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# ASSESSMENT OF PORT SITE CLOSURE OUTCOMES USING HAND SUTURING AND CARTER–THOMASON NEEDLE TECHNIQUE IN LAPAROSCOPIC PROCEDURES.

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## Abstract

***Background:*** Port site closure is an essential step in laparoscopic surgeries to prevent postoperative complications such as port site hernia, wound infection, bleeding, and visceral injury. Conventional hand suturing is widely practiced but may be technically challenging, especially in obese patients and deep fascial defects. The Carter–Thomason needle closure technique has emerged as an alternative method that may facilitate faster and safer fascial closure with improved accuracy and reduced operative difficulty. ***Aim:*** To compare the efficacy, safety, and postoperative outcomes of hand suturing versus Carter–Thomason needle closure of port sites in laparoscopic surgeries. ***Materials and Methods:*** This prospective comparative study was conducted over a period of 12 months among 110 patients undergoing elective laparoscopic surgeries at a tertiary care teaching hospital. Patients were randomly divided into two groups with 55 patients each. Group A underwent conventional hand suturing for port site closure, while Group B underwent closure using the Carter–Thomason needle technique. Demographic details, body mass index, duration of port closure, intraoperative difficulty, postoperative pain, wound infection, seroma formation, port site hernia, and duration of hospital stay were assessed and analyzed. Statistical analysis was performed using appropriate tests, and p-value <0.05 was considered statistically significant. ***Results:*** The majority of patients belonged to the 31–50 years age group, with female predominance accounting for 64 (58.2%) cases. Mean duration of port site closure was significantly lower in the Carter–Thomason group (4.8 ± 1.2 minutes) compared to the hand suturing group (8.1 ± 1.7 minutes) ($p < 0.001$). Intraoperative difficulty was observed in 18 (32.7%) patients undergoing hand suturing, whereas only 6 (10.9%) patients in the Carter–Thomason group experienced technical difficulty. Postoperative pain scores at 24 hours were significantly lower in the Carter–Thomason group ($p = 0.02$). Wound infection developed in 8 (14.5%) patients in the hand suturing group compared to 3 (5.5%) patients in the Carter–Thomason group. Seroma formation was noted in 6 (10.9%) and 2 (3.6%) patients respectively. ***Conclusion:*** The Carter–Thomason needle closure technique is a safe, effective, and time-saving alternative to conventional hand suturing for laparoscopic port site closure. Routine use of the Carter–Thomason technique may improve surgical efficiency and reduce postoperative morbidity in laparoscopic surgeries.

**Keywords:** Carter–Thomason needle, Hand suturing, Laparoscopic surgery, Port site closure, Port site hernia, Wound complications.

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## INTRODUCTION

Laparoscopic surgery has revolutionized modern surgical practice by offering a minimally invasive approach associated with reduced postoperative pain, shorter hospital stays, improved cosmetic outcomes, faster recovery, and earlier return to routine activities.1 Over the past few decades, laparoscopic procedures have become the preferred approach for a wide range of abdominal and pelvic surgeries including cholecystectomy, appendicectomy, hernia repair, gynecological procedures, and diagnostic interventions. Despite the advantages of minimally invasive surgery, complications related to trocar insertion and port site closure remain clinically significant and may adversely affect postoperative outcomes.2. Port site closure is a critical step in laparoscopic surgeries, particularly for trocar sites measuring 10 mm or larger. Inadequate closure of fascial defects may lead to complications such as port site hernia, wound infection, hematoma formation, bowel entrapment, chronic pain, and poor cosmetic appearance.3,4 Port site hernia is one of the most important long-term complications and may result in bowel obstruction or strangulation requiring emergency surgical intervention. The incidence of port site hernia varies depending on trocar size, obesity, wound infection, operative duration, and the technique of fascial closure used during surgery.5

Conventional hand suturing is the most practiced method for port site closure. Although widely accepted, hand suturing can be technically challenging in obese individuals, deep abdominal walls, or difficult anatomical locations.6,7 Accurate visualization and approximation of fascial edges may be difficult, increasing the risk of incomplete closure and postoperative complications. Conventional closure techniques may also prolong operative time and require greater tissue handling, which can contribute to postoperative pain and wound-related morbidity.8. To overcome these limitations, several port closure devices and techniques have been developed to facilitate safe and effective fascial closure. Among them, the Carter–Thomason needle closure system has gained increasing popularity. The Carter–Thomason technique utilizes a specialized suture passer and guide system that enables direct visualization and secure fascial closure with minimal tissue trauma.9 The method is considered technically easier, especially in obese patients and deep trocar sites, while also reducing the risk of visceral injury and incomplete fascial approximation.10

The Carter–Thomason needle technique may offer several advantages over conventional hand suturing. These include shorter closure time, reduced operative difficulty, lower postoperative pain, decreased wound complications, and improved cosmetic results.11 Despite these proposed benefits, the technique is not universally adopted in routine laparoscopic practice, partly due to limited comparative studies evaluating its efficacy and safety in different patient populations. The findings may help identify a safer, technically easier, and more effective closure method that can improve patient outcomes and reduce postoperative morbidity in laparoscopic surgeries.

**AIMS AND OBJECTIVES**

- To compare the efficacy, safety, and postoperative outcomes of hand suturing versus Carter–Thomason needle closure of port sites in laparoscopic surgeries.

## MATERIALS AND METHODS

This prospective comparative study was conducted in the Department of General Surgery at Sree Mookambika Institute of Medical Sciences over a period of 12 months from January 2025 to December 2025. Informed written consent from all patients willing to participate in the study. A total of 110 patients undergoing elective laparoscopic surgeries were included in the study. Patients were randomly allocated into two groups consisting of 55 patients each. Group A underwent conventional hand suturing for laparoscopic port site closure, while Group B underwent closure using the Carter–Thomason needle closure technique.

Patients aged between 18 and 70 years undergoing elective laparoscopic procedures such as laparoscopic cholecystectomy, appendicectomy, hernia repair, and diagnostic laparoscopy with at least one port size measuring 10 mm or more were included in the study. Both male and female patients who provided informed consent and were fit for surgery under general anesthesia were considered eligible for participation.

Patients with previous abdominal wall hernia, prior major abdominal surgery involving the port site region, immunocompromised status, uncontrolled diabetes mellitus, coagulopathy, severe obesity with body mass index greater than 40 kg/m², pregnancy, emergency laparoscopic procedures, conversion to open surgery, and patients unwilling to participate were excluded from the study. Patients with pre-existing wound infection or connective tissue disorders affecting wound healing were also excluded.

Detailed demographic data including age, sex, body mass index, comorbidities, diagnosis, and type of laparoscopic surgery performed were recorded. Preoperative clinical evaluation and routine laboratory investigations were carried out in all patients. All surgeries were performed under standard aseptic precautions and general anesthesia by experienced surgeons familiar with both closure techniques. Pneumoperitoneum was created using standard laparoscopic techniques, and trocar ports were inserted according to the surgical procedure performed.

In Group A, port site closure was performed by conventional hand suturing using absorbable suture material with direct fascial approximation. In Group B, closure was performed using the Carter–Thomason needle closure device under direct visualization to facilitate fascial closure with minimal tissue handling. The duration required for port site closure was recorded from insertion of the closure instrument or suture needle until completion of fascial closure. Intraoperative difficulty during closure, need for additional assistance, and accidental tissue injury were also documented.

Postoperative assessment included evaluation of pain using visual analog scale scores at 24 hours, wound infection, seroma formation, hematoma, port site hernia, and duration of hospital stay. Patients were followed up at regular intervals during the postoperative period for assessment of wound healing and detection of late complications such as port site hernia. Cosmetic outcome and surgeon satisfaction regarding ease of closure were also evaluated.

The collected data were entered into Microsoft Excel and analysed using Statistical Package for Social Sciences (SPSS) software version 25. Quantitative variables were expressed as mean and standard deviation, while qualitative variables were presented as frequency and percentage. Chi-square test and Student's t-test were used for comparison between groups wherever appropriate. A p-value of less than 0.05 was considered statistically significant.

## RESULTS

Majority of patients belonged to the 31–50 years age group accounting for 56 (50.9%) cases. Female predominance was observed with 64 (58.2%) patients. Both study groups were comparable with respect to age and gender distribution, and no statistically significant difference was observed ($p > 0.05$). (Table 1).

**Table 1: Age and Gender Distribution of Study Participants**

| Variable | Hand Suturing Group (n=55) | Carter–Thomason Group (n=55) | Total (n=110) | p-value |
|---|---|---|---|---|
| 18–30 years | 11 (20.0%) | 13 (23.6%) | 24 (21.8%) | 0.81 |
| 31–50 years | 29 (52.7%) | 27 (49.1%) | 56 (50.9%) | |
| >50 years | 15 (27.3%) | 15 (27.3%) | 30 (27.3%) | |
| Male | 22 (40.0%) | 24 (43.6%) | 46 (41.8%) | 0.70 |
| Female | 33 (60.0%) | 31 (56.4%) | 64 (58.2%) | |

Laparoscopic cholecystectomy was the most performed procedure constituting 50 (45.5%) cases followed by laparoscopic appendicectomy in 32 (29.1%) patients. The distribution of surgical procedures was similar in both groups without statistically significant difference. (Table 2).

**Table 2: Distribution According to Type of Laparoscopic Surgery**

| Type of Surgery | Hand Suturing Group (n=55) | Carter–Thomason Group (n=55) | Total | p-value |
|---|---|---|---|---|
| Laparoscopic cholecystectomy | 26 (47.3%) | 24 (43.6%) | 50 (45.5%) | 0.88 |
| Laparoscopic appendicectomy | 15 (27.3%) | 17 (30.9%) | 32 (29.1%) | |
| Laparoscopic hernia repair | 9 (16.4%) | 8 (14.5%) | 17 (15.5%) | |
| Diagnostic laparoscopy | 5 (9.1%) | 6 (10.9%) | 11 (10.0%) | |

The mean duration of port site closure was significantly lower in the Carter–Thomason group compared to the hand suturing group ($p < 0.001$). Intraoperative difficulty and need for additional assistance were significantly more common with conventional hand suturing, indicating better technical feasibility of the Carter–Thomason technique. (Table 3).

**Table 3: Comparison of Operative Parameters.**

| Parameter | Hand Suturing Group | Carter–Thomason Group | p-value |
|---|---|---|---|
| Mean port closure time (minutes) | 8.1 ± 1.7 | 4.8 ± 1.2 | <0.001 |
| Intraoperative difficulty | 18 (32.7%) | 6 (10.9%) | 0.006 |
| Need for additional assistance | 14 (25.5%) | 4 (7.3%) | 0.01 |
| Accidental tissue handling difficulty | 11 (20.0%) | 3 (5.5%) | 0.02 |

Postoperative wound complications were comparatively higher in the hand suturing group. Patients undergoing Carter–Thomason closure experienced significantly lower postoperative pain scores ($p = 0.02$), suggesting reduced tissue trauma and improved patient comfort. (Table 4)

**Table 4: Postoperative Complications in Both Groups**

| Complication | Hand Suturing Group (n=55) | Carter–Thomason Group (n=55) | p-value |
|---|---|---|---|
| Wound infection | 8 (14.5%) | 3 (5.5%) | 0.11 |
| Seroma formation | 6 (10.9%) | 2 (3.6%) | 0.14 |
| Hematoma | 4 (7.3%) | 1 (1.8%) | 0.17 |
| Port site hernia | 3 (5.5%) | 0 (0%) | 0.07 |
| Postoperative pain score >5 | 17 (30.9%) | 7 (12.7%) | 0.02 |

Intraoperative difficulty increased significantly with increasing body mass index (p = 0.01). Overweight and obese patients demonstrated greater technical challenges during port site closure, particularly in the hand suturing group. (Table 5).

**Table 5: Correlation Between BMI and Intraoperative Difficulty**

| BMI Category | Intraoperative Difficulty Present | Intraoperative Difficulty Absent | Total | p-value |
|---|---|---|---|---|
| Normal BMI | 5 (13.9%) | 31 (86.1%) | 36 | 0.01 |
| Overweight | 10 (31.3%) | 22 (68.7%) | 32 | |
| Obese | 9 (42.9%) | 12 (57.1%) | 21 | |
| Morbidly obese | 0 | 0 | 0 | |

Patients undergoing Carter–Thomason port closure had significantly shorter hospital stay compared to the hand suturing group (p = 0.02). Reduced postoperative pain and fewer wound complications may have contributed to earlier recovery and discharge. (Table 6).

**Table 6: Correlation Between Closure Technique and Hospital Stay**

| Closure Technique | Hospital Stay ≤3 Days | Hospital Stay >3 Days | p-value |
|---|---|---|---|
| Hand suturing | 31 (56.4%) | 24 (43.6%) | 0.02 |
| Carter–Thomason closure | 44 (80.0%) | 11 (20.0%) | |

## DISCUSSION

Majority of patients in the current study belonged to the 31–50 years age group, accounting for 56 (50.9%) cases, reflecting the high utilization of laparoscopic procedures among middle-aged individuals. Female predominance was observed in 64 (58.2%) patients, largely due to the greater number of laparoscopic cholecystectomies performed in women. Similar demographic distributions have been reported by Chaudhary G et al.11 who found comparable gender, BMI, and procedure characteristics between the Carter–Thomason and hand suturing groups. Likewise, Jeon Y et al.12 observed comparable baseline characteristics while evaluating trocar-site closure techniques. In the present study, port-site closure time was significantly lower in the Carter–Thomason group (4.8 ± 1.2 minutes) compared to the hand suturing group (8.1 ± 1.7 minutes). The reduction in closure time may be attributed to easier fascial access, improved visualization, and reduced tissue manipulation. Similar findings were reported by Chaudhary G et al.11 who demonstrated significantly shorter closure times with the Carter–Thomason technique (4.37 ± 1.69 minutes) compared to hand suturing (5.20 ± 1.30 minutes). Likewise, Ranjani CM et al.13 reported a significantly shorter closure time with the Veress needle technique (4.8 ± 1.2 minutes) compared to conventional suturing (6.2 ± 1.5 minutes). Further supporting these observations, Jeon Y et al.12 found that the EZ-Close™ device significantly reduced closure time compared to hand suturing, particularly in overweight and obese patients. Similarly, del Junco M et al.14 demonstrated shorter closure times with the EFx closure system compared to the Carter–Thomason device in a cadaveric model, emphasizing the ongoing evolution of port closure techniques aimed at improving efficiency. Intraoperative difficulty was encountered less frequently in the Carter–Thomason group compared with conventional hand suturing. Difficult fascial approximation was particularly noted in overweight and obese individuals due to increased abdominal wall thickness. These findings correlate with the observations of Jeon Y et al.12 who reported that closure devices maintained procedural efficiency even in patients with higher body mass index and greater abdominal wall thickness, conditions that commonly challenge conventional closure methods.

Postoperative pain was comparatively lower among patients who underwent Carter–Thomason closure. Pain scores greater than 5 were observed in only 12.7% of patients in the Carter–Thomason group compared with 30.9% in the hand suturing group. Reduced tissue trauma and minimal fascial manipulation likely contributed to improved postoperative comfort. Similar findings were reported by Ranjani CM et al.13 who demonstrated significantly lower postoperative pain scores in patients undergoing device-assisted closure. Likewise, Shetty A et al.15 reported reduced postoperative discomfort with the Carter–Thomason method. Previous studies evaluating the Carter–Thomason device have also noted lower postoperative pain and improved patient satisfaction when compared with conventional suturing techniques. Wound-related complications were more frequent among patients undergoing conventional hand suturing. Wound infection occurred in 14.5% of patients in the hand suturing group compared to 5.5% in the Carter–Thomason group. Seroma formation was observed in 10.9% and 3.6% of patients respectively, while port-site hernia occurred only in the hand suturing group. These findings are consistent with the study by Chaudhary G et al.11 who reported a lower incidence of port-site infection in the Carter–Thomason group, although the difference did not reach statistical significance. Similarly, Ranjani CM et al.13 observed higher rates of wound infection and wound dehiscence in the hand suturing group. Shetty A et al.15 also concluded that Carter–Thomason closure was associated with fewer wound and bowel-related complications compared with conventional closure methods.

The absence of port-site hernia in the Carter–Thomason group in the present study further highlights the effectiveness of secure fascial closure. Comparable findings were reported by Chaudhary G et al.11 who observed no port-site hernias

during follow-up in either study group. Long-term evidence supporting device-assisted closure has been provided by Muñoz-Leija MA et al.16 who reported lower rates of secondary surgery for port-site hernia in patients undergoing Carter–Thomason closure compared with conventional closure or non-closure techniques. Their findings reinforce the importance of meticulous fascial closure for trocar sites measuring 10 mm or greater. Hospital stay was significantly shorter among patients managed with Carter–Thomason closure. Hospital stay exceeding three days was observed in 43.6% of patients in the hand suturing group compared with only 20.0% in the Carter–Thomason group. Faster recovery, reduced pain, fewer wound complications, and earlier mobilization likely contributed to earlier discharge. Similar trends have been reported by Shetty A et al.15 who noted improved postoperative recovery and fewer complications with Carter–Thomason closure. Reduced morbidity associated with device-assisted closure techniques has consistently translated into enhanced postoperative outcomes and shorter recovery periods across several studies.

## CONCLUSION

The present study concludes that the Carter–Thomason needle closure technique is a safe, effective, and efficient method for laparoscopic port site closure compared to conventional hand suturing. The technique significantly reduced port closure time, intraoperative difficulty, postoperative pain, wound complications, and duration of hospital stay. Accurate fascial approximation achieved with the Carter–Thomason method also contributed to lower incidence of port site hernia and improved postoperative recovery. Although both techniques were effective for port closure, the Carter–Thomason technique demonstrated superior overall outcomes and technical convenience. Routine use of this method may improve surgical efficiency and reduce postoperative morbidity in laparoscopic surgeries.

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**CONFLICTS OF INTEREST**

There are no conflicts of interest.

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