Original Article

Single incision multiport versus conventional laparoscopic inguinal hernia repair: A matched comparison

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Abstract

Background: The popularity of single-incision procedures is on the rise as wound cosmesis is increasingly being seen as an important body image-related outcome. In this study, we assess the potential benefits of single-incision multiport laparoscopic totally extra-peritoneal (S-TEP) without using specialised ports or instruments and compare the same with the conventional laparoscopic TEP (C-TEP) surgery in terms of operative time, post-operative pain, complications, cost and cosmesis.

Materials and Methods: This is a prospective case-matched study of the patients undergoing S-TEP versus C-TEP from June 2014 to December 2015.

Results: Each group had 36 patients. The two groups were comparable in the clinical characteristics. The mean duration of surgery for a unilateral hernia in C-TEP and S-TEP was 45.13 ± 10.58 min and 72.63 ± 15.23 min, respectively. The mean visual analogue scale (VAS) score for pain was significantly higher in S-TEP group at post-operative day (POD) 0 and 1. However, at POD 7, there was no significant difference between the groups. At 1st and 6-week post-surgery, the cosmetic results were significantly better in S-TEP group as compared to C-TEP, however, at 6 months, the scar was highly acceptable in both treatment groups.

Conclusion: S-TEP, using conventional laparoscopic instruments, is safe and feasible even in resource challenged setting. However, there is a need to review the indications and advantages of single-incision laparoscopic surgery, as no difference in cosmetic outcome by VAS score in S-TEP versus conventional laparoscopic arm seen by the end of 1 month.

Keywords: Inguinal hernia, laparoscopic hernia repair, single-incision multiport laparoscopic surgery, totally extra-peritoneal

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INTRODUCTION

Although the interest in the use of single-incision laparoscopic surgeries (SILSs) developed following the progress of minimally invasive surgery approach, the pace remained gradual, mainly because of technical difficulties faced by surgeons, like loss of triangulation, clustering of instruments, very narrow working angle,[1] etc. As the experiences in conventional laparoscopic surgeries have improved, SILS procedures too are popularising, partly contributed by improved learning curves of surgical

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fraternity along with increasing patient's awareness towards the cosmetic appearances.

SILS totally extra-peritoneal (TEP) was first reported in 2009[2] and since then few prospective studies[3-5] have demonstrated its safety and feasibility but major issue with the propagation of SILS is requirement of special instruments and modern expensive ports, contributing to enhanced cost of surgery, with added economic burden to the patients and hence, practical utility and benefits of SILS remain out of reach for most, especially in resource poor setting. To reduce the cost associated with special instruments, we have a modified the approach towards SILS known as single-incision multiport laparoscopic surgery (SIMPLE) technique using conventional laparoscopic instruments. Very few studies have reported on SILS-totally extra-peritoneal (SILS-TEP) using conventional laparoscopic instruments.[3]

With this study, we aimed to analyse the feasibility, safety and potential benefits of single-incision multiport laparoscopic TEP (S-TEP) without using specialised ports or instruments and compare the same with case-matched controls of conventional laparoscopic TEP (C-TEP) in terms of cosmesis, post-operative pain, operative time, complications and cost.

MATERIALS AND METHODS

Study area and design

This prospective case-matched study included all the inguinal hernia cases undergoing S-TEP mesh repair at our institute, from June 2014 to December 2015. These were matched (1:1 proportion) with cases of C-TEP, based on age (<40 and >40 years groups), side of hernia (direct/indirect) and unilateral versus bilateral types. The inclusion criteria incorporated were, a diagnosed case of symptomatic direct or early indirect inguinal hernia planned for laparoscopic TEP hernia repair. Cases like large inguinoscrotal hernia, the American Society of Anesthesiologists grade >2, with a history of lower abdominal surgery and recurrent hernia were excluded from the study.

Primary outcome assessed was wound cosmesis, evaluated by visual analogue scale (VAS). Secondary outcomes assessed include post-operative pain, operative time, blood loss, intraoperative complications, conversion, surgical site infection (SSI), the length of hospital stay and total direct cost.

Data collection

All data relating to the clinical characteristics of the patients, intraoperative and post-operative parameters and procedure related cost, were analysed. Pain assessment was done by VAS at day 0, day 1 and day 7. Cosmetic outcome was assessed at 6 weeks and 6 months using visual analogue score. All patients were asked to evaluate an open surgery scar photo like groin incision scar for standard Lichtenstein's mesh repair and compare it with their surgical scar on a VAS scoring chart, the open scar was accepted as 0 and the highest satisfaction with cosmetic appearance was rated as 10.

Statistical analysis

Descriptive statistics were used to evaluate demographic and disease-specific characteristics. All quantitative data were expressed as mean (μ) along with standard deviation. Cosmesis and pain (VAS) scores at different time intervals with rest of continuous variables were compared using two-tailed Student's independent *t*-test. Comparison between categorical variables (clinicopathological and outcomes) was done using Chi-square test or Fischer's exact test depending on the dispersion of data. Multivariate analysis was performed using factorial ANOVA, linear and logistic regression model. The significance level was accepted at $P \leq 0.05$. SPSS version 23 (IBM Corp. New York, United States) statistical software was used for analysis.

Post-operative follow-up

Post-operatively patients were assessed for outcomes at 7th day, 6 weeks, 6 months and 1 year. The outcomes assessed at 7th day were pain (VAS score), post-operative complication such as SSI and new symptoms if any. The outcomes assessed at 6 weeks and 6 months were cosmesis (VAS score), long-term post-operative complication and recurrence, if any.

Surgical technique of single-incision multiport laparoscopic totally extraperitoneal mesh repair for an inguinal hernia

All patients were catheterised after induction of anaesthesia and received 1 g of injection cephazolin. Patients were prepped with provodine-iodine from the mid thighs to the epigastrium. The patient is placed in the supine position under general anaesthesia with the right arm tucked. The monitor is placed at the foot of the operating table. The surgeon stood first on patient's left and later on the patient's head end side [Figure 1].

A 2.5-cm transverse skin crease incision is made in the lower margin of the umbilicus. The subcutaneous tissue is dissected down to the anterior rectus sheath on the side of a hernia for a unilateral hernia or the side of the larger hernia in cases of bilateral one, with the aid of long blade

L-shaped retractor. The anterior rectus sheath is then incised transversely from midline to laterally with care being taken to avoid going through the intersection. The fleshy part of the rectus muscle can usually be seen through the anterior rectus sheath. The L-shaped retractors are then used to retract the rectus muscle laterally and anteriorly. A long artery is used to create or widen space between muscle and posterior rectus sheath, into two layers of transversalis fascia. A 10-mm reusable metallic trocar is introduced behind the rectus muscle, into the pre-peritoneal space. Trocar is fixed to the sheath at place using silk 1–0 to prevent loss of pneumo from extra peritoneal space. A zero degree, normal length and rigid scope are advanced into the 10-mm trocar, and the pre-peritoneal space is insufflated to 12 mmHg to create and maintain pre-peritoneal space. At this stage, the patient is placed, 10° to 15° head down. This space is further dissected using the telescope by gradual, progressive, up and down movements, first on the right and then on the left side, under direct vision. The extra subcutaneous plane is created above posterior sheath, adjacent to original dissection. Two 5 mm reusable metallic trocars are inserted into pre-peritoneal space under vision at 10 o' clock and 2 o' clock position for bilateral hernia repair [Figure 2].

The dissection then proceeds in the same way as for standard laparoscopic TEP repair using two standard laparoscopic dissectors. The principles of TEP, dissection and repair remain essentially the same and must be followed to avoid injuries to the bladder, vessels, nerves and cord structures. The symphysis pubis is identified and dissected free of areolar tissues, and the bladder is pushed downwards. The inferior epigastric vessels are identified, space is created just laterally to vessels and continued medially until the cord structures are identified. The pre-peritoneal space is cleared out laterally towards the anterior superior iliac spine. Parietalisation of cord structures is done upto an optimum distance. A direct hernia, if present, is reduced by gentle traction on the pseudo sac. The indirect hernia sac is found along with the spermatic cord and immediately cephalad to it [Figure 3]. Within the spermatic cord, usually the vas deferens is located medially and the spermatic vessels laterally, both merging through the internal ring. The indirect sac dissected of all sling fibres and is reduced from the internal ring by gentle traction and dissection. If the sac is too long or too large, it can be isolated, divided just beyond the internal ring, and closed with polypropylene loop. The distal end of the transacted sac is left open to avoid the formation of hydrocele. The peritoneum is pushed back as far as possible into the abdominal cavity. Polypropylene mesh (Trulene, Sutures India Pvt Ltd, Bangalore, India) of size 18 cm x 12 cm is fashioned accordingly with bladder cut on the medial side and introduced from 10 mm trocar [Figure 4]. Mesh is positioned over the myopectineal orifice of Fruchaud [Figure 5] and is fixed to Cooper's ligament using 1–0 prolene by intracorporeal fashion. If a bilateral inguinal hernia is present, then similar dissection follows on the opposite side. Once the mesh is in place, deflation occurs under direct vision with the patient being placed at 15° head up. The rectus sheath is now closed with interrupted Nylon no 1 sutures. The subcutaneous layer is closed with 2.0 Vicryl, and the skin is closed with 4.0 Monocryl subcuticular [Figure 6]. One point of caution is that if the skin incision is slightly small or the procedure takes a long time, then the skin edges, usually the inferior edge, tend to become ischaemic, and this must then be excised to prevent poor wound healing and potential infection. The wound is then dressed with SteriStrips (3M, Minneapolis, USA) and Opsite (Smith and Nephew, London, UK). Patients are usually allowed orals after 4 h, discharged next day.

Unique challenge with loss of triangulation

Dissection techniques must be modified to accomplish safe and efficient TEP repair with SIMPLE. Because all three instruments are in the same port, clashing of these instruments can occur, especially, if a normal 10-mm scope is used. Two of the most important manoeuvres are first the "inline" dissection, i.e., with one dissecting instrument pushing away and the other pulling the instrument out. This manoeuvre is, especially, useful for reducing an indirect sac or lipoma of the cord. The second important manoeuvre is the "vertical" dissection technique whereby dissecting instruments go vertically in opposite directions on either side of the laparoscope. This is, especially, useful for dissecting the lateral space. The normal "horizontal" dissection technique can still be used, but this is limited, because of the clashing of instruments, to achieving dissection of delicate structures in millimetres at a time.

RESULTS

During the study, a total of 122 patients with inguinal hernias fulfilled the inclusion criteria. Among them, forty patients underwent S-TEP surgery (S-TEP group), and 82 patients underwent C-TEP hernia repair (C-TEP group). To compare operative outcomes and cosmetic outcomes, 36 patients of the S-TEP group could be matched on an equal basis with 36 patients who received C-TEP. There were no statistically significant

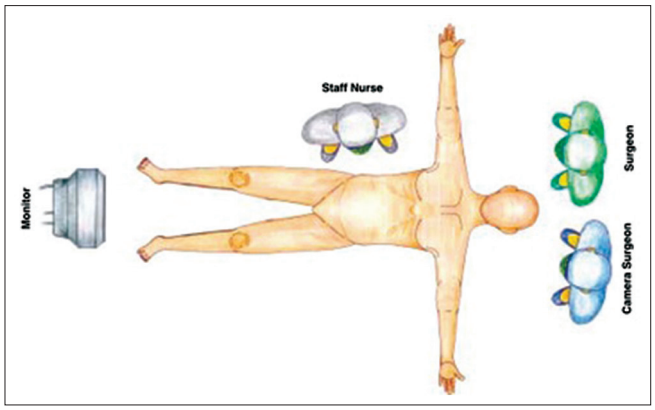

Figure 1: Position of the operating team and monitor

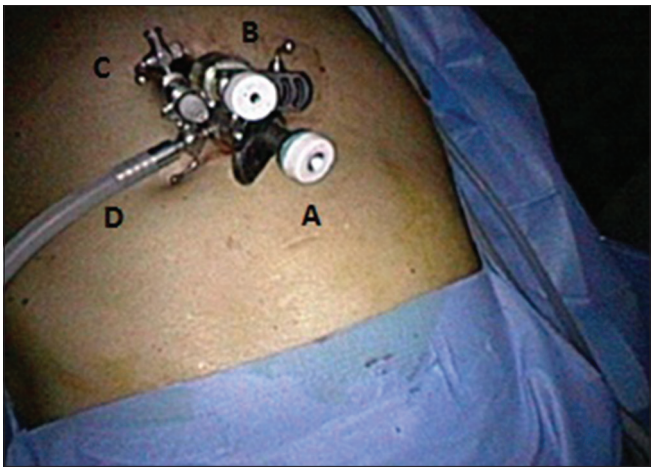

Figure 2: Port position: (A) 10 mm port for camera. (B) Right hand working port (5 mm). (C) Left hand working port (5 mm). (D) Gas tube for insufflation of CO2°

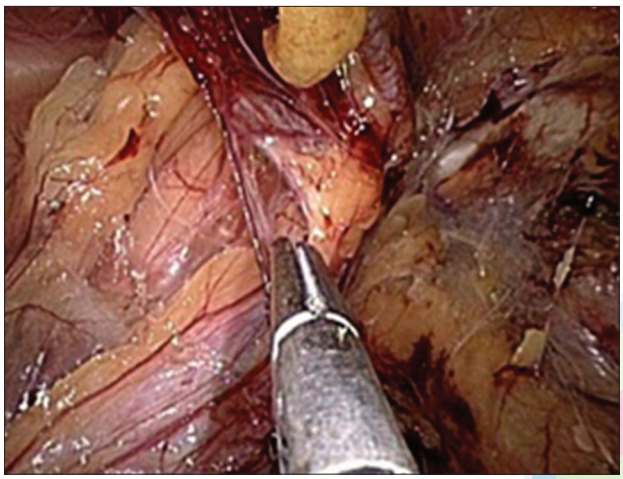

Figure 3: Dissection of hernial sac

Figure 4: Introduction of mesh through 10 mm camera port

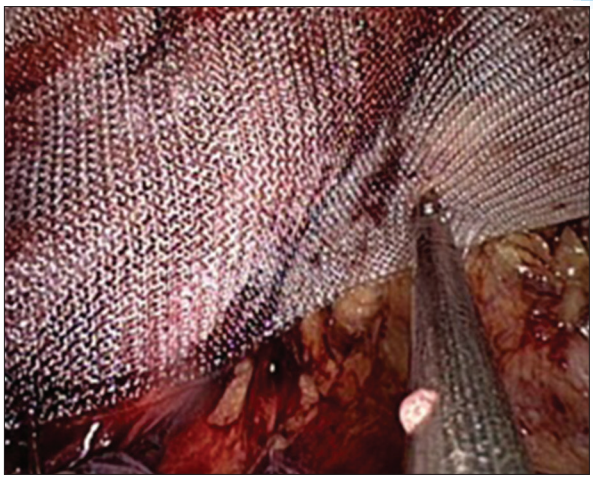

Figure 5: Fixation of mesh to Cooper's ligament

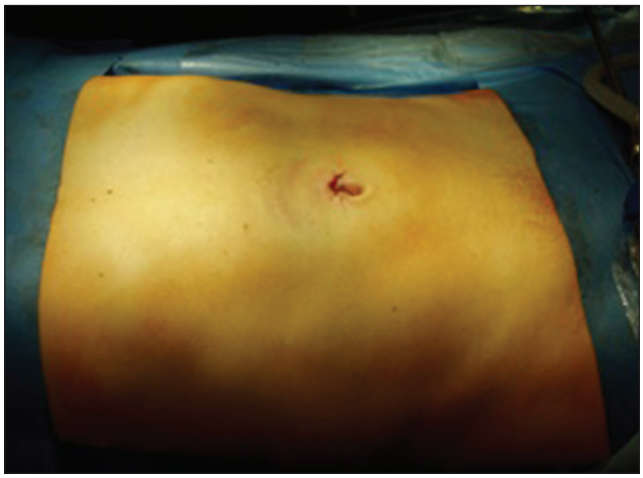

Figure 6: Port site closed and final scar

differences in clinical characteristics of patients between two groups [Table 1]. As types and sides of hernias were case matched, were equal in both arms. Out of total 72 patients, the study had 39 direct and 33 indirect types, of which 24 were unilateral. In terms of operative results [Table 2], the mean duration of surgery was significantly longer ($P = 0.001$) in S-TEP for unilateral as well as bilateral hernia repair than its conventional counterpart (C-TEP).

The mean blood loss was comparable in either groups (P = 0.2). Various complications like vascular injury, peritoneal tear, cord and nerve injuries were assessed between two treatment groups. The most common intraoperative complication was a peritoneal tear, but there was no significant difference between two groups (P = 0.53). Vascular injury (inferior epigastric artery) was observed in two patients of C-TEP group (5.5%) and four patients in S-TEP group (11.1%), without significant difference (P = 0.45). There was no cord or nerve injury in either of the groups. In S-TEP group, 2 (5.5%) patients were converted to conventional laparoscopy, but without any open conversion.

Post-operative parameters

Post-operative pain was assessed at post-operative day (POD) 0, 1, before discharge and POD 7 in OPD during first follow-up. On comparing the two treatment groups, the mean pain score (VAS) was significantly higher in S-TEP group at initially, but was similar at 7th day [Table 3].

Post-operative complications

Most common, post-operative complication observed was seroma. No patients in either of group developed port site haematoma, flap necrosis, SSI or port site hernia. There was no recurrence of hernia in either of the group at 1-year follow-up. There was no readmission in either of the disease groups for treatment-related complication. S-TEP scores better in terms of cosmesis till 6 months, after which difference becomes insignificant [Chart 1].

DISCUSSION

Since the laparoscopic approach to inguinal hernia repair was described in the early 1990s, this technique has spread widely and experienced substantial changes.[6] Minimally invasive surgery aims to provide effective treatment of surgical diseases while decreasing access-related morbidity.

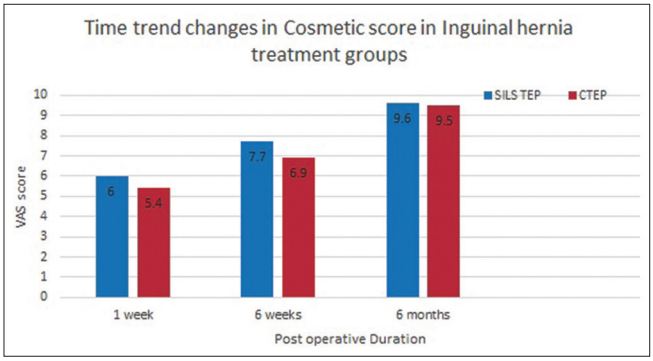

Chart 1: Changes in cosmetic scores during post-operative period (n = 72) single incision laparoscopic surgery totally extra-peritoneal hernia repair conventional totally extra-peritoneal hernia repair

SILS is the result of the continuous search for increasingly less invasive approaches, although it appears to be a complex technique. SILS has the potential to provide patients with improved cosmesis, decreased pain and higher satisfaction for with having only a single-wound.[7] SILS obviates the need to place ports externally for triangulation, thus allowing for the creation of a small, solitary portal of entry into the abdomen for inguinal hernia repair. In the present study, there is a significant difference between two treatment groups (P = 0.001) in operative time for both unilateral and bilateral hernias. Most studies report

Table 1: Comparison of demographic variables in two treatment groups (n=72)

Demographics	C-TEP group (n=36)	S-TEP group (n=36)	P
Age (mean±SD)	45.38±13.08	46.41±12.51	0.7
Gender (male:female)	35:1	33:3	0.3
BMI (mean±SD)	24.76±3.49	23.51±3.14	0.11
ASA score			
I	26	27	0.5
II	10	9	

C-TEP: Conventional totally extra-peritoneal, S-TEP: Single-incision multiple port laproscopic totally extra-peritoneal, BMI: Body mass index, ASA: American Society of Anaesthesiologists, SD: Standard deviation

Table 2: Intraoperative outcomes characteristics (n=72)

Variable	C-TEP	S-TEP	P
Operative time (min)			
Unilateral	45.13±10.58	72.63±15.23	0.001
Bilateral	61.15±9.5	90.12±10.5	0.001
Blood loss (ml)	15.9±2.6	16.9±4.5	0.2
Conversion	0	2 (5.5)	0.2
Intraoperative complications, n (%)			
Peritoneal tear	3 (8.3)	4 (11.1)	0.45
Vascular injury	2 (5.5)	4 (11.1)	

C-TEP: Conventional totally extra-peritoneal, S-TEP: Single-incision multiple port laproscopic totally extra-peritoneal

Table 3: Post-operative outcomes (n=72)

Variable	C-TEP	S-TEP	P
Hospital stay, days	1.08±0.28	1.02±0.16	0.3
Complications			
Seroma	3 (8.3)	5 (13.9)	0.7
Recurrence	0	0	
Re admission	0	0	
Post-operative pain analysis, VAS score at			
POD 0	5.61	6.05	0.01
POD 1	3.02	3.36	0.02
POD 7	0.36	0.19	0.24
Cosmesis analysis, VAS score at			
1 week	5.4±0.5	6.0±0.2	0.001
6 weeks	6.9±0.82	7.7±0.65	0.001
6 months	9.5±0.5	9.6±0.4	0.4
Cost analysis (Rs.)	40,194.4±624	42,500±1647	0.1

C-TEP: Conventional totally extra-peritoneal, S-TEP: Single-incision multiple port laproscopic totally extra-peritoneal, POD: Post-operative day, VAS: Visual analogue scale

initial longer operating times, which tend to improve after learning curve and experience have been achieved[3,5] but will remain more than that for C-TEP due to use of conventional rigid laparoscopic instruments creating an ergonomically challenged operating field.

Peritoneal tear is the most common intraoperative complication in our study (S-TEP – 11.1%, C-TEP – 8.3%, $P = 0.45$), comparable with a study by Tsai *et al.* who reported 8% peritoneal tear. Two (5.5%) patients in S-TEP were converted to C-TEP repair ($P = 0.2$). However, no patient from either of the groups was converted to open surgery. Buckley *et al.*[8] had a conversion rate of 3.8% in SILS group. Hospital stay in our study is comparable with data published elsewhere.[9,10] Seroma was the only post-operative complication seen in the present study whose occurrence is comparable to observed literature, Wakasugi *et al.*[11] reporting a seroma incidence of 11% and Wijerathne *et al.*[10] having a 7.7% incidence of seroma. In this study, intraoperative complications, such as injury to cord structures and iliac vessels and post-operative complications such as acute urinary retention, mesh infection, ischaemic orchitis, recurrence of a hernia and chronic pain, were not observed in any of the subjects during a follow-up period of 12 months. There were no instances of port site SSIs or haematoma in the immediate post-operative period and no instances of port site hernias on follow-up of 12 months. The results of our study are comparable with results of the study by Tran,[12] who reported no intraoperative or post-operative complications with a high patient satisfaction score.

On comparing the two treatment groups, the mean pain score (VAS) was significantly higher in S-TEP group at POD 0 and 1. However, at POD 7, there was no significant difference between the groups, probably attributable to a bigger incision in S-TEP. Meta-analysis by Lo *et al.*,[13] four studies used the visual analogue scale to evaluate the post-operative pain on the 7th day after operation[4,5,9,10] and didn't show a significant difference. A similar article by Wakasugi *et al.*,[11] SILS-TEP repair is comparable to conventional TEP repair in terms of the post-operative pain scores 3 months after surgery. Studies reporting pain reduction after SILS-TEP also exists, highlighting the importance of reduced number of skin incisions made during SILS-TEP.[9] Although it is hypothesised that the use of fewer ports and a shorter total skin incision length would reduce the post-operative pain, most patients complained of pain in the inguinal dissection area rather than at the post-insertion site, and the inguinal dissection area in the two groups was the same. Our study showed no significant differences in the VAS scores between the two groups at 7 days after surgery.

This study has analysed cosmetic score using VAS score at 1 week, 6 weeks and 6 months after surgery. At 1 week post-surgery, the cosmetic results were significantly better in S-TEP group as compared to C-TEP (S-TEP – 6.0 ± 0.2, C-TEP – 5.4 ± 0.5, $P = 0.001$). Despite satisfactory scar (i.e., score better than 5) in both treatment groups, cosmesis was significantly better in S-TEP group at 6 weeks as compared to C-TEP (S-TEP – 7.7 ± 0.65, C-TEP – 6.9 ± 0.82, $P = 0.001$). But at 6 months the scar was highly acceptable (i.e., VAS score more than 9) in both treatment groups (S-TEP – 9.6 ± 0.4, C-TEP – 9.5 ± 0.5, $P = 0.4$), fading the difference S-TEP offered initially. Tsai *et al.*,[9] showed that SILS definitely decreased the number and sum of skin incision. This advantage was unfortunately not proved by the patient-reported questionnaire, although the cosmetic advantage had been confirmed by a few randomised trials.[14,15] A recent study comparing patient-reported body image and cosmesis among patients who underwent SILS, laparoscopy, or open surgery showed that viewing photographs of alternative scars could greatly affect levels of satisfaction.[16] In other words, without alternative scar comparisons, the self-reported questionnaire might fail to show any cosmetic advantage of SILS.

In SILS, there is technical difficulty such as loss of triangulation, clustering of instruments, very narrow working angle due to closely placed trocars, resulting in increased duration of learning curve.[7] However, newer ports, 'in line' telescopes, new generation of articulating instruments have overcome these limitations by providing pseudo or cross triangulation,[17] but these sophisticated instruments add to the cost of surgery and add economic burden to the patients, and hence practical applicability and benefits of SILS remain out of reach for patients in resource poor setting. To avoid this crisis, we have been using the routine laparoscopic instruments for single-incision multiple-port laparoscopic surgery (SIMPLE), so that the cost of the special port and instruments is avoided.

In cost sensitive country like India, it leads to significant savings in not using the specialised ports and instruments. Each special port cost between Rs 35,000/- and Rs 75,000/- which is ultimately transmitting in higher procedural cost. In today's world where no country is untouched by the economic downturns and constraints in healthcare-related funding, it may help save precious resources for better use. In our study, the cost in S-TEP group, using routine laparoscopic instruments was not statistically different from the conventional group (C-TEP) without compromising the safety of the patient. However, the actual cost when using specialised ports and articulating

instruments is significantly higher. Few initial reports have been encouraging. However, the concrete data regarding this concept remains scarce.[18] These results are similar to certain published studies.[18-20] There is no increase in the conversion rates or post-operative complications with the usage of conventional laparoscopic instruments for SILS, rather it would considerably reduce the cost and could ensure the development of SILS as a standard of care even in resource poor settings.

Finally, there are no real contraindications for this type of approach, being the same as those that may exist for the conventional laparoscopic approach. However, the cases, where there is a difficulty even for conventional laparoscopic surgery, such as large inguinoscrotal hernias, are not the best cases for this new type of SILS approach, since there will be limited traction by using conventional instruments, in reducing the hernia sac, thereby becoming a very complex surgery. A conventional laparoscopic approach is advisable for these cases. On the other hand, the use of SILS in females can be a good indication, as usually they have smaller hernias and cosmetic results will be appreciated with a high degree of satisfaction.

Although the ease of performing one access over other could not be analysed objectively, the higher learning curve requirement and surgeon's stress for SIMPLE laparoscopic surgeries can be extrapolated from higher operating time. Considering the volume of cases and ample technical expertise available at this centre, where the present study was conducted, it is advisable to avoid SIMPLE approach, especially during the initial part of career. As the demand for single incision procedures is likely to increase over the coming period, in view of perceived cosmetic benefits, it the duty of surgical fraternity to educate the patient regarding the actual results, but at the same time surgeon's should familiarise themselves for this evolving technology, especially, single-incision, multiport technique, which allows the procedure to be done with routine instrumentation, reducing requirement for specials port as well as can benefit from improved the angulation to an extent, so as to reduce surgeon's struggle, and thus ultimately influencing patient related outcomes.

CONCLUSION

Single incision approach didn't offer any advantages in terms of cosmesis and pain as measured by VAS score by the end of 1 month. The modified SILS (SIMPLE) procedures cost more as compared to their laparoscopic counterparts, although no special instrumentation was needed, the difference is mainly contributed by increased operating time. The other various secondary outcomes like post-operative pain (VAS), blood loss, complications, conversion and the length of hospital stay did not show any statistically significant difference. Single-TEP can be used safely if the surgeon is sufficiently knowledgeable of inguinal anatomy and proficient in laparoscopic surgical techniques.

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Conflicts of interest

There are no conflicts of interest.

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