



Research Article

## A Comparative Study Between Vertical Mattress and Subcuticular Sutures In Inguinoscrotal Surgeries

Dr Yashwanth Mentha<sup>1</sup>, Dr. Sarada<sup>2</sup>, Dr. P Suresh Babu<sup>3</sup>

<sup>1</sup>Post Graduate, Dept. Of General Surgery, SVMC

<sup>2</sup>MS, Assosociate Professor, Dept. Of General Surgery SVMC Tirupati

<sup>3</sup>MS, Assistant Professor, Dept. Of General Surgery SVMC Tirupati



### Corresponding Author:

**Dr. P Suresh Babu**

MS, Assistant Professor, Dept. Of  
General Surgery SVMC Tirupati

Received: 05-09-2025

Accepted: 26-09-2025

Available online: 08-10-2025

Copyright © International Journal of  
Medical and Pharmaceutical Research

### ABSTRACT

**Introduction:** Hernia repair is one of the most common surgical procedure performed by general surgeons. There are many techniques available for inguinal hernia repair. The two main techniques of skin closure used by surgeons, are removable skin staples and skin sutures. We decided to study the various skin closure techniques in hernia surgery. **Material and Method:** The present study was a comparative study carried out at a tertiary care hospital over a period of two years. Total 100 patients of hernia were included in the present study. Patients were divided into 2 groups based on the method of skin closure applied. Main parameters investigated were postoperative pain, postoperative wound infection rates, cosmetic acceptability of scar and time required for skin closure. Statistical analysis was used wherever applicable. **Results:** The incidence of hernia is common in the younger age group, the mean age being in the 41 years. The majority of cases were unilateral (right side); right sided indirect inguinal hernia was the most frequent type observed in this study. At 48hrs subcuticular group experienced only mild, nagging pain. At discharge Subcuticular closure group has significantly less pain. At 48 hrs, highest wound infection rate was in subcuticular group (60%). At time of suture removal, highest number of wound complication occur in subcuticular group. **Conclusion:** Subcuticular closure of inguinal skin incision gives best cosmetic scar to patients. Subcuticular skin closure technique is painless. Skin Stapler is most rapid method of skin closure.

**Keywords:** Hernia, Suture, Subcuticular.

### INTRODUCTION

Hernia repair is one of the most common surgical procedure performed by general surgeons. With the development of accelerated rehabilitation and the pressure placed on surgeons to reduce length of stay in hospital, the method of skin closure has become increasingly important. Wound complications are one of the major sources of morbidity after any surgical procedures and can prolong the inpatient stay or lead to re-admission <sup>(1)</sup>.

There are many operations available in a general surgeon's armamentarium that of hernia repairs has been written about repeatedly. It is estimated that at least 5% of the population will develop a groin hernia in their lifetime, making groin hernia repair one of the most common operations performed by general surgeons. In some countries Inguinal Hernia surgeries are most common elective operations performed by general surgeons <sup>(2)</sup>. There are many techniques available for inguinal hernia repair; skin closure remains limited to two main techniques, either by using removable skin staples or skin sutures. The most commonly used methods for skin closure after surgery are metal staples or sutures. Both methods act to hold the skin edges together while healing occurs. <sup>(2)</sup>

We decided to study the various skin closure techniques in hernia surgery, with the aim to study which type of wound closure is simple, fast, tension free with no subsequent adverse reactions, creation of protective barrier to pathogens has a

simple post-operative management, simple for suture removal and optimal cosmetic appearance<sup>(3)</sup>. and cost effectiveness<sup>(4)</sup>.

## **MATERIALS AND METHODS**

The present study is a comparative Study carried out in a tertiary care centre over a period of two years. Total 100 patients of inguinal hernia were included in the study. Out of 100 patients, 50 patients allotted to each group by random envelope allocation method and into 2 groups. The study was approved by the local research ethics committee.

GROUP A: Subcuticular skin closure

GROUP B: Simple Interrupted mattress skin closure

### **Suture Material Used:**

Non-absorbable Monofilament Polyamide black 3-0 RC (reverse cutting)

### **Inclusion Criteria:**

- With diagnosis of Inguinal Hernia
- Age between 18 to 65 years of either sex
- Normal Body Mass Index
- Ready to give written informed consent were considered.

### **Exclusion Criteria:**

- Age less than 18 years OR more than 65 years
- Complicated hernia such as bowel obstruction, bowel strangulation, peritonitis, bowel perforation, local and systemic infection
- Recurrent hernia
- Sero-status positive (HIV and HBsAg infection)
- Diabetes mellitus
- On chemotherapy, immuno-suppressants, and steroid medication were not considered in study.

parameters investigated were postoperative pain, postoperative wound infection rates, cosmetic acceptability of scar and time required for skin closure. The diagnosis of inguinal hernia was made by clinical examination. The preoperative evaluation included history, clinical findings, and routine lab investigations. Body mass index was calculated. Ultrasonographic evaluation of the abdomen was done in selected patients. X ray and ECG were done for patients above 40 years of age for anesthetic evaluation. Lichtenstein tension free hernioplasty was done in all patients under general or spinal anesthesia. A single dose of preoperative broad spectrum antibiotic was given followed by the same for 3 days postoperatively. Information was gathered at operation on whether the hernia was anatomically direct, indirect or pantaloon. The time taken for skin closure with subcuticular sutures or simple interrupted sutures was measured in seconds. Post operatively wounds were covered with a padded occlusive dressing with micropore. Analgesics were given postoperatively for 2 days. Post-operative pain was recorded by using Visual Analog Scale (0-10; 0- Best, 10-Worst) at 48 hrs. and at time of discharge. An independent assessor examined the wound at 48 hrs. and at the time of suture removal for any cutaneous signs of infection. sutures were removed at 10 days.

Wound infection grades used were (0-4) as follows:

- 0- None
- 1- Erythema / Induration / Stich Abscess
- 2- Exudates / Subcutaneous Abscess
- 3- Partial dehiscence
- 4- Complete dehiscence

Cosmetic acceptability of scar was assessed by independent assessor at 6 weeks during follow up examination. Scar assessment scale was Patient and Observer Scar Assessment Scale (POSAS). The observer scale of the POSAS consists of six items (vascularity, pigmentation, thickness, relief, pliability and surface area). All items are scored on a scale ranging from 1 ('like normal skin') to 10 ('worst scar imaginable'). The sum of the six items results in a total score of the POSAS observer scale. Furthermore, an overall opinion was scored on a scale ranging from 1 to 10. Statistical analysis was done wherever applicable using standard tests of significance.

## **RESULTS**

Over the past two years, we studied 100 consecutive cases of primary inguinal hernia and its skin closure at our Tertiary Health Centre. The data was collected and tabulated in the form of a Master chart and various parameters studied.

These patients randomly divided into three groups for comparison, with 30 patients each in Group A (Stapled), Group B (Subcuticular) and Group C (Simple interrupted). On analysing data we obtained the following results.

The Age wise distribution of the cases of Primary inguinal hernia skin closure in our Tertiary Health Centre were as follows:

**Table 1: MeanAge Distribution**

Parameters	Group A	Group B
No. of cases	50	50
Age (yrs.)		
Mean	40.10	41.93
SD	13.21	13.22
Range	20 – 62	19 – 63

By Anova  $P > 0.05$ , Not Significant

The age distribution of the patients in the study was taken into consideration. average age being 40.10 and 41.93 years among Group B (Subcuticular) & C (Simple Interrupted) respectively. In our study group age of the cases were ranging from 19-64 years.

All patients were males. Over period of study, no female patient was presented with aforesaid inclusion criteria.

**Table 3: Laterality of Inguinal Hernia**

Types	Group B (N = 50) No.	%	Group C (N = 50) No	%
Unilateral	41	83.3	41	83.3
Bilateral	09	16.7	09	16.7

By Chi-Square, Test  $P > 0.05$ , not significant

In our study, most of patients presented with unilateral inguinal hernia (n=80 i.e. 80%) and remaining were bilateral inguinal hernia (n=20 i.e.20%). Forty one (83.3%) cases, each had Unilateral inguinal hernia among subcuticular and simple interrupted closure. Among Bilateral inguinal hernia each 9 (16.7%) were closed with subcuticular and simple interrupted, respectively. The difference was not significant.

**Table 4: Operated Side of Inguinal Hernia**

Sides	Group A (N = 50) No.	%	Group B (N = 50) No.	%
Right	35	70.0	33	66.7
Left	15	30.0	17	33.3

By Chi-Square, Test  $P > 0.05$ , Not significant

Highest number of right sided inguinal hernia skin closure was in subcuticular group (n=35 i.e. 70 %). It was comparable with number of cases among simple interrupted group (n=33 i.e. 66.7%). Among left sided inguinal hernia skin closure, 30 % (n=15) and 33.3% (n=17) cases with subcuticular and simple interrupted closure, respectively. But difference was not significant.

**Table 5: Intra-Operative Findings**

Types	Group A (N = 50) No.	%	Group B (N = 50) No.	%
Direct	18	36.7	17	33.3
Indirect	25	50.0	25	50.0
Both	07	13.3	08	16.7

By Chi-Square Test  $P > 0.05$ , not significant

Above profile reveals that, in our study; 50 patients found to be have indirect hernia intraoperative. (50%). Among remaining 50 patients, 35 were have direct hernia sac (35%) and 15 were have both sacs i.e. pantaloon hernia (15%). 36.7% and 33.3% of the cases among subcuticular and simple interrupted group respectively had direct sac, but difference was not significant.

50% each of the cases among subcuticular and simple interrupted group had indirect sac respectively, but difference was not significant.

**Table 6 : Post - Op Pain by using VAS Score between the groups(At 48 hrs)**

Groups	Mean VAS score ( $\bar{X} \pm SD$ )
B (N = 50)	2.97 + 0.61
C (N = 50)	*3.87 + 0.73
Total (N = 90)	03.30 ± 01.01
P value	*0.004

By Anova (Bonferonni Test) \* Significant

This analysis states that mean overall VAS Score at 48 hrs was 3.30. Mean VAS score at 48 hrs was 3.87 among simple interrupted group, which was significantly more ( $p\text{ value}=0.004$ ) as compared to 2.97 among subcuticular group .

It showed that patients having simple interrupted closure complained uncomfortable, troublesome nagging pain at 48 hrs. opposed to rest subcuticular groups which had only mild, annoying pain.

**Table 7:** Post - Op pain by using VAS score between the group(At discharge)

Groups	Mean VAS score ( $\bar{X} \pm SD$ )
A(N = 50)	*1.13 $\pm$ 1.36
B(N = 50)	1.87 $\pm$ 1.22
Total (N = 100)	01.60 $\pm$ 01.41
P value	*0.026

By Anova(Bonferonni Test) \* Significant

As per the above data, Mean VAS score at discharge was 1.13 among Subcuticular closure group, which was significantly less ( $p=0.026$ ) as compared to 1.87 among simple interrupted group. At time of discharge patients with subcuticular closure had pain which was almost negligible in contrast simple interrupted group. Mean overall VAS score at discharge was 1.60

**Table 8:** Wound Infection Rate between the groups (at 48 hrs)

Grade	Group A (N = 50)		Group B (N = 50)	
	No.	%	No.	%
0	38	76.0	40	80.0
1	07	14.0	10	20.0
2	05	10.0	-	-
3	-	-	-	-
Infection rate	24.0%		20.0%	
Overall Wound Infection Rate	22%			

By Chi-Square Test Pvalue = 0.03, \*Significant

Above data reveals that, Overall wound infection rate was 22% (n=22).At 48 hrs. highest wound infection rate was in subcuticular group (24%) followed by simple interrupted group (20%).Wound infection rates between subcuticular and simple interrupted group were comparable but difference was not significant.In subcuticular group, 24% patients had wound infection at 48 hrs. Out of which, 15 patients had erythema or induration (Grade 1).10 patients of simple interrupted group had erythema (Grade 1) at 48 hrs.None of the patient had partial or complete dehiscence of wound.

**Table 9:** Cosmetic Acceptability of Scar (Total POSAS Score)

Groups	Mean total score ( $\bar{X} \pm SD$ )
A (N = 50)	*13.53 $\pm$ 2.78
B (N =530)	23.87 $\pm$ 3.05
P value	0.002

By Anova (Bonferonni Test) \* Significant

Cosmetic appearance of scar was found best in subcuticular group with mean Total POSAS Score (13.3  $\pm$  2.78) which was significantly less ( $p=0.002$ ) as compared to 24.30 among simple interrupted group respectively.

**Table 10:** Time required for Skin Closure

Group	Mean Time required (Sec.) ( $\bar{X} \pm SD$ )
A (N = 30)	459.93 $\pm$ 59.29
B (N = 30)	193.33 $\pm$ 55.47
P value	0.005

By Anova (Bonferonni Test)\* Significant

As per the analysis, average time required for skin closure 459.93sec in subcuticular group and 193.33 sec in simple interrupted closure. Whereas closure with simple interrupted was quicker compared to subcuticular and the difference was statistically significant.

## DISCUSSION

In our comparative study, we compared two of commonly used methods of skin closure of Primary Inguinal hernia skin incision. We compared 2 methods (, Subcuticular and Simple interrupted) without control group depending on specific statistical tests (ANOVA, Chi- square test) which are used for different variables.

At the end of 2 years and after studying 100 consecutive cases of inguinal hernia skin incision, we made these inferences-

## Patient's Characteristics

One of the most striking epidemiological features of inguinal hernia repair is its age and sex distribution.

In our study, differences among age and sex were not significant and did not affect the results of other variables. The mean age in stapled group was 40.93 yrs. In subcuticular group was 40.10 yrs. and that of in simple interrupted group was 41.93.

This is comparable with the randomized controlled study by Malekpour F et al<sup>(5)</sup> wherein the mean study age was  $45 \pm 18$  years.

Overwhelming majority of inguinal hernia occur in males as compared to females. Of inguinal hernia repairs, 90% are performed in males and 10% in females. As in prospective randomised trial by Brown JK<sup>(3)</sup> et. al. patients were predominantly male (82%). Over period of study, no female patient was presented with aforesaid inclusion criteria in our study. Incidence of inguinal hernia in males has a bimodal distribution with peak before 1 year of age and then again after age 40.

So, in our study; all result are attributed to male patients and hence comparison with female population is not possible.

Most of patients presented with unilateral inguinal hernia (n=72 i.e. 80%) and remaining were bilateral inguinal hernia (n=18 i.e.20%). Majority of patients were operated on right side (n=59 i.e. 65.55%) as compared to operations performed on left side (n=31 i.e.34.54%). Laterality and operated side of hernia doesn't affect the final outcome of closure technique. In our study; 46 patients found to be have indirect hernia intraoperative. (51.11%) Among remaining 44 patients, 26 were have direct hernia sac (28.88%) and 16 were have both sacs i.e. pantaloon hernia (17.77%).

## Parameters:

### Pain:

Our study show that there was significantly more pain at 48 hrs when the skin incision was closed with polyamide black 3-0 RC simple interrupted compared to subcuticular closure. It is mostly attributed to free nerve endings of the pain modality in the superficial layers of the dermis and the germinal and granular zones of the epidermis are known to respond to physical deformity and a full thickness simple interrupted suture, when tied would embrace considerably more free nerve endings (pain). While a subcuticular bite at dermis/epidermis junction contains a small fraction of the corresponding nerve endings. But at time of discharge patients with subcuticular closure had pain which was almost negligible in contrast to other groups have mild, annoying pain at discharge. This our findings are consistent with Mr. A Subramanian et.al.<sup>(6)</sup> who found significantly more pain when inguinal skin incision is closed with staples.

ALISTAIR B. CASSIE<sup>(7)</sup> found less pain as with monofilament absorbable poly-dioxanone (PDS) as compared with non-absorbable polyamide black (Nylon). Frishman GN, Schwartz T<sup>(8)</sup> reported significantly less pain following subcuticular closure at both the time of discharge ( $P < \text{or} = .01$ ) and the postoperative visit ( $P < \text{or} = .002$ ) and his results are consistent with our results.

## Wound Infection Rates:

As per our analysis, we detected though overall wound infection rate was high (42.2%); it was mostly grade 1 that means erythema. Wound infection rate was least *significantly* ( $p=0.03$ ) with use stapler in inguinal incision as opposed to rest of two suture techniques.

At time of suture removal five patients have partial dehiscence and all were belonged to suture group (subcuticular). Rate of Grade 2 (exudates or subcutaneous abscess) was more with simple interrupted closure as if edges are tightly opposed already, the oedema may compress capillaries and reduces blood supply. It leads delayed wound healing and may lead to wound infection.

Iavazzo C, Gkegkes ID<sup>(12)</sup> found fewer wound infection rates in the staples group compared with the sutures group(s) (12 studies, 1529 patients; odds ratio, 2.06; 95% CI, 1.20 to 3.51).

Clay FS, Walsh CA<sup>(13)</sup> found wound separation (pooled odds ratio, 4.01;  $P < .0001$ ) and composite wound complication (pooled odds ratio, 2.11;  $P = .003$ ) rates were higher with staples. Mackeen AD<sup>(14)</sup>, Agbakwuru EA<sup>(15)</sup>, Lundbald R<sup>(16)</sup>, MR. A Subramanian<sup>(6)</sup>, and Eldrup<sup>(17)</sup> et.al. found no difference in postoperative infection rates using sutures.

## Cosmetic Acceptability of Scar:

Cosmetic acceptability of scar was assessed by independent assessor at 6 weeks during follow up examination. Scar assessment scale was Patient and Observer Scar Assessment Scale (POSAS). The observer scale of the POSAS consists of

six items All items are scored on a scale ranging from 1 ('like normal skin') to 10 ('worst scar imaginable'). Both total and overall opinion was studied. Draaijers LJ, Tempelman FR, Botman YA<sup>(18)</sup> showed that POSAS scale offers a suitable, reliable, and complete scar evaluation tool. Both Total and Overall POSAS score was significantly less ( $p=0.002$  &  $p=0.003$  respectively) in subcuticular group. Overall best cosmetic appearance of skin was with subcuticular followed by simple. In a study closure with nylon wound closure in head and neck surgeries by Meiring<sup>(4)</sup> et al showed that the cosmetic result of staples is as good as if not better than that with nylon sutures. Lubowski D<sup>(19)</sup> et al compared stapled and sutured abdominal wound closure which resulted in almost equal cosmetic scores for vertical wounds. No significant difference in wound appearances was found in a study conducted by R Bhatia<sup>(9)</sup> et al in closure of palmar skin following Dupuytren's contracture.

Cromi A, Ghezzi F, Gottardi A<sup>(20)</sup> et al compared scar quality associated with 3 different types of subcuticular sutures in cesarean section. In the overall study population, objective scores correlated with patient rating, and correlation was strongest between the observer and patient components of the POSAS ( $r=0.4$  stapled wounds and those closed with subcuticular sutures result in equivalent cosmetic appearance of the scar. However in our study, it was found to be statistically significant.

Shetty et. al.<sup>(21)</sup> subcuticular suture had better cosmetic scar appearance than skin clips in hip surgeries.

A.N. OSUIGWE et. al.<sup>(22)</sup> showed best cosmetic results with nylon subcutaneous continuous running sutures as compared with interrupted group.

Abu N.G.A.<sup>(23)</sup> et al found that the skin staplers had better cosmetic scar appearance than subcuticular suture in prospective randomised trial for closure of scalp laceration in pediatric emergency department. Chughtai Tet. al.<sup>(24)</sup> noted closure with a subcuticular technique achieves better outcomes than the use of skin clips.

#### Time for Skin Closure:

Average time required for skin closure 459.93 sec in subcuticular group and 193.33 sec in simple interrupted closure. Meiring L.<sup>(4)</sup> et al found that time saving of 80% is possible with the stapling device but a certain amount of experience and practice facilitates its usage. Dos Santos LR<sup>(25)</sup> et al undertook a prospective trial to investigate the advantages and disadvantages of stapled skin closure versus nylon sutures in head and neck surgery and even he found that the use of skin staplers speeds up closure time by 80%.

In a study done by J. H. Wolterbeek et al<sup>(26)</sup>, they compared various methods of skin closure in infra-inguinal bypass surgeries and came to a conclusion that time needed for wound closure is significantly reduced using metallic staples. Our results are also supported by other workers who found that, whilst operating time was significantly reduced when using staples rather than a non-absorbable subcuticular sutures. Alderdice F.<sup>(27)</sup>, Bhatia R.<sup>(9)</sup>, Frishman GN.<sup>(8)</sup>, Clay FS<sup>(13)</sup>, Walsh CA<sup>(13)</sup>, Gkegkes ID<sup>(12)</sup>, and et. al. found in meta-analysis regarding the time needed for wound closure, staples were superior to sutures; the mean difference observed between the sutures and staples groups was 5.56 minutes per wound which is comparable with 6.55 minutes in subcuticular group. The difference is because as subcuticular suture are difficult to place and require expertise. Simple interrupted closure is quick as compared to subcuticular.

## CONCLUSION

The present study is a comparative study between subcuticular and simple interrupted inguinal hernia skin closure. The study was conducted with an intention to observe the effect of aforesaid skin closure technique on post-operative pain, wound complications, cosmetic acceptability of scar and time required for skin closure. We have drawn these important conclusions from our study:

- Subcuticular closure of inguinal skin incision gives best cosmetic scar to patients.
- Subcuticular skin closure technique is painless.
- Simple interrupted skin closure is painful.
- Subcuticular skin closure is time consuming.
- Wound complications are more with subcuticular skin closure.

## REFERENCES

1. Calabrese EJ. Historical foundations of wound healing and its potential for acceleration: dose-response considerations. Wound repair and regeneration : official publication of the Wound Healing Society [and] the European Tissue Repair Society. 2013; 21(2):180-93.
2. Aabakke AJ, Krebs L, Pipper CB, Secher NJ. Subcuticular suture compared with staples for skin closure after cesarean delivery: a randomized controlled trial. Obstetrics and gynecology. 2013; 122(4):878-84.
3. Brown JK, Campbell BT, Drongowski RA, Alderman AK, Geiger JD, Teitelbaum DH, et al. A prospective,



- randomized comparison of skin adhesive and subcuticular suture for closure of pediatric hernia incisions: cost and cosmetic considerations. *Journal of pediatric surgery*. 2009;44(7):1418-22.
4. Meiring L, Cilliers K, Barry R, Nel CJ. A comparison of a disposable skin stapler and nylon sutures for wound closure. *South African medical journal = Suid-Afrikaanse tydskrif vir geneeskunde*. 1982;62(11):371-2.
  5. Malekpour F et.al. Ilio-inguinal nerve excision in open mesh repair of inguinal hernia- Results of a randomized clinical trial: Simple solution for a difficult problem. *American journal of surgery*. 2008;195(6):735-40.
  6. Mr. SUBRAMANIAN MAHet.al. A Prospective Randomised Controoled Trial Comparing the use of Staples with Subcuticular Prolene Suture in Inguinal Hernia Incisions. *The Journal of One-Day Surgery*. 2006;vol. 15(No. 1):61-3.
  7. Cassie AB, Chatterjee AK, Mehta S, Haworth JM. Pain quantum and wound healing: a comparison of interrupted inversion PDS and standard nylon sutures in abdominal skin closure. *Annals of the Royal College of Surgeons of England*. 1988;70(6):339-42.
  8. Frishman GN, Schwartz T, Hogan JW. Closure of Pfannenstiel skin incisions. Staples vs. subcuticular suture. *The Journal of reproductive medicine*. 1997;42(10):627-30.
  9. Bhatia R, Blackshaw G, Barr V, Savage R. Comparative study of "staples versus sutures" in skin closure following Dupuytren's surgery. *Journal of hand surgery*. 2002;27(1):534.
  10. Richard M Stillman, Stephen J Seligman. Skin wound closure: The effect of various wound closure methods on susceptibility to infection. *Arch Surg*. 1980;115:674-78.
  11. Stillman RM, Seligman SJ. Skin staples in potentially contaminated wounds. *Archives of Surgery*. 1984, July;119(7):821-2.
  12. Iavazzo C, Gkegkes ID, Vouloumanou EK, Mamais I, Peppas G, Falagas ME. Sutures versus staples for the management of surgical wounds: a meta-analysis of randomized controlled trials. *The American surgeon*. 2011;77(9):1206-21.
  13. Clay FS, Walsh CA, Walsh SR. Staples vs subcuticular sutures for skin closure at cesarean delivery: a metaanalysis of randomized controlled trials. *American journal of obstetrics and gynecology*. 2011;204(5):378-83.
  14. Mackeen AD, Berghella V, Larsen ML. Techniques and materials for skin closure in caesarean section. *The Cochrane database of systematic reviews*. 2012;11:CD003577.
  15. Agbakwuru EA, Olabanji JK, Alatise OI, Katung IA, Onakpoya UU. Single versus two layer suturing for wound closure after inguinal hernia repair. *Nigerian journal of clinical practice*. 2009;12(2):162-4.
  16. Lundblad R, Simensen HV, Wiig JN, Niels Gruner OP. [Skin closure. A prospective randomized study]. *Tidsskrift for den Norske lægeforening : tidsskrift for praktisk medicin, ny raekke*. 1989;109(12):1307-9.
  17. Eldrup J WU, Andersen B. *Acta Chir Scand* 1981; 147(7): 501-2. Randomised trial comparing Proximate stapler with conventional skin closure. *Acta Chir Scand*. 1981;147(7):501-2.
  18. Draaijers LJ, Tempelman FR, Botman YA, Tuinebreijer WE, Middelkoop E, Kreis RW, et al. The patient and observer scar assessment scale: a reliable and feasible tool for scar evaluation. *Plastic and reconstructive surgery*. 2004;113(7):1960-5; discussion 6-7.
  19. Lubowski D, Hunt D. Abdominal wound closure comparing the proximate stapler with sutures. *The Australian and New Zealand journal of surgery*. 1985;55(4):405-6.
  20. Cromi A, Ghezzi F, Gottardi A, Cherubino M, Uccella S, Valdatta L. Cosmetic outcomes of various skin closure methods following cesarean delivery: a randomized trial. *American journal of obstetrics and gynecology*. 2010;203(1):36 e1-8.
  21. Shetty AA, Kumar VS, Morgan-Hough C, Georgeu GA, James KD, Nicholl JE. Comparing wound complication rates following closure of hip wounds with metallic skin staples or subcuticular vicryl suture: a prospective randomised trial. *J Orthop Surg (Hong Kong)* 2004;12(2):191-193.
  22. AN Osuigwe, CN Ekwunife, CH Ihekwoaba. Skin closure after groin hernia repair in children: a comparative study of three suture materials and two suture techniques.