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SUBCUTANEOUS ENDOSCOPE ASSISTED LIGATION VERSUS CONVENTIONAL HERNIOTOMY IN PEDIATRIC INGUINAL HERNIA: A PROSPECTIVE COMPARATIVE STUDY

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ABSTRACT

Background
The usual treatment for pediatric inguinal hernia is conventional herniotomy. Recently, a new alternative technique (subcutaneous Endoscope-Assisted Ligation, SEAL) has become available, which may achieve the same surgical results while offering better cosmetic outcomes.
Objective
To compare SEAL with conventional herniotomy in terms of early recurrence, operating time, wound infection and cosmesis in children who have inguinal hernia.
Methodology
The study was conducted at the Department of Pediatric and Neonatal Surgery, The Children's Hospital, Pakistan Institute of Medical Sciences, Islamabad, a prospective non random comparative study. The 220 children, aged 1-14 years, who had clinical diagnosis of inguinal hernia, were allocated to two groups: SEAL group (n=110) and the conventional herniotomy group (n=110). Patients were followed up for 1 month following surgery. Operative time, wound infection, early recurrence and cosmetic outcome were documented and statistically analyzed with SPSS 25.
Results
There was no significant difference in mean operative time between the SEAL (40.9 ± 9.3 minutes) and conventional herniotomy (42.4 ± 7.8 minutes) groups (p=0.184). Wound infection was reported in 0.9% and 1.8% of patients, respectively (p=0.561) and early recurrence occurred in 3.6% and 1.8% of patients (p=0.684). Compared to conventional herniotomy, excellent cosmetic result was obtained in 56.4% of children who had undergone SEAL (p=0.031).
Conclusion
The early recurrence and wound infection rates were low and both SEAL and conventional herniotomy were safe and effective procedures. Despite similar operative time, cosmetic results were significantly superior with SEAL and may be a preferred minimally invasive option, if available and appropriate expertise and equipment.

Keyword: Pediatric inguinal hernia, Subcutaneous Endoscope-Assisted Ligation, Conventional Herniotomy, Minimally Invasive Surgery, Cosmetic Outcome.

INTRODUCTION

Inguinal hernia is the most common surgical condition seen in children and is responsible for a significant number of surgical procedures performed in children all over the world. Caused by the non-resolution of the processus vaginalis leading to the passage of abdominal organs through the inguinal canal. It is more common in males, prematurely born babies and children with some congenital abnormalities. Some children may never develop symptoms, but surgery is recommended due to the potential for incarceration and strangulation and the risk of affecting the viability of the bowel or gonadal structures if not addressed [1].

Conventional herniotomy has been used as the gold standard operation for pediatric inguinal hernia repair due to its good long-term outcomes, low rate of recurrence and favorable safety profile. The operation encompasses a small incision in the groin, identification of the hernia sac and high ligation of the patent processus vaginalis. Conventional herniotomy is still popular in pediatric surgical centers around the world as it is simple and effective [2].

Subcutaneous Endoscope-Assisted Ligation (SEAL) is one of the alternative procedures that have appeared in the management of pediatric inguinal hernia due to the advancements in minimally invasive pediatric surgery. SEAL works from the inside out, by inserting a small endoscope through the umbilicus, and ligating the internal inguinal ring percutaneously, without a traditional groin cut. This method offers good visualization of the internal inguinal ring with minimal dissection and operative trauma. During the same procedure, the contralateral internal inguinal ring can also be checked and a contralateral patent processus vaginalis can be identified and treated without a second procedure being necessary [3].

Several studies have described the possible benefits of SEAL when compared to a traditional herniotomy. These benefits range from smaller surgical scars to less tissue handling, decreased postoperative discomfort, quicker recovery, and better cosmesis. Additionally, the minimally invasive surgery technique could reduce wound complications without compromising the effectiveness of the surgery. Moreover, the direct endoscopic visualization helps in accurate placement of the ligature around the internal ring, which can be a contribution to good clinical result [4].

Although these potential benefits exist, there are some concerns about the long-term effectiveness of SEAL, especially for recurrence. Recurrence is one of the key parameters of the success of the surgery after pediatric inguinal hernia repair. In published studies, recurrence rates after SEAL and conventional herniotomy have been reported to vary from 0% to 20% depending on the surgical experience, differences in the surgical technique, patient factors, and length of follow-up. Therefore, future research and assessment of both technologies in various healthcare environments are still relevant [5].

The length of the operation and the complications after the surgery also have a significant influence in choosing the best surgical technique. Previous studies have shown conflicting results in comparison of operative times between SEAL and conventional herniotomy, and incidences of postoperative complications, including wound infection, hematoma, scrotal edema, and recurrence have been reported to be rare in both cases. However, due to the fact that results can differ between different institutions and surgeons, local comparative studies can be helpful and give an idea of the performance of these techniques in routine clinical practice [6].

Now cosmetic outcome has become more and more a part of surgical quality assessment, especially in pediatric surgery where both the parent and the child's satisfaction is an important factor. Since SEAL involves making very small puncture incisions (no groin incision), it is often perceived as more cosmetically pleasing and less noticeable than traditional herniotomy. Evaluating the scar quality has therefore become an important assessment outcome along with the traditional clinical outcomes of recurrence and postoperative complications [7].

Comparative studies of recent years have demonstrated that SEAL and conventional herniotomy are successful and safe methods of treating paediatric inguinal hernia. The recurrence and complication rates seem to be similar for both methods, but SEAL may offer other benefits such as cosmesis and visualization of the opposite internal inguinal ring. But data from Pakistan is limited especially from tertiary pediatric surgical centres. Thus, locally generated data are important to assess the short-term results of these procedures and to inform clinical decision making for inguinal hernia surgery based on evidence.

Objective

The objective of this study was to compare Subcutaneous Endoscope-Assisted Ligation (SEAL) with Conventional Herniotomy (CH) in children with inguinal hernia by evaluating early recurrence, operative time, postoperative wound infection, and cosmetic outcomes.

METHODOLOGY

Study Design and Setting

The non-randomized prospective comparative study was carried out at Department of Pediatric and Neonatal Surgery, Pakistan Institute of Medical Sciences (PIMS), Islamabad, Pakistan. The study was performed after obtaining approval from the Institutional Ethical Review Committee. The study was carried out for 4 months starting from October 20, 2025 to February 19, 2026; 3 months for patient recruitment and 1 month for post-operative follow-up.

Study Population and Sampling

A non-probability consecutive sampling technique was used. The sample size was determined using the sample size formula for the comparison of two proportions with the following parameters: a 95% confidence level, 80% study power, 5% level of significance and previously reported differences in postoperative outcomes between minimally invasive and conventional pediatric inguinal hernia repair techniques [6].

There were 220 children with clinically diagnosed inguinal Hernia. The patients were divided into two groups of equal size:
Subcutaneous Endoscope-Assisted Ligation (SEAL) (n = 110)
Conventional Herniotomy (CH) (n = 110)

Inclusion Criteria

All children (aged 1–14 years) with a clinically diagnosed inguinal hernia (bilateral or unilateral) that was reducible were included.

Exclusion Criteria

Child patients were excluded from the study if they had incarcerated, strangulated, or irreducible inguinal hernia, recurrent inguinal hernia, major congenital anomalies, significant systemic illness likely to affect surgical outcome, or if they required any other inguinoscrotal surgery, such as orchiopexy or hydrocelectomy.

Surgical Procedures

Parents/legal guardians gave written informed consent prior to surgery. The patients were operated at either SEAL or conventional herniotomy depending on the operating consultant pediatric surgeon's preference. Consultant pediatric surgeons experienced in both procedures performed all under general anesthesia.

SEAL procedure:

After induction of general anesthesia, a 5 mm umbilical port was inserted and pneumoperitoneum was created. A laparoscope was inserted via the umbilical port to look at the inguinal ring inside. A 2-mm stab incision was made over the skin corresponding to the deep inguinal ring. The 20-gauge spinal needle was advanced extraperitoneally around the internal inguinal ring under endoscopic visualization and then a 3-0 polypropylene (Prolene) was tied to it. The ends of the sutures were retrieved at the outside and tied outside of the hernia sac, so that the hernia sac was completely encircled. Steri-Strips were placed over inguinal stab incision and interrupted 3-0 Vicryl sutures were used for closure of umbilical fascial incision.

Conventional Herniotomy

Conventional herniotomy was done using the standard inguinal skin crease incision. The external oblique aponeurosis was exposed and the hernia sac was explored and carefully separated from the structures of the spermatic cord and mobilized up to the internal inguinal ring. The hernia sac was then high ligated with absorbable suture and the distal sac removed. The wound was irrigated, haemostasis was achieved and closure was done in layers with simple surgical techniques.

Follow-up

Patients were discharged according to the institutional postoperative protocol after satisfactory recovery from anesthesia and surgery. They were subsequently followed in the outpatient clinic for one month after surgery. Follow-up visits were scheduled to assess postoperative recovery, wound-related complications, early recurrence, and cosmetic outcomes. Any suspected recurrence was confirmed by clinical examination, with ultrasonography performed when the clinical findings were inconclusive

Data Collection

A structured proforma was used to collect data. Baseline characteristics included age, sex, duration of hernia, and location of the hernia (right, left, or bilateral).
The outcome measures were:

- Operative time (minutes)
- Wound infection within 30 days after surgery

Early recurrence = recurrence within 1 month
Cosmetic results at 1 month.
The cosmetic outcome was evaluated by the operating paediatric surgeon according to the appearance of the scars and classified as excellent, good or poor.

Statistical Analysis

The data were entered and analyzed on SPSS software version 25. The continuous variables, such as age, duration of hernia and operative time were reported as mean ± SD while the categorical variables were reported as frequencies and percentages.
Baseline data were compared for the two study groups to see if they were comparable. Mean operative time in the SEAL and conventional herniotomy groups was compared by using the independent-samples t-test. A Chi-square test or Fisher's exact test was used to compare categorical outcomes such as wound infection, early recurrence and cosmetic outcome, as appropriate. The p value of 0.05 or less were targeted as statistically significant.

RESULTS

The number of children included in the study was 220, who had clinically diagnosed inguinal hernia. Of these, 110 patients had Subcutaneous Endoscope-Assisted Ligation (SEAL), whereas 110 patients had Conventional Herniotomy (CH). No significant difference was seen between the two groups with regards to the baseline characteristics. The mean age of the patients in both groups was similar and the majority of patients in both groups were male. The most frequent hernia was right sided, thereafter followed bilateral and left sided hernias (Table 1).

The mean operative time was 40.9 ± 9.3 minutes in SEAL group and 42.4 ± 7.8 minutes in Conventional Herniotomy group. The mean operative time was slightly reduced in the SEAL group, but failed to reach statistical significance (p = 0.184) (Table 2).
There was rarely any recurrence in early post surgery period in both the groups. Recurrence was observed in four of the 110 patients in the SEAL group (3.6%) and two of the 110 patients in the Conventional Herniotomy group during the 1-month follow-up period. However, there was no statistical difference between the two (p = 0.684).
One patient (0.9%) had wound infection after SEAL and two patients (1.8%) had wound infection after Conventional Herniotomy. Incidence of wound infection was low for both groups, and was not statistically significant (p = 0.561).
Children with SEAL had significantly improved scar appearance at 1 month assessment of cosmetic outcome. The SEAL group had an excellent cosmetic result in 62 cases (56.4%) while the Conventional Herniotomy group had an excellent cosmetic result for 47 (42.7%) patients. In contrast, satisfactory and unsatisfactory cosmetic result was more common after Conventional Herniotomy. Statistically significant difference between both groups was found for cosmetic outcome (p = 0.031) (Table 3).
SEAL and Conventional Herniotomy were both found to have low early recurrence and postoperative wound infections, and the cosmetic results were superior with SEAL with no increase in operative time..

Table 1. Baseline Characteristics of Children Undergoing Subcutaneous Endoscope-Assisted Ligation (SEAL) and Conventional Herniotomy (n = 220)

Characteristics	SEAL (n=110)	Conventional Herniotomy (n=110)	Total (n=220)
Age (years), Mean ± SD	5.01 ± 2.86	4.63 ± 3.28	4.82 ± 3.08
Duration of Hernia (months), Mean ± SD	6.54 ± 4.72	7.01 ± 4.91	6.77 ± 4.81
Gender			
Male	83 (75.5%)	88 (80.0%)	171 (77.7%)
Female	27 (24.5%)	22 (20.0%)	49 (22.3%)
Side of Hernia			
Right	73 (66.4%)	71 (64.5%)	144 (65.5%)
Left	16 (14.5%)	21 (19.1%)	37 (16.8%)
Bilateral	21 (19.1%)	18 (16.4%)	39 (17.7%)

Table 2. Comparison of Operative Time Between Subcutaneous Endoscope-Assisted Ligation (SEAL) and Conventional Herniotomy (n = 220)

Variable	SEAL (n=110)	Conventional Herniotomy (n=110)	P-value
Operative Time (minutes), Mean ± SD	40.9 ± 9.3	42.4 ± 7.8	0.184

Table 3. Comparison of Early Postoperative Outcomes Between Subcutaneous Endoscope-Assisted Ligation (SEAL) and Conventional Herniotomy (n = 220)

Outcome Variable	SEAL (n=110)	Conventional Herniotomy (n=110)	P-value
Wound Infection			
Yes	1 (0.9%)	2 (1.8%)	0.561
No	109 (99.1%)	108 (98.2%)	
Early Recurrence			
Yes	4 (3.6%)	2 (1.8%)	0.684
No	106 (96.4%)	108 (98.2%)	
Cosmetic Outcome			
Excellent	62 (56.4%)	47 (42.7%)	
Good	47 (42.7%)	58 (52.7%)	**0.031***
Poor	1 (0.9%)	5 (4.6%)	

Statistically significant at $p \leq 0.05$.

DISCUSSION

The aim of the present study was to compare the short-term results of two surgical techniques, Subcutaneous Endoscope-Assisted Ligation (SEAL) and Conventional Herniotomy (CH), in children undergoing inguinal hernia surgery. Early recurrence, operative time, wound infection, and cosmetic outcome were the major outcomes that were assessed. Both techniques proved safe and effective with low recurrence and postoperative complications.

Compared with conventional herniotomy, SEAL demonstrated significantly better cosmetic outcomes while maintaining similar operative time and early clinical outcomes

The demographic data of the patients at the beginning of the study were similar for both groups. There was a definite male predominance and the most common presentation was of right-sided inguinal hernia. These results are similar to the known epidemiology of inguinal hernia in children, which is a result of delay in the right processus vaginalis to close and is a higher incidence in male children [9,10].

The mean operative time was slightly recorded less in the SEAL group (40.9 ± 9.3 minutes) than in the Conventional Herniotomy group (42.4 ± 7.8 minutes) but the difference was not statistically significant. In previous comparative studies of MIRs in children, operative times for both minimally invasive and conventional herniotomy were shown to be similar after the learning curve [6,10,11]. The slightly shorter operative times found in the present study could be attributed to the growing experience of the surgeons in using the SEAL technique and efficiency of the procedure.

Recurrence continues to be among the most essential parameters of successful repair of hernias. The rates of early recurrence in the SEAL group (3.6%) and Conventional Herniotomy group (1.8%) were not significantly different in the present study. The overall frequency of recurrence was low, but was numerically higher in the SEAL group. This is similar to a previous study, which reported comparable recurrence rates after minimally invasive extraperitoneal ligation to the conventional herniotomy and surgical technique, experience, and proper closure of the internal inguinal ring had a significant impact on recurrence [5,9,12]. The results indicate that SEAL can be performed by expert paediatric surgeons with acceptable short-term surgical results.

Wound infection after surgery was rare in both groups (less than 2% of patients). The rates of surgical site infection are low, which is similar to the results of previous studies that showed high safety rates for both minimally invasive and conventional approach to inguinal hernia repair in children [7,11,13]. The good incidence of infection rates seen in this study could be due to the careful surgical technique, aseptics, infection prevention measures around surgery and the generally healthy population of children that were included in the study.

One of the most interesting results of the present study was the significant superiority of cosmetic results in SEAL. Appearing scar was significantly better in the SEAL group than in the Conventional Herniotomy group (more than half children in the SEAL group had excellent appearance of the scar). This is an advantage because SEAL only does a small umbilical incision and a very small hole above the groin as compared to the traditional groin incision. The same comparative studies have also found that cosmetic satisfaction was better with minimally invasive extraperitoneal ligation methods due to the less dissection of the soft tissues and minimal scarring [3,6,10,14]. Better cosmesis can have a positive impact on the parents' satisfaction, and this is an important factor in choosing the surgical procedure for children.

Another benefit of SEAL is the opportunity to examine the contralateral internal inguinal ring in the same procedure. This makes it easier to identify a contralateral patent processus vaginalis which can be repaired at the same time if indicated, lowering the risk of developing a contralateral inguinal hernia [3,15]. Contralateral exploration was not specifically assessed in the present investigation, but is a significant practical advantage of the SEAL technique and is likely to be a factor in the expanding use of the technique in the treatment of children.

In conclusion, the results of the present study confirm those of recent literature that minimal access extraperitoneal ligation methods (SEAL) yield clinical results that are in line with those of Conventional Herniotomy but with excellent cosmetic results. Recent systematic and comparative reviews have shown that there is no difference between the two techniques in recurrence or postoperative complications, while there are consistent advantages of the minimally invasive method in terms of cosmesis and visualization of the contralateral inguinal ring [3, 6, 16, 17]. Therefore, surgical approach should be tailored to the specific skill and resources of the surgeon, and to the patient's particular circumstances.

The results of this study have clinical significance. SEAL and Conventional Herniotomy have the advantage of being safe and effective for the treatment of pediatric inguinal hernia with low early recurrence rate and postoperative wound infection. In centers with suitable endoscopic equipment and surgical skills, however, better cosmetic results with SEAL may make it the preferred treatment. Additional multicenter trials with longer follow-up periods and larger numbers of patients are recommended to assess the rates of recurrence, chronic postoperative complications, and patient/parent satisfaction after both techniques [18-20].

Limitations

There were some limitations in this study. The non-randomized nature of the study design may be responsible for selection bias, due to the selection of the operative technique by the consultant surgeon. Secondly, the follow-up period was only 1 month, which did not allow for long-term recurrence or late postoperative complications to be evaluated. Third, the outcome assessment wasn't completed by a validated cosmetic assessment tool completed by parents or patients, leading to the potential for observer bias. Lastly, the study was performed at one tertiary care center, so the results may not be generalizable. Longterm multicenter randomized controlled trials with longer follow-up are recommended to validate its long term efficacy and safety in children compared to Conventional Herniotomy.

CONCLUSION

In the treatment of pediatric inguinal hernia, both Subcutaneous Endoscope-Assisted Ligation (SEAL) and Conventional Herniotomy (CH) were demonstrated to be safe and effective techniques, and the early recurrence and postoperative wound infection rates were low. Time in surgery was similar for both procedures. SEAL was however, associated with significantly better cosmetic outcomes with a higher percentage of children having an excellent scar appearance at 1 month follow-up. The results indicate that both methods yield good clinical results in the short term, but SEAL has an added aesthetic benefit and could be the preferred minimally invasive method in centers with the proper expertise and equipment. Additional multicenter, randomized trials with longer follow-up time are suggested to assess long-term recurrence, functional outcome, and patient's/parent's satisfaction.

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