tip is. Most cases use a 3/8 needle.¹⁷

Several types of sutures are widely used in daily

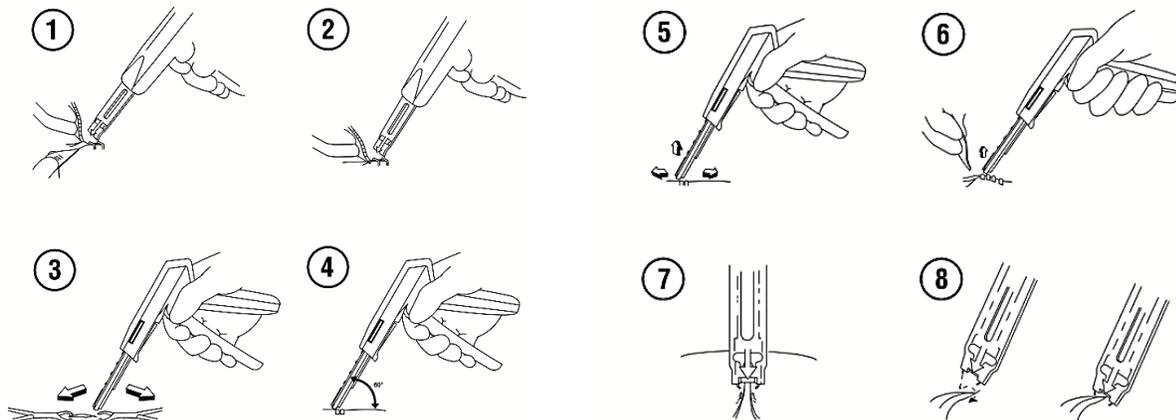


Figure 5 Overview of the tool A. Skin stapler and the stages of attaching a stapler to the skin (1,2,3,4,5,6,7,8).[13]

practice, including simple interrupted, vertical mattress, horizontal mattress and sub-cuticular.¹⁸

Stapler technique

Closing the wound using the staple technique is a good alternative for suture closure, especially for staples made of stainless steel. One of the advantages of surgical wound closure using staples is related to the low level of tissue reactivity resulting in higher resistance to infection in contaminated wounds and can reduce the local inflammatory response. Wound closure using staples has been reported to have good cosmetic results and has a better fixation rate, although in some RCTs it was reported that there was no difference between the use of the suture method and the use of staples in the rate of wound infection.^{13,19,20}

Staple closure is indicated for scalp lacerations that do not require extensive hemostasis and do not involve a tear in the area of the fronto-occipital aponeurosis (galea). Staples are also indicated for non-facial linear lacerations caused by shearing forces for example lacerations caused by sharp objects. Wound closure using staples consists of non-absorbable and absorbable. The non-absorbable staples are made of stainless steel. This type of staple is available in two sizes, namely the regular size and the wide size.^{13,21}

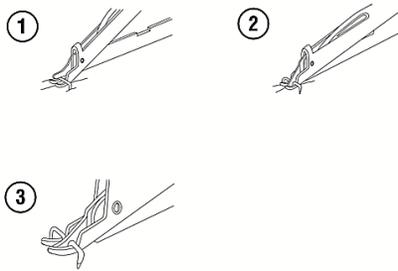


Figure 6 Overview A. Skin stapler extractor and stages of taking staples on the skin (1,2,3).[13]



Figure 7 Wound closure technique using adhesive glue on the forehead area.[22]

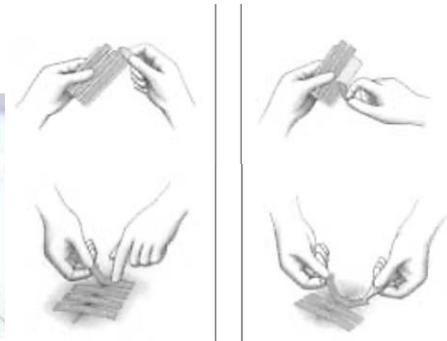


Figure 8 Adhesive technique. (adhesive) with steps A. Remove tapes using sterile technique, B. Remove tapes as needed, C. Apply tapes at 1/8-inch intervals as needed and make sure the skin around the wound is dry before applying tapes, D. When healing occurs, remove the tapes from the outside to the edge of the wound and gently lift the tapes off the wound.[13]

Table 1 Advantages and disadvantages of using adhesive tape for skin wound closure.[13]

| <i>Advantage</i> | <i>Disadvantage</i> |
|---|---------------------------------------|
| Quick and simple closing | Relatively poor patient compliance |
| Causes minimal local inflammatory process | Easy to release by patient |
| No risk of needle stick injury for healthcare workers | Must keep dry |
| Does not cause ischemia and tissue necrosis | Cannot be used on oily or hairy areas |

Metal staples provide faster closure when compared to wound closure using the suture technique. Metal staples also provide excellent wound edge eversion without tissue strangulation and produce minimal cross-scarring. Staples have satisfactory results for skin wound closure in a variety of circumstances and are very useful in the fixation of skin grafts and have slightly superior cosmetic results when used to close scalp wounds. Contaminated wounds that are closed with staples have a lower incidence of infection when compared to sutures. There are extractors specifically designed to remove staples, although staple removal can also be done using a hemostat.^{13,21}

Skin staples can be removed for the same duration as suture removal in the skin based on their location. In the wound area on the scalp, the staples can be removed on the 7th day after insertion. In injured areas of the body and extremities, staples can be removed with a

duration of between 7 to 14 days. Stapling wounds can be treated with topical antibiotic ointment and the patient is advised to take a shower the next day after the stapler is placed. If staples are applied to the scalp area, the patient is advised to be careful when combing the hair. There is a disposable stapler that is specially designed for one hand and is provided by a healthcare provider.¹³

Adhesive compound technique

Adhesive techniques can use adhesive tape or adhesive glue to close the edges of the laceration, seal the skin, and can be used as an aid in certain surgical procedures. Adhesive compounds are often associated with minimal tissue reactivity and have a low infection rate but tend to be released when there is excessive tension or moisture. One of the advantages of adhesive compounds, among others, is that it is fast and easy to use, the patient tends to be more

comfortable, requires low costs and benefits for the operator, among others, there is no risk of injury because of needle sticks during wound closure procedures. Closure of seams with adhesive compounds can be left for a long time without causing scars.¹³

Tissue adhesive glue has been used in surgery since the 1960s and has been approved by the United States Food and Drug Administration or the U.S. Food and Drug Administration (FDA) in 1998. Skin adhesive glue is a safe and effective material, but wound selection is also very important regarding the success process. The most widely used leather adhesives are cyanoacrylates. It consists of liquid monomers that react with formaldehyde upon contact with skin or other surfaces. This polymerization will result in an exothermic reaction to create a bridge as well as adhesion to the skin. One study showed that today's adhesives have the equivalent strength of a 4.0 nylon thread in wound closure.²²

Indications for the use of surgical tapes or the use of adhesive tapes are an effective alternative to wound closure when tensile strength and resistance to infection are not important factors. Surgical tapes can also be used to complete the suture process or staple closure. Surgical tapes or the use of adhesive tapes are not recommended to be used as the only modality for primary wound closure because there are several complications that may occur, including tissue detachment or dehiscence, difficulties when applied to hairy areas and the need to keep the adhesive tape dry. Surgical tapes also cannot be used on deep wounds and cannot be used to control bleeding.¹³

Surgical tapes or adhesive tapes should be held together for as long as possible at least as long as the seams have not come off. Patients can be educated to keep the adhesive tape area dry, and

the tape does not come off. The patient is still allowed to take a bath in the first week by covering the wound with a plaster or bandage to protect it from high humidity.¹³

Evidence-based review

The choice of surgical wound closure technique, whether for major or minor surgical procedures, always generates several issues, one of which is connected to how quickly the wound heals after surgery and how much pain the patient experiences. Sutures, staples, and adhesive compounds are only a few of the possibilities for wound closure procedures that have evolved. According to a 2018 Indian study, there was no statistically significant difference between the cosmetic outcomes of scars treated with sutures, staples, and skin adhesive compounds.²³

The use of 2-cyanoacrylate in the wound closure process using adhesive compounds is a good alternative when compared to using suture techniques. This allows for a needle-free method of wound closure, thus preventing health care workers from being injured. The advantages of using this material include that it does not require wound closure with a bandage, has antimicrobial properties, does not need to be removed or removed from the skin, can disappear naturally when the incision heals and does not leave a scar. The use of protective eyewear is recommended during the application of skin adhesive glue as it can cause ulceration of the cornea if accidentally enters the eye.²³

Conventional wound closure using sutures causes pain to the patient during the postoperative period. The patient is also unable to bathe and has to come back to the health facility for suture removal which is often accompanied by pain and can cause scars on the suture marks. Based on another study conducted by Toriumi DM *et al.* regarding postoperative



Figure 9 Scars on day 28 after surgery using (A) skin adhesive glue, (B) staples, (C) sutures.[23]



Figure 10 Postoperative images for bilateral groin injuries on A. 5th day treatment and B. 14th day treatment.[29]

scars assessed using the Modified Hollander Cosmesis Scale (MHCS) and Visual Analogue scale (VAS) it was stated that the use of skin adhesive compounds was superior when compared to wound closure using sutures even though in the other study that was conducted by Allali N *et al.* with the same object stated that postoperative wounds with wound closure using stitches, staples and adhesive glue cosmetically did not have a significant difference.²³

In a study conducted by Rohin Krishnan *et al.* in 2016 related to the process of wound closure in the skin by comparing the use of sutures and staples, it was also stated that there was no significant difference in the possibility of superficial infection at the site of surgical site infection (SSI). as well as in terms of the length of time for wound closure, the possibility of inflammation, length of hospitalization, pain, abscess formation, necrosis, and the occurrence of dehiscence. In another comparative study conducted by Ananda B.B *et al.* in 2019 it was stated that adhesive compounds had superior results in terms of lower postoperative pain and lower wound complication rates. pain relief and better overall cosmetic outcome when compared with skin staples and sutures. This is also supported by other advantages, which the presence of bacteriostatic properties of the adhesive compound and no postoperative removal is required.^{24,25}

Another study was also conducted at Iraq in 2021 regarding the comparison of using subcuticular sutures and staples for skin wound closure. There are several things that are compared in this study, including wound healing time, the cost of the procedure, the infection rate, the pain during the procedure and the resulting scars. Based on the time of wound closure, it was found that wound closure using staples (2.35) was faster than wound closure using sutures (8.77) with p-value <0.05.²⁶

In the same study, it was also found that the infection rate was higher in sutures (8%) when compared to wound closure using staples (4%) although there was no statistically significant difference (p-value 0.237). The cost stated that the use of staples (12 USD) is more expensive than the use of stitches (2 USD). The process of postoperative scar formation, it was found that the scars produced in the subcuticular suture group were found to be higher (94%) when compared to using staples (90%) but statistically there was no significant difference (p-value 0.223).²⁶

Another study in 2021 stated that in a multi-center study related to the comparison between the use of running subcuticular sutures and interrupted sutures for surgery in the facial area on evaluation at 12 months after surgery, it was stated that these two suture techniques had the same good cosmetic results. Based on the results

of other evaluations in 12 randomized controlled trials (RCT) and 3 case studies, it was stated that wound closure using the subcuticular technique had superior esthetic results when compared to wound closure using interrupted sutures or simple sutures on the body area. The Cochrane review in 2020 regarding the technique of using subcuticular sutures for wound closure in the skin has a higher level of patient satisfaction with cosmetic results when compared to the use of other suture techniques even though it takes longer.²⁷

In the same study in 2021 it was stated that based on a survey of 68 Mohs surgeons, it was found that Mohs surgeons preferred wound closure using staples when compared to sutures, especially for wounds in the head area. This is because aesthetically the use of staples is considered to have a lower risk of complications, has cosmetic results and a high level of patient satisfaction when compared to the suture technique. In a double-blind study of 80 patients undergoing surgery for head and neck cancer, it was found that skin staples are a good alternative when compared to suture techniques. In another study in India in 2022 that compared wound closure using staples, simple interrupted and subcuticular, it was found that the time used for wound closure using staples was faster when compared to the other two techniques, while pain was found to be less in wound closure process using subcuticular suture technique.^{27,28}

There was a study in Nigeria in 2022 that compared wound closure techniques between the use of adhesive compounds or steri-strips® with suture techniques. The use of steri-strips® was reported to reduce erythema but had no significant difference in pain, cosmetic outcome or edema when compared with subcuticular wound closure techniques. In a prospective randomized study of cardiac surgical

procedures, it was stated that the combination of both wound closure techniques, using adhesive compounds or steri-strips® and absorbable suture techniques, was an effective technique for wound closure.²⁹

Conclusion

Surgical wound closure aims to support rapid wound healing with good cosmetic results with a low risk of complications. Several methods have been developed for the process of wound closure in the skin in the last 30 years which include wound closure techniques with sutures, staples or surgical tapes. Based on several studies that have been carried out, when viewed from cosmetic factors, secondary infections that may arise, pain, large costs to be incurred and the time used for the wound closure process, the results are quite varied but there is no significant difference between the three techniques.

References

1. Tottoli EM, Dorati R, Genta I, Chiesa E, Pisani S, Conti B. Skin Wound Healing Process and New Emerging Technologies for Skin Wound Care and Regeneration. *Pharmaceutics*. 2020;**12**(8):735.
2. Lawton S. Skin 1: The structure and functions of the skin. *Nursing Times*. 2019; **155**(12):30-3.
3. Wintoko R, Yadika ADN. Manajemen Terkini Perawatan Luka. *JK Unila*. 2020; **4**(2):183-9.
4. Suryadi IA, Asmarajaya AAGN, Maliawan S. Wound Healing Process And Wound Care. *E-Jurnal Medika Udayana*. 2013; **2**(2):254-72.
5. Purnama H, Sriwidodo RS, Ratnawulan S. Review Sistematis: Proses Penyembuhan Dan Perawatan Luka. *Farmaka*. 2017;**15**(2):251-6.
6. Kokolakis G, Von Grawert L, Ulrich M, Lademann J, Zuberbier T, Hofmann MA. Wound healing process after thermomechanical skin ablation. *Lasers Surg Med*. 2020;**52**(8):730-4.
7. Kalangi SJR. Histofisiologi Kulit. *Jurnal Biomedik* 2013;**5**(3):512-20.

8. Yousef H, Alhaji M, Sharma S. Anatomy, Skin (Integument), Epidermis. In: StatPearls [Internet]. Treasure Island: StatPearls Publishing 2022.
9. Prasetyono TOH. General concept of wound healing, revisited. *Med J Indonesia*. 2009; **18(3)**:208-16.
10. Saalabian A, Covi J, Horch RE. A Review On Wound Closure Techniques. *J Wound Tech*. 2011;**14**:10-4.
11. Ariningrum D, Subandono J. Buku Pedoman Keterampilan Klinis: Manajemen Luka. *Skill Lab* 2018;19-20.
12. Herman TF, Bordoni B. Wound Classification. In: StatPearls [Internet]. Treasure Island: StatPearls Publishing 2022.
13. Kim J, Simon R. Calculated Decisions: Wound Closure Classification. *Pediatr Emerg Med Pract*. 2018;**14(10)**:1-3.
14. Salcido R. Healing by Intention, Advances in Skin & Wound Care. *Wound Care Journal* 2017;**30(6)**:246-47.
15. Mandal N. Illustrated Surgery: A Road Map. The Health Sciences Publisher 2016.
16. Hendricks BK, Cohen-Gadol A. Suturing and Closure. Researchgate 2020;3.
17. Rose J, Tuma F. Sutures and Needles. In StatPearls (Internet). Treasure Island: StatPearls Publishing; 2022.
18. University of Glasgow *et al*. Suturing Procedures Guidance. In gla.ac.uk (Internet); 2017.
19. Cochetti G, Abraha I, Randolph J, Montedori A, Boni A, Arezzo A, *et al*. Surgical wound closure by staples or sutures?: Systematic review. *Medicine (Baltimore)* 2020; 99(25).
20. Feng J, Jiang X, Zhi Z. Subcuticular sutures versus staples for skin closure in patients undergoing abdominal surgery: A meta-analysis of randomized controlled trials. *PLoS One*. 2021;**4**:16(5).
21. Hochberg J, Meyer KM, Marion MD. Suture choice and other methods of skin closure. *Surg Clin North Am*. 2009;**89(3)**:627-41.
22. Swathi Krishna, K. V., *et al*. Surgical Glue- a Promising Technology for Wound Healing. In *J Res Pharmaceut Sci Tech*. 2018;**1(1)**:9-11.
23. Pawar, Arjun, Mohan A. Joshi, Meenakshi Gadhire., *et al*. Prospective randomized comparative study of skin adhesive glue (2-methyl -2- cyanopropionate or cyanoacrylate) versus conventional skin suturing by suture material/skin stapler in clean surgical cases. *Int Sur J*. 2018;**5(1)**: 168-73.
24. Krishnan R, MacNeil SD, Malvankar-Mehta MS. Comparing sutures versus staples for skin closure after orthopaedic surgery: systematic review and meta-analysis. *BMJ Open*. 2016;**1(20)**:6.
25. B. B., Ananda, Vikram J., Ramesh B. S., Hosni Mubarak Khan. A comparative study between conventional skin sutures, staples adhesive skin glue for surgical skin closure. *Int Surg J*. 2019;**6(3)**:775-82.
26. Ali G Mohammed Redha, Adil A Jaber, Aqeel M Nassir. Staples Vs Subcuticular Sutures For Skin Closure In Inguinal Hernia Repair: A Comparative Study. *Basrah J Surg*. 2021;**27(1)**:66-70.
27. Ashraf I, Butt E, Veitch D, Wernham A. Dermatological surgery: an update on suture materials and techniques. Part 1. *Clin Exp Dermatol*. 2021;**46(8)**:1400-10.
28. Das AM. Comparative study of staplersvs simple interrupted vs sub-cuticular method of skin closure of surgical wounds. *Eur J Mol Clin Med*. 2022;**9(03)**.
29. Ladipo-Ajayi OA, Lawal TA, Ogundoyin OO, Michael AI. Steri-strip™ versus subcuticular skin closure of paediatric groin wounds: A randomised study. *Afr J Paediatr Surg*. 2022;**19(3)**:137-43.