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A NOVEL LAPAROSCOPIC PORT CLOSURE NEEDLE VERSUS THE CONVENTIONAL SUTURE PASSER FOR TROCAR-SITE FASCIAL CLOSURE: A PROSPECTIVE COMPARATIVE STUDY

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ABSTRACT

Background: Trocar defects of 10 mm or larger must be securely approximated, or they can progress to port-site hernia and other wound-related morbidity. Standard suture-passer instruments frequently need several attempts to capture the fascia and leave the operating surgeon fatigued, an effect that is magnified in patients with a thick abdominal wall. We therefore assessed a newly engineered, reusable needle built specifically to make trocar-site closure more straightforward.

Methods: Thirty adults scheduled for elective laparoscopic cholecystectomy, appendicectomy, TAPP repair or IPOM repair, each requiring closure of at least one 10-mm or larger port, took part in this prospective, interventional, two-arm comparison. Fifteen patients had their trocar sites closed with the newly developed needle and fifteen with a standard suture passer. Time taken to close the port served as the primary endpoint; secondary endpoints comprised surgeon-reported ease of handling and fatigue on a 10-point visual analogue scale, complications occurring during surgery, pain scored at 24 hours after surgery, and wound-related problems tracked for three months afterward. Group differences for numerical data were tested with an unpaired t-test, while proportions were compared using chi-square analysis or Fisher's exact test as appropriate (SPSS version 26.0); a p-value below 0.05 was taken to indicate significance.

Results: The two groups did not differ on any baseline demographic or clinical variable ($p>0.05$ throughout). Closure of the port took considerably less time with the new instrument, averaging 1.68±0.18 minutes against 3.49±0.31 minutes for the conventional passer ($p<0.001$). Surgeons also rated the novel needle easier to handle (score 9.27±0.24 versus 7.21±0.24; $p<0.001$) and reported markedly less fatigue while using it (2.05±0.25 versus 4.50±0.24; $p<0.001$); pain scores 24 hours after surgery were likewise lower in the novel-needle arm (2.33±0.49 versus 3.47±0.52; $p<0.001$). Complications occurring either during or after the operation — for instance instrument breakage (0% versus 13.3%) and port-site hernia (0% versus 6.7%) — trended lower with the new device, although none of these differences reached statistical significance.

Conclusion: Compared with the conventional suture passer, the newly designed needle closed fascial defects more quickly, was easier to operate, and produced less surgeon fatigue, while its safety profile remained similar. These early results justify continued refinement of the prototype and testing in larger trials spanning multiple centres.

KEYWORDS: laparoscopic surgery; trocar-site closure; port-site hernia; suture passer; surgical instrument design; fascial closure

INTRODUCTION

For many abdominal procedures, surgeons now favour the laparoscopic route over open surgery, largely because it causes less pain afterward, allows patients to leave hospital sooner, speeds functional recovery and leaves a more acceptable scar[1-3]. Yet placing a trocar of 10 mm or more opens a gap in the fascia, and if that gap is not properly closed it can progress to port-site hernia, entrapment of bowel, wound infection, a collection of blood, or ongoing discomfort — sometimes serious enough to warrant a further operation[5-8].

Closing the fascia by suturing directly through the skin incision becomes difficult when the patient is obese or the fascial edges cannot be seen clearly[8,16]. A range of purpose-built tools have been introduced to make fascial capture more reliable[9,12], among them the Cobbler needle, J-needle, aneurysm needle, Carter-Thomason CloseSure System, Weck EFx Shield, VersaOne, and the motorised NeoClose system (Figure 1). Yet each comes with drawbacks: some need several needle passes, others are mechanically complicated, expensive, or dependent on single-use parts. Despite these alternatives, the ordinary suture passer is still used most often, even though it commonly needs repeated attempts and leaves surgeons noticeably fatigued, a problem that worsens when the abdominal wall is thick[9,13,15].

Figure 1. **Existing laparoscopic port closure instruments**

(a) conventional suture passer; (b) Cobbler needle; (c) J-needle; (d) Carter-Thomason CloseSure System; (e) Weck EFx Shield Fascial Closure System; (f) NeoClose Automated Closure System; (g) VersaOne Fascial Closure System.

In response to these limitations, we developed and built a new laparoscopic port closure needle (a patent application covering the design has been filed) that combines an ergonomic handle, a pivoting joint, a sliding mechanism for suture retrieval, and a conical tip with a groove that holds the suture securely[12,14]. This study set out to weigh its practicality, safety and effectiveness against those of the standard suture passer among patients undergoing elective laparoscopic procedures.

Aim: To determine whether the novel laparoscopic port closure needle is at least as practical, safe and effective as the conventional suture passer when used for fascial closure during laparoscopic surgery.

The main objectives were to compare the time required to close the port, along with surgeon-rated ease of handling and fatigue, between the two instruments. Additional objectives covered intraoperative bleeding, breakage of the instrument, injury to intra-abdominal organs, pain after surgery, and wound complications during follow-up, namely infection, seroma, haematoma and port-site hernia.

MATERIALS AND METHODS

Study Design and Setting

This prospective, interventional comparison took place across a 12-month period (January 2025 to January 2026) in the General Surgery department at Saveetha Medical College and Hospital, part of SIMATS in Chennai, India; each enrolled patient was then followed for a further three months after surgery. Institutional ethics committee clearance was obtained beforehand, the trial was carried out in line with the principles of the Declaration of Helsinki, and it is registered as CTRI/2026/03/105914. Every participant gave written consent prior to enrolment.

Participants

Eligibility was open to adults of 18 years or above who were booked for elective laparoscopic cholecystectomy, appendicectomy, TAPP hernia repair, or IPOM repair[4,20] and who needed at least one trocar site of 10 mm or wider closed. Excluded were patients operated on as an emergency, anyone converted to an open procedure during surgery, pregnant patients, those with abdominal-wall distortion from a prior port site, an ongoing wound infection, or an inability to attend follow-up visits. Recruitment proceeded consecutively until thirty patients were enrolled, split evenly between Group A (novel needle, n=15) and Group B (conventional suture passer, n=15).

The Novel Port Closure Needle

Built from medical-grade stainless steel so that it can withstand repeated autoclaving without wearing out, the instrument has four functional parts. An ergonomically shaped handle gives the surgeon a secure, comfortable grip; a pivot joint carries the movement of the handle down to the working tip; a sliding component lets the distal end be advanced or withdrawn in a controlled way so the suture can be caught and pulled back without repeated fumbling; and a sharply pointed conical tip carries a groove running along its length that holds the suture firmly as the instrument passes through the abdominal wall and is later withdrawn (Figure 2).

Figure 2. The novel laparoscopic port closure needle.

(a) the full instrument in lateral view, showing the ergonomic handle, pivot joint and sliding mechanism; (b) close-up of the conical tip; (c) close-up of the tip showing the longitudinal suture-retention groove.

Operative Technique

Once the main operation was finished, intra-abdominal pressure was lowered to 8–10 mmHg and the trocar drawn back partway so the fascial edges came into view. For patients in Group A, the grooved tip loaded with suture was passed through one edge of the fascial opening under direct laparoscopic view, withdrawn, and then reinserted on the opposite side; the sliding component was then engaged to catch and draw back the free suture end, so that the suture crossed the defect on both sides. Group B patients had their ports closed using the conventional suture passer in its usual manner. Both arms used identical delayed-absorbable suture material, with interrupted knots used to close the fascia, followed by standard closure of the skin. An observer not involved in the surgery recorded all operative variables as they occurred. Figure 3 depicts the sequence of steps followed with the novel needle.

Figure 3. Operative steps using the novel laparoscopic port closure needle.

(a) suture loading into the grooved tip; (b) introduction of the needle through the trocar-site fascial edge; (c) laparoscopic view of suture passage through the fascial layer; (d) retrieval of the suture from the opposite fascial edge; (e) knot tying to complete fascial closure.

Outcome Measures
Port closure time — measured in minutes from when the instrument was first inserted to when the final knot was secured — was the study's primary endpoint, and it was clocked by an observer independent of the surgical team. Additional intraoperative measures included the surgeon's own rating of ease of use and fatigue, each recorded on a 10-point scale straight after closure, along with any bleeding from the abdominal wall or port site, breakage of the instrument, and injury to intra-abdominal organs. After surgery, pain was scored on a 0–10 scale at the 24-hour mark, and patients were checked on day 7 and again at one and three months for wound complications such as infection, seroma, haematoma, or hernia at the port site.

Statistical Analysis
All data were logged in Microsoft Excel before being analysed in IBM SPSS Statistics, version 26.0 (IBM Corp., Armonk, NY, USA). Numerical variables are reported as mean±SD and were compared between the two arms with an unpaired t-test; categorical variables are given as counts and percentages and were assessed using the chi-square test, switching to Fisher's exact test whenever an expected cell count fell below five. Statistical significance was set at a two-tailed p-value of less than 0.05.

RESULTS
The final cohort numbered thirty patients, fifteen per arm. As Table 1 shows, the two arms were well matched on demographic and clinical variables at study entry, confirming that the groups were suitable for comparison. Cholecystectomy accounted for the largest share of procedures in each arm (40.0%), followed in frequency by appendicectomy, TAPP repair, and IPOM repair; the mix of procedures did not differ meaningfully between arms (p=0.932).

Table 1. Baseline demographic and clinical characteristics.

Characteristic	Novel Needle (n=15)	Conventional Passer (n=15)	p-value
Age, years (mean±SD)	46.87 ± 9.12	48.53 ± 10.05	0.641
Male sex, n (%)	9 (60.0)	8 (53.3)	0.713
BMI, kg/m² (mean±SD)	26.94 ± 2.81	27.36 ± 3.04	0.694
Diabetes mellitus, n (%)	3 (20.0)	4 (26.7)	0.666
Hypertension, n (%)	5 (33.3)	5 (33.3)	1.000
Smoker, n (%)	2 (13.3)	3 (20.0)	0.624

Primary Outcome: Port Closure Time
Fascial closure was completed considerably faster with the novel needle, at 1.68 ± 0.18 minutes on average, versus 3.49 ± 0.31 minutes for the conventional passer (p<0.001) — more than a 50% reduction in time (Figure 4).

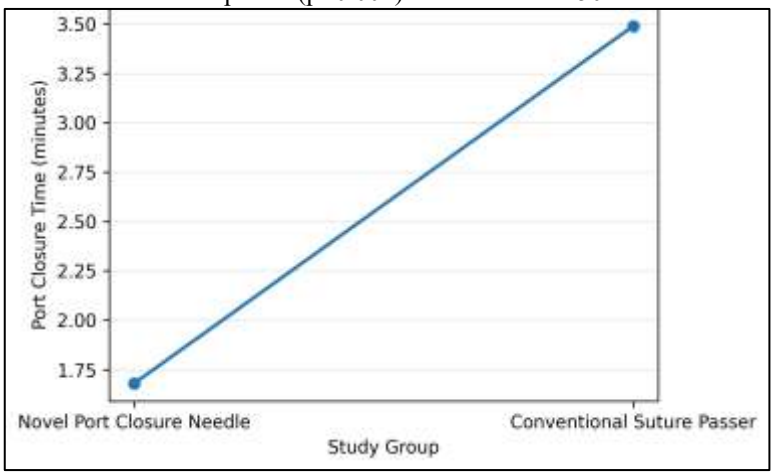

Figure 4. Mean port closure time (minutes) with the novel needle versus the conventional suture passer (p<0.001)

Ease of Use and Surgeon Fatigue
Surgeons rated the novel instrument as considerably easier to use (score 9.27 ± 0.24 against 7.21 ± 0.24 for the passer; p<0.001) and reported far less fatigue when operating it (2.05 ± 0.25 versus 4.50 ± 0.24; p<0.001) (Figure

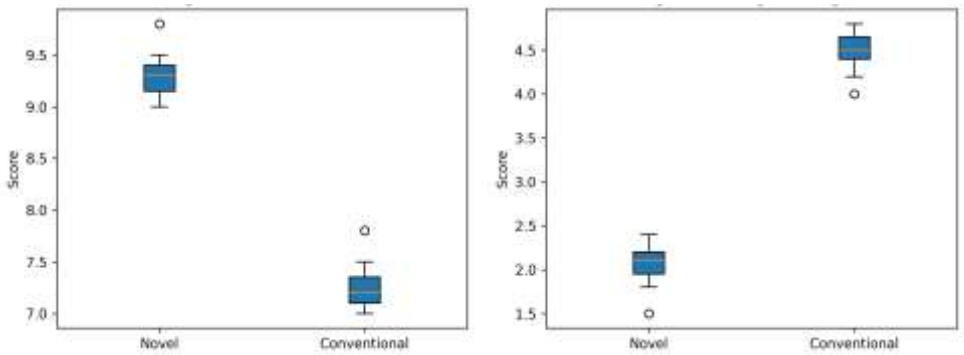

Figure 5. Ease-of-use scores (left) and surgeon fatigue scores (right), 10-point VAS, for the novel needle versus the conventional suture passer (both p<0.001)

Intraoperative and Postoperative Outcomes

Complications, whether occurring during the operation or afterwards, were uncommon in both arms and the between-group differences did not reach significance (Table 2). The novel needle caused no instrument breakage and no injury to intra-abdominal organs, whereas the conventional passer broke in two patients (13.3%). Twenty-four hours after surgery, patients closed with the novel needle reported markedly less pain (VAS 2.33 ± 0.49 versus 3.47 ± 0.52; p<0.001). By the end of the three-month follow-up period, no patient in the novel-needle group had developed a port-site hernia, compared with one patient (6.7%) in the conventional-passer group, although this gap did not reach statistical significance.

Table 2. Intraoperative and postoperative outcomes.

Outcome	Novel Needle (n=15)	Conventional Passer (n=15)	p-value
Abdominal wall bleeding, n (%)	1 (6.7)	2 (13.3)	0.543
Port-site bleeding, n (%)	0 (0)	1 (6.7)	0.309
Instrument breakage, n (%)	0 (0)	2 (13.3)	0.140
Intra-abdominal organ injury, n (%)	0 (0)	0 (0)	–
Postoperative pain, VAS 24 h (mean±SD)	2.33 ± 0.49	3.47 ± 0.52	<0.001
Surgical site infection, n (%)	1 (6.7)	2 (13.3)	0.543
Seroma, n (%)	1 (6.7)	2 (13.3)	0.543
Haematoma, n (%)	0 (0)	1 (6.7)	0.309
Port-site hernia (3 months), n (%)	0 (0)	1 (6.7)	0.309

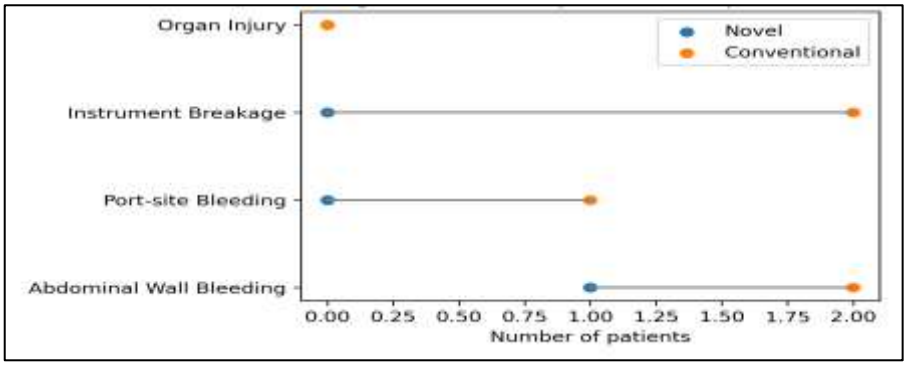

Figure 6. Number of patients experiencing each intraoperative complication, comparing the novel needle with the conventional suture passer (p>0.05 for all comparisons)

DISCUSSION

Across this comparison, the newly built needle closed the fascial defect at roughly twice the speed of the conventional passer, scored better on the surgeons' own ease-of-use ratings, produced less fatigue, and left patients with less pain in the early postoperative period — all without any corresponding rise in complications during or after surgery. Such results fit with how the device was conceived: its grooved conical tip holds the suture firmly whether it is being inserted or withdrawn, and its sliding mechanism lets the surgeon capture the suture in one controlled motion, avoiding the repeated blind probing that conventional passers often demand.

These gains in speed and reduced fatigue matter clinically, since repeated instrument passes over a prolonged period are a well-documented cause of musculoskeletal strain among laparoscopic surgeons[13-16], an effect compounded when several ports must be closed or the procedure runs long[17]. By cutting down the number of attempts needed to capture the suture successfully, an instrument of this kind could offer surgeons a cumulative ergonomic advantage across their working lives, on top of simply shortening the operation itself.

No breakages were recorded with the novel needle, against two with the conventional device, and bleeding events also trended lower — findings that point toward a mechanically sound design, though the modest number of patients studied means firm conclusions about relative safety cannot yet be drawn. Wound-related problems after surgery, port-site hernia included, followed the same pattern: numerically fewer with the new device but not significantly different statistically. This is not unexpected, since both instruments achieve full-thickness closure of the fascia under direct vision, and events such as hernia or infection occur too rarely for a study of this size to reliably detect a true difference between the groups[5,7,19].

A few limitations temper how these results should be read. With only thirty patients enrolled, the study lacks the power to reliably detect differences in uncommon events like port-site hernia or wound infection; because it was carried out at a single centre, the findings may not generalise elsewhere; three months of follow-up, though sufficient to capture early outcomes, could miss hernias that present later[6,18]; and although ease-of-use and fatigue were measured on standardised scales, such ratings inevitably reflect each surgeon's own experience and judgement[14,15]. Confirming these early observations, and properly testing whether the novel needle is non-inferior or superior with regard to hernia rates, will require larger trials run across multiple centres with extended follow-up.

CONCLUSION

Compared with the conventional suture passer, the novel needle closed 10-mm-and-larger trocar sites significantly faster, with less effort and fatigue for the operating surgeon, while intraoperative and postoperative safety remained on a par with the standard device. Such promising early results warrant further work on the prototype — a slimmer shaft, a refined suture-holding groove, and a more positive handle action are all worth pursuing — together with validation in larger, multicentre studies with longer follow-up before the instrument is adopted more widely in practice.

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