Comparative study of time taken for skin closure, infection rate and postoperative pain in skin closure with sutures and staplers in open inguinal hernioplasty

Rajasenthil V*, Sriraman K B, Kaliyappa C
General Surgery, Sri Ramachandra University, Chennai, Tamil Nadu, India

ABSTRACT
Wound healing is a complex and dynamic process and is influenced by surgical technique. Optimal wound healing, with a minimal scar that compromises neither appearance nor function, is the desired result. This process is affected by both local and systemic factors. Many local conditions are readily controlled at the time of wound closure, and several fundamental principles of surgical wound closure exist that should be adhered to in the management. Skin is usually closed with sutures then later with skin staplers. Skin staplers are quick and easy to use, but an assistant is usually required to hold the skin edges accurately with forceps or skin hooks. Stapler’s closure also causes considerably less damage to wound defenses than closure with least reactive non-absorbable suture. Standard suturing causes significantly more necrosis than stapling in myocutaneous flaps. We did this study to compare the time required for the closure of skin, infection rate, pain at the operated site with sutures and staplers in open inguinal hernia repair. 80 patients who were posted for elective open inguinal hernia surgery at Sri Ramachandra Medical College & Research Institute, porur, Chennai was included in this study. Time taken for closure of skin, infection rate and the pain was less in patients with stapler closure than with skin sutures

INTRODUCTION
An incision over the skin is properly planned as to shape, direction, and size. In general, incisions are made along the normal skin lines or along Langer lines (Son and Harijan, 2014). Skin management is aimed to prevent skin necrosis.
In closing wounds, sutures are either used in an interrupted or continuous fashion. The purpose of a suture is to hold tissues in apposition to leave a good scar. The surgical technique, surgical sutures, staplers, and a needle is quite important to achieve optimum wound healing.
Sutures are conveniently classified into two broad groups (Table 1)

1. Absorbable
2. Non-absorbable

Advantages and Disadvantages of suture materials

Monofilament
Russel (2000) consists of the single strand on synthetic material. The resistance of the suture is reduced after each time it passes the tissues, and the bacterial adherence is decreased due to its smooth surface contour. But any crushing or kinking of
Table 1: Types of suture materials

| Suture Materials | Absorbable                                                                 | Non-Absorbable          |
|------------------|-----------------------------------------------------------------------------|-------------------------|
| Monofilament     | 1. Surgical gut                                                            | 1. Polypropylene         |
|                  | Plain and Chromic                                                          | 2. Stainless steel      |
|                  | 2. Collagen                                                                | 3. Polyester            |
|                  | Plain and Chromic                                                          |                         |
|                  | 3. Monocryl                                                                |                         |
|                  | 4. PDS II                                                                  |                         |
|                  | 5. Polyglactin 910                                                         |                         |
| Multifilament    | 1. Poliglycolic Acid                                                        | 1. Surgical silk         |
|                  | 2. Poliglycolating 910                                                     | 2. Surgical linen        |
| Others           | 1. Surgical Stapler                                                         |                         |

The suture may result in a weak spot in the strand and can lead to surface breakage. Knot slippage is greater with monofilament suture.

Braided materials have the advantage of adjusting the knot and its tension accurately.

They have a high degree of drag when they pass through the tissues, and due to their capillary action, they cause tissue reaction, which may lead to stitch abscess.

The quantity of suture used must be adequate to secure the tissue, but excess material increases tissue reaction (foreign body) and inflammation of healthy tissues.

An absorbable suture is prepared from either from animal tissue or synthetic polymers. Those from natural sources elicit a foreign body response from tissues with resultant digestion from tissue enzymes, where as synthetic absorbable polymers are hydrolyzed to smaller monomers, which are metabolized by tissues.

Non-absorbable sutures are permanent and resist digestion by body enzymes or hydrolysis by tissue.

**Strength of Suture**

1. Strength of suture material is expressed using the terms Stress and Strain.

2. Strength represents the instantaneous force applied to the sutures (N/Msq).

3. Strain is a measure of instantaneous length/starting length (Units).

4. Strength is peak stress at the point of suture rupture, whereas the toughness is the energy required to rupture the suture (J/mtq).

Table 2 Kudur et al. (2009)

**Nylon**

Nylon is available in both monofilament and multifilament form. Nylon is non-absorbable, but there is progressive hydrolysis of the nylon in vivo may result in gradual loss of tensile strength over time. So nylon suture should not be used in suturisation when permanent retention of tensile is required.

**Prolene (Polypropylene)**

Stockley and Elsom (1987); Johnson et al. (1981) is a monofilament synthetic suture material and is chemically extruded from a purified and dyed polymer, which is neither absorbed nor weakened by the action of tissue enzymes. It has an extremely high tensile strength, which it retains indefinitely on implantation. This lack of adherence to tissues facilitates its use as a permanent suture. It can extend up to 30% before breaking and hence is useful in situations to accommodate the post-operative swelling, and there by helps to prevent tissue strangulation. Handling is good, and knotting is very secure since the material deforms on knotting and allows the knot to bend down on itself. It has no coefficient of friction and slides through tissue readily. By tapering the end of the suture, it may be swaged in to a needle of a similar diameter, which provides a haemostatic advantage in vascular anastomosis.
It is extremely smooth, and it is less thrombogenic as compared to silk. It is inert and non-biodegradable. Being monofilament, it should be carefully handled during surgery, as rough handling and inadvertent crushing will damage it. Rough handling may cause a fracture on the strand, which may break later in the postoperative period. It is sterilized by ethylene oxide.

**Staplers**

Hulti Humer, in 1908, introduced surgical skin staplers, which was massive by today’s standards weighing 7.5 pounds. Von Petz modified it into a lighter and simpler device, and in 1934 Fredrick of Ulm designed an instrument that resembled the modern linear stapler. The next major advances came from Russia after World War II. In 1958, Ravich, who, through research and development, refined the instruments to their current state. The most significant modification has been the introduction of absorbable staples. When these are used in gynecological operations, morbidity related to infectious granulomas and dysparunia has been diminished. They are best avoided in the face and hand. Skin staplers are easy to use, less time consuming, but an assistant is usually required to hold the skin edges accurately with forceps or skin hooks. The application is then aligned on the wound, often there is an arrow or mark to assist, and the trigger is pulled. In one action, a staple is driven into the tissues and closed.

For removal, a special extractor is required, which bends the staple back with its original configuration where upon it can be withdrawn.

**MATERIALS AND METHODS**

80 patients who undergoing elective open inguinal hernia surgery at Sri Ramachandra Medical College & Research Institute, porur, Chennai was taken into the study.

**Inclusion criteria**

1. Age > 18 years.
2. Patients undergoing uncomplicated inguinal hernia surgeries.

**Exclusion criteria**

1. Age < 18 years.
2. Patients with complicated hernias. (obstructed, strangulated hernia)
3. Patient not willing to give consent

Skin closure was measured in seconds, the length of the wound was measured, and the time taken per centimeter of a wound is calculated. Staples were removed with a device that painlessly opened them sideways, while sutures were removed in a conventional way. Wound closures were generally removed at ten days, and the ease or difficulty of removal was recorded. Pain attributable to the skin closure was assessed by a verbal numerical scale on pod 1, pod3, and on day of removal. Wound assessment was done using the Hollanders score.

**Hollanders scale**

1. Step off borders
2. Contour irregularity - puckering.
3. Scar width: greater than 2 mm
4. Edge inversion or sinking or curling
5. Inflammation: redness and discharge
6. Overall cosmoses

The total score is the addition of all the scores, A ‘WES scale’ used for evaluation of the wound. In each of the six variables, the score of 0 is given for yes and 1 for no.
RESULTS AND DISCUSSION

38 patients underwent wound closure by staplers, and 42 patients underwent wound closure with monofilament nylon mattress suturing.

Time

The time taken for stapling had a statistically significant advantage over the suture group with staple taking an average time of 9.05 seconds per centimeter and sutures taking 22.19 seconds per centimeter.

Skin site infection

3 patients among the 42 patients in the suture group developed skin and subcutaneous infection, and no infections noted in the stapler group, which is not statistically significant.

Pain

Pain on post operative day 1 and at times of suture removal were observed and were not statistically significant, but pain on post operative day 3 showed a statistically significant advantage over the suture group.

Cosmesis

The overall appearance and wound evaluation was significantly better in the stapler group over the suture group, and patient acceptance was also better in the stapler group.

Collected data were analyzed with IBM SPSS statistics software 23.0 Version. Percentage analysis were used for categorical variables, and the mean, median & S.D were used for continuous variables. To find the significant difference between the bivariate samples in Independent groups (Sutures & Staplers), the Unpaired sample t-test was used for normal data, and the Mann-Whitney U test was used for skewed data. To find the significance in categorical data, the Fisher’s Exact was used. In all the above statistical tools, the probability value .05 is considered as a significant level.

1. P – Value : Highly Significant at P < .01
2. P – Value : Significant at P < .05
3. P – Value : Significant at P > .05

Wound score

The stapler group shows better wound cosmesis with a P-value of 0.0005, which is statistically highly significant. Wound closure results in a healthy scar; it is the surgeon’s responsibility to ensure its aesthetically pleasing appearance. Skin staples offer an alternative to regular sutures in improving the aesthetics. Time taken to complete wound closure was significantly less with the use of staplers as compared to sutures. The average time taken to approximate 1 cm of the wound was 9.05 seconds with the staplers were as with sutures; it was 22.19 seconds in our study (Table 3).

Ranaboldo et al. (1992) analyzed skin stapler and subcuticular suture in 48 patients undergoing abdominal exploration and concluded that the time taken in stapler closure was less, but the cost was five times greater with staples. The rate of wound closure was 8 seconds/cm with a stapler and 12.7 seconds/cm with sutures in a study by Ranaboldo et al. (1992). Kanegaye et al. (1997) observed that staplers were six times faster than standard suture in skin closure for scalp lacerations in children (Kanegaye et al., 1997).

In our study, postoperative pain on 3rd day was higher in the suture group than the stapler group. Eldrup et al. (1981) studied 137 patients undergoing abdominal and breast surgery in a randomized control study, which found that time was saved in staple closure, as with mechanical sutures took one-third of the time required for the conventional method and found pain was present in the staple group (Eldrup et al., 1981).

The overall appearance and wound evaluation was significantly better in the stapler group over the suture group, and patient acceptance was also better in the stapler group.

Meiring et al. reported slightly better cosmetic results in a group of 40 patients undergoing laparotomy with an 80% time saved in staple closure over skin suturing (Meiring et al., 1982). Harvey and Logan studied a group of 20 patients undergoing surgery for varicose veins in both lower limbs, using a different method of skin closure in each leg. They reported a saving of 66.6% in closure time and a similar cosmetic result (Harvey and Logan, 1986).

Zwart and Ruiter achieved better cosmetic results with the subcuticular suture than with metal suture
Table 3: Time taken for skin closure in seconds

| Skin Closure | Times in Seconds       |
|--------------|------------------------|
| Sutures      | 22.19 seconds per centimetre |
| Staplers     | 9.05 seconds per centimetre |

Stapler group has an advantage over the suture group, and it is statistically highly significant with P-value of 0.0005.

Table 4: Infection * Groups Cross tabulation

|     | Sutures | Staplers | Total |
|-----|---------|----------|-------|
| % within Groups |
| yes Count | 3 | 0 | 3 |
| % within Groups |
| Total Count | 42 | 38 | 80 |
| % within Groups | 100.0% | 100.0% | 100.0% |

Wound infection does not show statistical significant with P-value of 0.093.

1 month after surgery; however, after 6 months, the results of both the methods were similar. They argued that it is advantageous to use sutures with staples in contaminated surgery (Zwart et al., 1989; Kumar, 2017).

In the present study, three complications were encountered in the suture group in the form of wound infection. In the stapler group wound infections were absent (Table 4).

Luiz R Medina dos Santos et al. in their study of 20 consecutive patients during head and neck surgery concluded that the use of skin staplers closure saves time by 80%, with better cosmetic results, and does not increase the incidence of infections, although the slightly higher cost was involved (Santos et al., 1995). It had wound infection in 8 patients (5 in the stapled group : 3 in suture group)

According to the study by Tuuli Mehodinn et al., the risk of developing a wound infection was four times greater after staple closure than in subcuticular skin closure in caesarean section (Tuuli et al., 2011).

CONCLUSIONS

Considerable evolution has taken place from the conventional skin suture technique and switch over to the new era of cosmoses, in the form of skin stapling to achieve a near virgin scar less skin. Further, it helps to bring down the time required for skin closure and achieving better cosmesis.

REFERENCES

Eldrup, J., Wied, U., Anderson, B. 1981. Randomised trial comparing Proximate® stapler with conventional skin closure. Acta Chirurgica Scandinavica, 147:501–502.

Harvey, C. F., Logan, C. J. H. 1986. A prospective trial of skin staples and sutures in skin closure. Irish Journal of Medical Science, 155(6):194–196.

Johnson, A., Rodeheaver, G. T., Durand, L. S., Edgerton, M. T., Edlich, R. F. 1981. Automatic disposable stapling devices for wound closure. Annals of Emergency Medicine, 10(12):80086–80094.

Kanegaye, J. T., Vance, C. W., Chan, L., Schonfeld, N. 1997. Comparison of skin stapling devices and standard sutures for pediatric scalp lacerations: A randomized study of cost and time benefits. The Journal of Pediatrics, 130(5):808–813.

Kudur, M., Pai, S., Sripathi, H., Prabhu, S. 2009. Sutures and suturing techniques in skin closure. Indian Journal of Dermatology, Venereology and Leprology.

Kumar, R. 2017. Sutures versus staplers for skin closure of midline incision in laparotomy patients and their outcome. International Journal of Surgery and Medicine, 1.

Meiring, L., Cilliers, K., Barry, R., Nel, C. J. C. 1982. A comparison of a disposable skin stapler and nylon sutures for wound closure. South African Medical Journal, 62:371–372.
Ranaboldo, C. J., R.-J., D. C. 1992. Closure of laparotomy wounds: skin staples versus sutures. *Br J Surg,* 79:1172–1173.

Russel, R. C. G. 2000. Bailey & Love’s short practice of surgery 23rd edition. pages 31–39, Arnold London. Noraman WG Clips bulstrode Arnold London.

Santos, L. R. M. D., Freitas, C. A. F., Hojaij, F. C., Filho, V. J. F. A., Cernea, C. R., o, L. G. B., Ferraz, A. R. 1995. Prospective study using skin staplers in head and neck surgery. *The American Journal of Surgery,* 170(5):451–452.

Son, D., Harijan, A. 2014. Overview of Surgical Scar Prevention and Management. *Journal of Korean Medical Science,* 29(6):751–751.

Stockley, I., Elsom, R. A. 1987. Skin Closure using staples and nylon Sutures: a comparison of results. *Ann R Coll Surg Engl,* 69:76–84.

Tuuli, M. G., Rampersad, R. M., Carbone, J. F., Stamilio, D., Macones, G. A., Odibo, A. O. 2011. Staples Compared With Subcuticular Suture for Skin Closure After Cesarean Delivery. *Obstetrics & Gynecology,* 117(3):682–690.

Zwart, H. J., Ruiter, D., P. 1989. Subcuticular, continuous and mechanical skin closure cosmetic results of a prospective randomized trial. *Neth J Surg,* 41:57–60.