

## A COMPARATIVE STUDY BETWEEN THE USE OF HEM-O-LOK CLIPS VS. ROEDER'S KNOT FOR APPENDICEAL STUMP CLOSURE IN LAPAROSCOPIC APPENDICECTOMY

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### ABSTRACT

**Background:** The standard surgical approach for acute appendicitis is laparoscopic appendectomy. Ensuring a secure closure of the appendiceal stump is an essential aspect of the procedure to mitigate the risk of postoperative complications, including stump leakage and intra-abdominal infection. Multiple approaches are employed for the closure of stumps, incorporating techniques like intracorporeal knotting methods, including Roeder's knot, as well as mechanical devices such as Hem-o-lok clips. This study aimed to compare the operation time between hem-o-lok clips and Roeder's knot in stump closure during laparoscopic appendectomy. **Materials and Methods:** This study, designed as a prospective cross-sectional comparative analysis, was carried out over a period of 12 months at a tertiary care center. Seventy adults diagnosed with acute appendicitis who were scheduled for laparoscopic appendectomy were included in the study and categorized into two groups: those receiving Roeder's knot and those receiving Hem-o-lok clips. The evaluated outcomes included operating time, drain utilization, duration of hospital stay, postoperative complications, and instances of stump leakage, with statistical analysis carried out using SPSS. **Results:** The average operating time was notably reduced in the Hem-o-lok clip group ( $34.97 \pm 5.41$  minutes) when contrasted with the Roeder's knot group ( $39.66 \pm 7.07$  minutes), and this difference reached statistical significance ( $p = 0.003$ ). The average length of hospital stay was notably reduced in the Hem-o-lok group ( $3.71 \pm 0.86$  days) in contrast to the Roeder's knot group ( $4.14 \pm 0.87$  days), with a statistically significant difference observed ( $p = 0.043$ ). **Conclusion:** Hem-o-lok clips and Roeder's knot are both secure and efficient methods for closing the appendiceal stump after laparoscopic appendectomy. Nonetheless, the application of Hem-o-lok clips demonstrated a correlation with decreased operating time and a shorter duration of hospital stay in comparison to Roeder's knot. Consequently, Hem-o-lok clips can be regarded as a practical and effective option for closing the appendiceal stump during laparoscopic appendectomy.

## INTRODUCTION

Appendicitis is defined by the inflammation of the vermiform appendix and usually manifests aggressively within 24 hours.<sup>[1]</sup> Acute appendicitis represents a prevalent surgical emergency encountered globally, with a lifetime risk estimated

to be between 7% and 8%.<sup>[2]</sup> Recurrent and chronic appendicitis are rarer than acute appendicitis; estimates range from 1% to 1.5% of all cases.<sup>[3]</sup> The management of the condition involves performing an appendectomy following adequate fluid resuscitation, administration of analgesics, and the initiation of intravenous antibiotics. Laparoscopic appendectomy demonstrates superior outcomes

compared to open appendectomy in the majority of cases, primarily due to its association with reduced postoperative pain and a decreased duration of hospital stay.<sup>[4]</sup>

Laparoscopic appendectomy is well-established, although appendiceal stump closure is controversial. Appendiceal stumps in earlier times were closed with Roeder or endoloops. The use of laparoscopic linear staplers in LA became "in vogue," especially for complex cases such as appendiceal base perforation.<sup>[5]</sup> Various techniques for laparoscopic closure of the appendiceal stump have been documented, including endoloops (EL), endoclips (both metallic and polymeric), linear stapler devices, suture ligation, and endocoagulation.<sup>6</sup> Endoloops and endoclips achieved comparable clinical outcomes at a lower cost and shorter surgical times. Endostaplers have the lowest perioperative problems, but their high cost limits their adoption in many healthcare settings.<sup>[6]</sup> The Roeder knot is frequently employed in laparoscopic suturing due to its ability to be tied extracorporeally and subsequently adjusted to the target tissue using a single maneuver with a knot pusher.<sup>[7]</sup> Hem-o-Lok clips are commonly employed in laparoscopic surgery as alternative ligation materials.<sup>[8]</sup> An array of modern techniques has been integrated into the original procedure to enhance and regulate the appendiceal stump closure. These include instrument-assisted knotting, bipolar coagulation, slipknot tying, metal clips, Hem-o-lok clips, endoloops, double endoloops, linear endo staplers, and ultrasonically activated scalpels. Stump closure currently involves the use of polymeric clips, pre-knotted loops, and staplers. Since this topic is up for debate, the best approach is unknown. Recent studies suggest that utilizing the Hem-o-Lok clip to seal the appendicular stump is safe. There have been more than a thousand surgical procedures that have confirmed the safety of utilizing Hem-o-Lok clips for ligation of ureters, bile ducts, arteries, and other similar structures. It is widely recognized that Hem-o-Lok clips are safe to use and that they are easy and fast to apply.<sup>[9]</sup> Hence, this study aimed to compare Hem-o-Lok clips vs Roeders knot in stump closure among patients who underwent laparoscopic appendectomy.

#### **Objective**

- To compare the operation time in hem o lok clips vs roeders knot in stump closure in laparoscopic appendectomy.

## **MATERIALS AND METHODS**

This prospective comparative study was carried out over a duration of 12 months within the Department of General Surgery at Trichy SRM Medical College Hospital and Research Centre, Tamil Nadu. The research focused on evaluating two distinct methods for closing the appendiceal stump during laparoscopic appendectomy: Hem-o-lok clips and Roeder's knot, specifically in patients with a

diagnosis of acute appendicitis. The study population included adult patients who presented to the general surgery department exhibiting clinical signs indicative of acute appendicitis and were scheduled for laparoscopic appendectomy. The study established a total sample size of 70 patients. The consecutive sampling technique was utilized, whereby all eligible patients meeting the established inclusion and exclusion criteria throughout the study period were recruited until the necessary sample size was attained. Individuals aged 18 to 60 years who received a diagnosis of acute appendicitis and met the criteria for laparoscopic appendectomy were incorporated into the study. Individuals exhibiting acute perforated appendicitis along with local or diffuse peritonitis, those deemed unfit for or having contraindications to laparoscopic surgery, and patients who declined to give informed consent were not included in the study. Patients who met the eligibility requirements were given a detailed explanation of the study's purpose, objectives, and procedures upon admission. All participants provided written informed consent before their enrollment. A comprehensive clinical history was gathered, and an extensive physical examination was conducted in each instance. The diagnosis of acute appendicitis before surgery was validated through abdominal and pelvic ultrasonography, revealing either tenderness upon probing in the right iliac fossa or the presence of an aperistaltic, non-compressible tubular appendix indicative of inflammation. Standard preoperative assessments were conducted in accordance with the established institutional guidelines. Patients were scheduled for laparoscopic appendectomy after having their diagnosis confirmed and preoperatively optimized. The 70 patients were divided into two groups, ensuring a similar distribution of age and gender across both groups. In Group H, the appendiceal stump was secured with Hem-o-lok clips, while in Group R, it was secured using Roeder's knot. The assignment to the respective groups was conducted in a way that ensured a balanced representation of demographic characteristics. All patients received thorough counseling about the surgical procedure, encompassing the technique for stump closure, potential intraoperative and postoperative complications, as well as anticipated outcomes. To reduce operator-related bias and inter-surgeon variability, all laparoscopic appendectomies were conducted by the same skilled surgeon employing a standardized surgical technique, with the exception of the stump closure method. Observations during the procedure were documented, and the total time of the operation was measured in minutes from the initial incision to the closure of the port sites. The study evaluated several key outcome parameters, including operation time, the utilization of drains, average length of hospital stays, postoperative complications, and the occurrence of stump leakage. The choice to implement an intra-abdominal drain was informed by the findings observed during the operation and the

assessment of the surgeon. All patients underwent postoperative monitoring throughout their hospital stay, with pertinent clinical parameters meticulously recorded. The duration of the hospital stay was measured in days, starting from the day of surgery until the patient was discharged. The collected data were systematically entered and analyzed utilizing the Statistical Package for the Social Sciences (SPSS) software, IBM version 26.0. Continuous variables underwent assessment for normality through the application of suitable statistical tests. Continuous variables that follow a normal distribution were presented as mean, standard deviation, and range. The independent Student's t-test was utilized to compare the mean values between the two groups. Frequencies and percentages were utilized to present categorical variables. The Chi-square test was employed to compare the two groups regarding categorical variables. A two-sided p-value below 0.05 was deemed statistically significant for all statistical evaluations. The study protocol received approval from the Institutional Ethical Committee of Trichy SRM Medical College Hospital and Research Centre before it commenced.

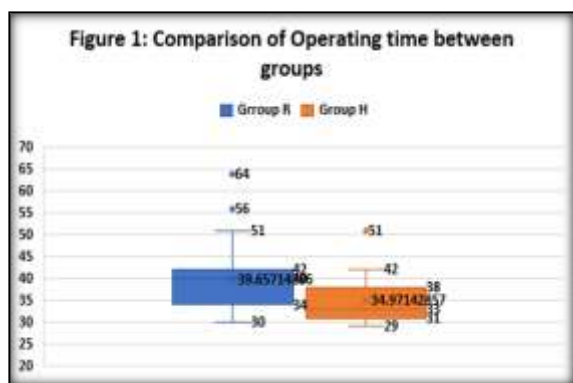
## RESULTS

A total of 70 patients diagnosed with acute appendicitis participated in the study and underwent

laparoscopic appendectomy. The participants were evenly allocated into two groups: Group R, which utilized Roeder's knot, and Group H, which employed Hem-o-lok clips, with each group consisting of 35 patients. The age distribution indicates that the predominant cohort in both groups falls within the 18–30 years range. In Group R, 22 patients (62.85%) fell within the age range of 18–30 years, whereas 23 patients (65.71%) in Group H were also in this age category. The age group of 31–40 years comprised 11 patients (31.42%) in Group R and 10 patients (28.57%) in Group H. A limited number of participants fell within the 41–50 years age range, with 2 patients (5.71%) represented in each group. The findings reveal that the majority of acute appendicitis cases within the study group were observed in younger adults. The analysis reveals that males represented the predominant portion in both groups. In Group R, there were 19 male patients, accounting for 54.28%, and 16 female patients, making up 45.71% of the group. In Group H, there were 20 male patients, accounting for 57.14%, and 15 female patients, representing 42.85% of the group. [Figure 1] shows the comparison of operating time between groups. The average operating time in Group R (Roeder's knot) was  $39.66 \pm 7.075$  minutes, while the average operating time in Group H (Hem-o-lok clips) was  $34.97 \pm 5.415$  minutes.

**Table 1: Descriptive data of participants (n = 70)**

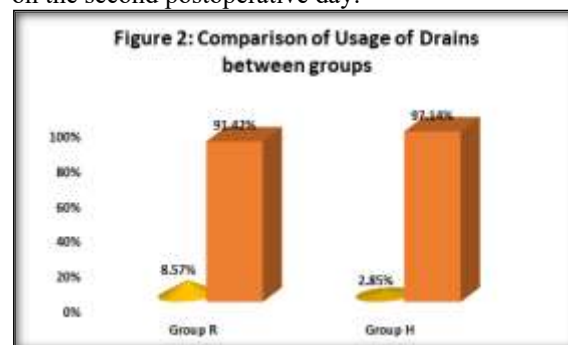
S No	Variables	Group R (n = 35)	Group H (n = 35)
1	Age	18 – 30 years	22 (62.85%)
		31 – 40 years	11 (31.42%)
		41 – 50 years	2 (5.71%)
2	Gender	Male	19 (54.28%)
		Female	16 (45.71%)



**Figure 1: Comparison of Operating time between groups**

[Figure 2] shows the use of drains postoperatively. In Group R (Roeder's knot), 3 patients (8.57%) necessitated the placement of a drain, while 32 patients (91.42%) did not require any drain insertion. In Group H, the use of Hem-o-lok clips resulted in only 1 patient (2.85%) in need of drain placement, whereas the vast majority, 34 patients (97.14%), did not require drains. The drain volume among patients

ranged from 30 to 50 ml per day, and it was removed on the second postoperative day.



**Figure 2: Comparison of Usage of Drains between groups**

[Table 2] compares operating time and hospital stay duration across groups. An independent samples t-test was conducted to evaluate the mean hospital stay duration between the two groups, indicating a statistically significant difference with a p-value of 0.043. The results demonstrate that patients in the Hem-o-lok clip cohort saw a markedly reduced hospital duration relative to those in the Roeder's knot

cohort. A t-test for independent samples was conducted to assess the mean operating time across the two groups, resulting in a statistically significant difference, indicated by a p-value of 0.003. The findings demonstrate that the duration of the procedure was notably reduced when utilizing Hem-

o-lok clips in comparison to Roeder's knot for the closure of the appendiceal stump. The mean duration of hospital stay was 4.14 days in Group R, which was longer than in Group H (3.71 days).

**Table 2: Comparison of Operating time and Duration of Hospital stay**

S No	Variable	Group R (n = 35)	Group H (n = 35)	p-value
1	Operating time	39.66±7.075	34.97±5.417	0.003
2	Duration of Hospital Stay	4.14±0.879	3.71±0.860	0.043

No group, whether utilizing Roeder's knot or Hem-o-lok clips for the closure of the appendiceal stump, reported any instances of stump leakage.

## DISCUSSION

In recent years, laparoscopic surgery has predominantly substituted open surgery for appendectomy, comparable to numerous other surgical interventions. Laparoscopic appendectomy (LA) presents numerous benefits compared to the open technique, such as diminished postoperative discomfort, decreased likelihood of wound infection, expedited recovery, swifter resumption of normal activities, and a reduced length of hospital stay. The advantages have resulted in the prevalent implementation of laparoscopic methods as the conventional therapy for acute appendicitis. One of the critical technical tasks in laparoscopic appendectomy is the secure closure of the appendiceal stump. A variety of methods for stump closure have been delineated, including endoloops (either handcrafted or commercially produced), endoclips (metallic or polymeric), staplers, manual intracorporeal suturing, and endocoagulation devices. Notwithstanding the existence of several procedures, a consensus on the ideal way for appendiceal stump closure remains elusive.<sup>[10]</sup> Proper closure of the appendiceal stump is crucial, as inadequate sealing may result in severe postoperative sequelae, including stump leaking, intra-abdominal abscess, postoperative ileus, wound infection, and small intestinal blockage. Consequently, the method employed for stump closure must be secure, dependable, facile to execute, and time-efficient.<sup>[11]</sup> This study aimed to compare two prevalent procedures for appendiceal stump closure during laparoscopic appendectomy: Roeder's knot and Hem-o-lok clips, focusing on operative results and postoperative parameters.

The average operating time in the current study was 39.66 ± 7.07 minutes for the Roeder's knot group and 34.97 ± 5.41 minutes for the Hem-o-lok clip group. The findings indicated that the duration of the procedure was markedly reduced in the Hem-o-lok clip cohort vs to the Roeder's knot cohort. The reduced operating duration associated with Hem-o-lok clips can be ascribed to their straightforward and swift administration, in contrast to the intracorporeal knot tying necessitated by Roeder's knot, which

requires enhanced technical proficiency and time investment. The results of the current investigation align with the data documented in numerous other studies. Kennedy J et al,<sup>[12]</sup> indicated that the duration of surgery was typically extended in patients receiving appendiceal stump closure using Roeder's knot in contrast to Hem-o-lok clips. In their study, most patients in the Hem-o-lok group had surgical times ranging from 45 to 60 minutes, while the majority of patients in the Roeder's knot group required 61 to 75 minutes to complete the procedure. Furthermore, they noted that the duration of hospital stay was marginally longer for patients treated with Roeder's knot compared with those managed with Hem-o-lok clips. Nonetheless, the incidence of intraoperative and postoperative complications were comparable across the two groups. Vinith J S et al,<sup>[13]</sup> conducted a study in Salem, Tamil Nadu, revealing that the mean operating time was significantly reduced in the Hem-o-lok clip group (34.7 minutes) compared to the Roeder's knot group (42.1 minutes). Their findings indicated that clip application is a more time-efficient method for closing the appendiceal stump during laparoscopic appendectomy. Gandhi A et al,<sup>[14]</sup> reported similar findings, noting that 54% of patients in the Hem-o-lok group had operational durations of 45 to 60 minutes, while 74% of patients in the Roeder's knot group had operative periods of 61 to 75 minutes. The disparity between the two groups was statistically significant, suggesting that the Hem-o-lok clip approach decreases operating duration.

Chandak et al,<sup>[15]</sup> similarly reported that the mean operative time in the Hem-o-lok group was 35.55 minutes, but it was 43.2 minutes in the Roeder's knot group. These data further corroborate the assertion that the utilization of clips facilitates expedited procedure completion. Dixit et al,<sup>[16]</sup> conducted a study in Karnataka, revealing that a significantly greater proportion of patients in the titanium clip group (60%) had operative times ranging from 45 to 60 minutes, while 83.33% of patients in the Roeder's knot group required 61 to 75 minutes, indicating a statistically significant difference between the two techniques. Pani et al,<sup>[17]</sup> conducted another investigation that revealed a markedly reduced operating time in the Hem-o-lok clip group (60.76 ± 11.07 minutes) compared to the Roeder's knot group (67.6 ± 8.98 minutes), underscoring the time efficiency linked to clip application.

In the current investigation, the average length of hospital stay was 4.14 days for the Roeder's knot group (Group R) and 3.71 days for the Hem-o-lok clip group (Group H), suggesting a marginally reduced hospital stay for patients whose appendiceal stump was secured with Hem-o-lok clips. The shorter length of stay in the Hem-o-lok group can likely be linked to a decrease in operative time and limited intraoperative intervention, potentially leading to a quicker recovery after surgery. In a comparative study conducted by Gandhi A et al,<sup>[14]</sup> in India, it was observed that the average duration of hospital stay was  $3.73 \pm 0.73$  days for the Hem-o-lok group, while the Roeder's knot group had an average stay of  $3.80 \pm 0.80$  days. The difference between these two groups was statistically insignificant ( $p = 0.725$ ). The findings indicate that while there may be slight differences in the duration of hospital stays associated with each technique, both approaches to appendiceal stump closure yield similar outcomes in terms of postoperative recovery and overall length of hospitalization. A shorter hospital stay may correlate with shorter operative duration and minimal tissue manipulation during clip placement. These findings align with prior research indicating marginally reduced hospital stays for patients having appendiceal stump closure using clips.

An additional significant finding in the current study was the absence of stump leaking cases reported in either group during the postoperative period and subsequent follow-up. This discovery indicates that both Roeder's knot and Hem-o-lok clips ensure secure and dependable closure of the appendiceal stump when executed properly.

This finding demonstrates that both techniques ensure a secure and dependable closure of the appendiceal stump during laparoscopic appendectomy when executed with the correct surgical approach. The results of the present study align with numerous studies that have been published before. Chandak et al,<sup>[15]</sup> observed that there were no postoperative complications in either group, indicating that both Roeder's knot and Hem-o-lok clips are reliable and effective methods for closing the appendiceal stump. Similarly, in a study carried out in Maharashtra, Bhakkad et al,<sup>[18]</sup> found that only 4% of patients in the Hem-o-lok clip group and 2% in the Roeder's knot group experienced postoperative complications, whereas 96% and 98% of patients, respectively, had no postoperative complications. This suggests that both techniques have a very low rate of complications.

The findings of this study indicate that both approaches are safe and effective for appendiceal stump closure in laparoscopic appendectomy. Nonetheless, the Hem-o-lok clip procedure presents certain benefits, notably in relation to abbreviated surgical duration and marginally decreased hospitalization period. Hem-o-lok clips, owing to their simplicity of application, repeatability, and time efficiency, may serve as a practical alternative to

intracorporeal knot tying for the closure of the appendiceal stump after laparoscopic appendectomy.

## CONCLUSION

This study evaluates the efficacy of Roeder's knot versus Hem-o-lok clips for closing the appendiceal stump in laparoscopic appendectomy procedures for patients diagnosed with acute appendicitis. Both techniques demonstrated safety and reliability in securing the appendiceal stump, with no instances of stump leakage or significant postoperative complications noted in either group. Still, the Hem-o-lok clip technique exhibited specific benefits, such as a notably shorter operating time and a decreased length of hospital stay in comparison to the Roeder's knot method. The simple-to-use and decreased technical difficulty of Hem-o-lok clips could enhance operative efficiency.

**Limitations:** This study included a small sample size and single centre experience, which limits generalizability.

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