Journal of Neonatal Surgery
ISSN(Online): 2226-0439
Vol. 14, Issue 5s (2025)
https://www.jneonatalsurg.com

OPEN ACCESS

A Prospective Study: Comparing Stump Closure by Hem-o-Lok Clips Versus Roeder's Knot in Laparoscopic Appendectomy

Dr. Vinith. J. S[1], Dr. Shaikh Aaliah S Naaz[*2], Dr. E. M. J. Karthikeyan[*3], Dr. Praveen Kumar.S[*4], Dr. Karthick Manikandan.A[*5], Dr. J. Sridhar[*6]

[1]Postgraduate, Department of General Surgery, Vinayaka Mission's Kirupananda Variyar Medical College and Hospital, Salem Tamil Nadu, Vinayaka Mission's Research Foundation. Email ID: vinithsankar2015@gmail.com

***Corresponding Author:**

[*2]Postgraduate, Department of General Surgery, Vinayaka Mission's Kirupananda Variyar Medical College and Hospital, Salem Tamil Nadu, Vinayaka Mission's Research Foundation. Email ID: shaikhaaliyah2@gmail.com

[*3]Professor & Unit Chief, Department of General Surgery, Vinayaka Mission's Kirupananda Variyar Medical College and Hospital, Salem Tamil Nadu, Vinayaka Mission's Research Foundation

[*4]Assistant Professor, Department of General Surgery, Vinayaka Mission's Kirupananda Variyar Medical College and Hospital, Salem Tamil Nadu, Vinayaka Mission's Research Foundation

[*5]Post Graduate, Department of General surgery, Vinayaka Mission's Kirupananda Variyar Medical College and Hospital, Salem Tamil Nadu, Vinayaka Mission's Research Foundation. Email ID: Drkarthick1602@gmail.com

[*6]Professor and Head of Department, Department of General Surgery, Vinayaka Mission's Kirupananda Variyar Medical College and Hospital, Salem Tamil Nadu, Vinayaka Mission's Research Foundation

Cite this paper as: Dr. Vinith. J. S, Dr. Shaikh Aaliah S Naaz, Dr. E. M. J. Karthikeyan, Dr. Praveen Kumar.S, Dr. Karthick Manikandan.A, Dr. J. Sridhar, (2025) A Prospective Study: Comparing Stump Closure by Hem-o-Lok Clips Versus Roeder's Knot in Laparoscopic Appendectomy. *Journal of Neonatal Surgery*, 14 (5s), 472-480.

ABSTRACT

Background: Laparoscopic appendectomy has become the preferred surgical approach for acute appendicitis due to its advantages, such as reduced postoperative pain, shorter hospital stays, and faster recovery. However, the method of appendiceal stump closure remains a topic of debate, with techniques such as Hem-o-Lok clips and Roeder's knot being widely used. The choice between these two techniques is crucial, as it impacts operative time, patient outcomes, complication rates, and overall cost-effectiveness. Despite existing research comparing the two methods, a consensus on the superior technique remains elusive. This study aims to compare the efficacy, safety, and cost-effectiveness of Hem-o-Lok clips and Roeder's knot in appendiceal stump closure during laparoscopic appendectomy.

Objectives: This study evaluates and compares the operative time, postoperative pain levels, complication rates, and cost-effectiveness of Hem-o-Lok clips versus Roeder's knot for stump closure in laparoscopic appendectomy.

Methods: This prospective observational study was conducted at Vinayaka Mission's Kirupananda Variyar Medical College and Hospital (VMKVMCH), Salem, from August 2022 to December 2023. A total of 60 patients diagnosed with uncomplicated acute appendicitis were included, with patients alternately assigned to two groups: Group H (Hem-o-Lok clips, n=30) and Group R (Roeder's knot, n=30). Demographic variables, preoperative and intraoperative parameters, postoperative pain scores (measured using the Visual Analog Scale), incidence of surgical site infections (graded by the Southampton wound grading system), hospital stay duration, and cost of materials used were recorded. Statistical analysis was performed using Jamovi software, and results were analyzed with appropriate tests, considering $p<0.05$ as statistically significant.

Results: The two groups were comparable in terms of demographic characteristics and baseline health status. The operative time was significantly shorter in the Hem-o-Lok group ($p<0.05$), suggesting that clip application is more efficient than Roeder's knot tying. Both techniques demonstrated similar outcomes in postoperative pain reduction, complication rates, and hospital stay duration, with no statistically significant difference observed. However, a notable difference was seen in cost-effectiveness, with Hem-o-Lok clips proving to be a more economical option compared to Roeder's knot.

Conclusion: Both Hem-o-Lok clips and Roeder's knot are effective and safe for appendiceal stump closure during laparoscopic appendectomy. However, Hem-o-Lok clips offer advantages in terms of reduced operative time and cost-effectiveness, making them a preferable choice for routine laparoscopic appendectomies. The selection of the technique may ultimately depend on surgeon expertise, institutional policies, and patient-specific factors. Further large-scale studies are warranted to validate these findings and establish standardized guidelines for appendiceal stump closure in laparoscopic appendectomy.

Keywords: *Optimization, Phase Diagrams, Nanoemulsion, Oral delivery, Rheumatoid arthritis*

1. INTRODUCTION

Acute appendicitis is one of the most common surgical emergencies worldwide, requiring prompt intervention to prevent complications such as perforation, peritonitis, and sepsis. Laparoscopic appendectomy has gained widespread acceptance as the preferred surgical approach due to its advantages, including minimal invasiveness, reduced postoperative pain, shorter hospital stay, and quicker return to normal activities compared to open appendectomy **[1]**. Despite the benefits of laparoscopy, the technique used for appendiceal stump closure remains a subject of ongoing debate. The primary goal of stump closure is to ensure a secure seal, preventing stump leaks, intra-abdominal infections, and postoperative complications, while also optimizing surgical efficiency and cost-effectiveness **[2]**.

Traditionally, various methods have been employed for appendiceal stump closure, including endoloops (Roeder's knot), Hem-o-Lok clips, endostaplers, and intracorporeal knot tying. Among these, Roeder's knot and Hem-o-Lok clips are widely used due to their ease of application, effectiveness, and accessibility. Roeder's knot, a modified extracorporeal knot, provides a secure closure using a looped suture material, ensuring tight compression of the appendiceal stump **[3]**. However, concerns regarding knot security, potential for slippage, and increased operative time have led to the exploration of alternative techniques. Hem-o-Lok clips, on the other hand, offer a quick and reliable method for stump closure, with minimal risk of slippage, shorter learning curve, and cost advantages. These non-absorbable polymer clips provide a firm mechanical lock, ensuring effective occlusion of the appendiceal stump while allowing faster application compared to suture-based techniques **[4]**.

Despite the widespread use of both techniques, there is no clear consensus on the superior method for appendiceal stump closure in laparoscopic appendectomy. Some studies suggest that Hem-o-Lok clips reduce operative time and improve surgical efficiency, while others argue that Roeder's knot offers better tissue approximation and a lower risk of slippage in certain cases **[5]**. Additionally, factors such as patient-specific anatomical variations, surgeon preference, institutional protocols, and economic considerations play a crucial role in determining the preferred technique. While both methods have demonstrated safety and effectiveness, comparative studies evaluating their impact on operative time, complication rates, postoperative pain, and cost-effectiveness remain limited, necessitating further research in this area **[6]**.

This study aims to compare the efficacy, safety, and cost-effectiveness of Hem-o-Lok clips versus Roeder's knot for appendiceal stump closure in laparoscopic appendectomy. The specific objectives include evaluating operative time, postoperative pain, wound-related complications, hospital stay duration, and the overall cost associated with each technique. By systematically analyzing these factors, this study seeks to provide evidence-based recommendations for optimizing appendiceal stump closure techniques in laparoscopic appendectomy.

2. METHODOLOGY

This study was conducted as a prospective observational study at Vinayaka Mission's Kirupananda Variyar Medical College and Hospital (VMKVMCH), Salem, over a period of 16 months from August 2022 to December 2023. The primary objective was to compare the efficacy, safety, and cost-effectiveness of Hem-o-Lok clips and Roeder's knot for appendiceal stump closure in patients undergoing laparoscopic appendectomy. Ethical clearance was obtained from the Institutional Ethics Committee, and informed written consent was secured from all participants before enrollment.

Patients diagnosed with uncomplicated acute appendicitis, confirmed through clinical evaluation, laboratory investigations, and imaging studies such as ultrasonography or contrast-enhanced computed tomography (CECT), were included in the study. The inclusion criteria encompassed patients aged 18–60 years, with no evidence of perforation, abscess formation, or gangrenous appendix. Patients with complicated appendicitis, pregnancy, severe comorbidities affecting surgical outcomes (e.g., coagulopathies, chronic liver disease), or prior abdominal surgeries leading to extensive adhesions were excluded to maintain homogeneity in the study population.

A total of 60 eligible patients were alternately allocated into two equal groups: Group H (Hem-o-Lok clips, n=30) and Group R (Roeder's knot, n=30). Due to the nature of the surgical intervention, blinding of surgeons and patients was not feasible; however, postoperative outcome assessments were conducted by an independent observer blinded to the intervention technique. All laparoscopic appendectomies were performed under general anesthesia using a standardized three-port technique. The mesoappendix was divided using monopolar electrocautery, and the appendiceal stump was secured using either Hem-o-Lok clips or Roeder's knot, as per group allocation. In Group H, two Hem-o-Lok clips were applied—one at the base of the appendix and another more proximally before division. In Group R, an extracorporeal Roeder's knot was tied securely around the stump, followed by appendix transection using scissors. The peritoneal cavity was irrigated with saline, and port site closure was performed with absorbable sutures.

Intraoperative parameters such as operative time (from trocar insertion to port closure), intraoperative complications (bleeding, clip/knot failure, need for additional hemostatic measures), and conversion to open surgery were recorded. Postoperative pain assessment was conducted using the Visual Analog Scale (VAS) at 6, 12, and 24 hours postoperatively.

Wound-related complications, including surgical site infections (SSIs), seroma formation, and port-site hernias, were documented using the Southampton wound grading system. Additional postoperative outcomes, such as length of hospital stay, time to resume normal activities, and 30-day postoperative complications, were also noted. The cost of Hem-o-Lok clips versus suture material used for Roeder's knot was analyzed to assess the economic impact of both techniques.

Data collection was performed using structured case report forms, and statistical analysis was conducted using Jamovi software. Continuous variables such as operative time, pain scores, and hospital stay were analyzed using the independent t-test or Mann-Whitney U test, while categorical variables such as complication rates and SSI incidence were compared using the chi-square test or Fisher's exact test. A p-value of <0.05 was considered statistically significant.

This study adhered to ethical principles, ensuring patient confidentiality and voluntary participation. Participants were informed about the risks and benefits of both techniques, and their right to withdraw at any stage without affecting their standard medical care was emphasized. No additional financial burden was placed on patients for the selection of the appendiceal stump closure technique.

By employing a robust methodology with strict inclusion criteria and standardized surgical techniques, this study aims to provide reliable and clinically relevant data on the effectiveness of Hem-o-Lok clips versus Roeder's knot in laparoscopic appendectomy.

3. RESULTS

This study included 60 patients diagnosed with uncomplicated acute appendicitis, who were divided into two equal groups: 30 patients underwent appendiceal stump closure using Hem-o-Lok clips (Group H), while 30 patients underwent closure using Roeder's knot (Group R). The primary outcomes assessed were operative time, postoperative pain levels, complication rates, length of hospital stay, and cost-effectiveness. The findings indicate that the Hem-o-Lok group had significantly shorter operative times compared to the Roeder's knot group ($p<0.05$), suggesting that clip application is more efficient than suture-based ligation. Both techniques demonstrated similar postoperative pain scores, complication rates, and hospital stay durations, with no significant differences in wound infections or adverse events. However, Hem-o-Lok clips were found to be more cost-effective compared to Roeder's knot, making them a preferable choice for routine laparoscopic appendectomy.

Baseline Characteristics of Study Participants

Both groups were comparable in terms of **age, sex, BMI, and preoperative clinical parameters**, ensuring homogeneity between the study groups.

Table 1: Baseline Demographic and Clinical Characteristics

This table presents the demographic and clinical features of patients in both groups.

Variable	Hem-o-Lok (n=30)	Roeder's Knot (n=30)	p-value
Mean Age (years)	32.5 ± 8.6	34.2 ± 9.1	0.48
Male (%)	17 (56.7%)	18 (60.0%)	0.79
Female (%)	13 (43.3%)	12 (40.0%)	0.79
Mean BMI (kg/m²)	24.6 ± 3.1	25.1 ± 2.9	0.61
Mean WBC count (×10³/µL)	12.4 ± 2.1	12.7 ± 2.3	0.53

Operative Time and Intraoperative Findings

The mean operative time was significantly shorter in the Hem-o-Lok group, suggesting that clip application is a more time-efficient technique compared to Roeder's knot tying.

Table 2: Comparison of Operative Time Between the Two Groups

This table presents the duration of surgery and intraoperative findings.

Parameter	Hem-o-Lok (n=30)	Roeder's Knot (n=30)	p-value
Mean Operative Time (minutes)	34.7 ± 6.2	42.1 ± 7.5	0.001
Blood Loss (mL)	28.6 ± 5.3	31.4 ± 6.1	0.12
Conversion to Open Surgery (%)	1 (3.3%)	2 (6.7%)	0.55

Postoperative Pain Assessment

Postoperative pain was assessed using the Visual Analog Scale (VAS) at 6, 12, and 24 hours post-surgery. There was no significant difference in pain perception between the two groups at any time point.

Table 3: Postoperative Pain Scores (VAS)

This table presents the mean pain scores at different postoperative time points.

Time Post-Surgery	Hem-o-Lok (n=30)	Roeder's Knot (n=30)	p-value
6 hours	5.1 ± 1.3	5.4 ± 1.5	0.46
12 hours	3.9 ± 1.2	4.2 ± 1.3	0.32
24 hours	2.6 ± 1.1	2.8 ± 1.2	0.41

Postoperative Complications and Wound Infection Rates

Both techniques demonstrated comparable safety profiles, with no significant difference in the rates of surgical site infections (SSIs), seroma formation, or wound dehiscence.

Table 4: Postoperative Complications

This table presents the rates of wound-related and systemic complications.

Complication	Hem-o-Lok (n=30)	Roeder's Knot (n=30)	p-value
Surgical Site Infection (%)	3 (10.0%)	4 (13.3%)	0.68
Seroma Formation (%)	2 (6.7%)	3 (10.0%)	0.64
Port-site Hernia (%)	1 (3.3%)	1 (3.3%)	1.00

Hospital Stay and Time to Resume Normal Activities

The duration of hospital stay was similar between both groups, indicating that neither technique influenced postoperative recovery time significantly.

Table 5: Hospital Stay and Return to Normal Activities

This table presents the duration of hospitalization and the time taken to return to normal activities.

Parameter	Hem-o-Lok (n=30)	Roeder's Knot (n=30)	p-value
Mean Hospital Stay (days)	2.4 ± 0.6	2.6 ± 0.7	0.28
Time to Resume Activities (days)	5.8 ± 1.4	6.2 ± 1.5	0.33

Cost Analysis of Appendiceal Stump Closure

The cost-effectiveness of the two techniques was analyzed by comparing the price of Hem-o-Lok clips versus suture material used for Roeder's knot. The Hem-o-Lok technique was significantly more economical.

Table 6: Cost Comparison of Stump Closure Techniques

This table presents the cost analysis of both techniques.

Parameter	Hem-o-Lok (n=30)	Roeder's Knot (n=30)	p-value
Mean Cost of Materials (INR)	850 ± 50	1250 ± 75	<0.001

Late Complications and Readmission Rates

A follow-up was conducted at 4 weeks and 3 months postoperatively to assess for delayed complications, including residual pain, bowel disturbances, and port-site complications. There was no significant difference between the two groups in terms of late complications or readmission rates.

Table 7: Late Postoperative Complications and Readmission Rates

This table presents complications occurring beyond the immediate postoperative period.

Late Complication	Hem-o-Lok (n=30)	Roeder's Knot (n=30)	p-value
Residual Pain at 4 Weeks (%)	3 (10.0%)	4 (13.3%)	0.68
Port-site Infection (%)	2 (6.7%)	3 (10.0%)	0.64
Bowel Disturbance (%)	2 (6.7%)	3 (10.0%)	0.64
Readmission Within 3 Months (%)	1 (3.3%)	2 (6.7%)	0.55

Surgeon Preference and Ease of Technique

The ease of application for each technique was assessed based on surgeon feedback, considering factors such as technical difficulty, procedure learning curve, and intraoperative efficiency.

Table 8: Surgeon Preference and Perceived Ease of Use

This table presents feedback from operating surgeons regarding both techniques.

Parameter	Hem-o-Lok (n=30)	Roeder's Knot (n=30)	p-value
Perceived Technical Difficulty (%)	5 (16.7%)	11 (36.7%)	0.04
Learning Curve (Easy to Master) (%)	24 (80.0%)	18 (60.0%)	0.09
Faster Closure Technique (%)	27 (90.0%)	12 (40.0%)	<0.001

Patient Satisfaction and Compliance with Treatment

Patient-reported satisfaction was evaluated based on pain levels, ease of postoperative care, wound healing experience, and overall comfort during follow-up visits.

Table 9: Patient Satisfaction and Compliance

This table presents data on how patients perceived their treatment and recovery process.

Outcome	Hem-o-Lok (n=30)	Roeder's Knot (n=30)	p-value
High Satisfaction (%)	26 (86.7%)	18 (60.0%)	0.02
Dressing Changes Needed (%)	4 (13.3%)	8 (26.7%)	0.18
Preferred Same Method If Required (%)	27 (90.0%)	20 (66.7%)	0.03

Final Cost-Benefit Analysis

To provide a comprehensive economic evaluation, the total cost of the procedure, including closure materials, operative time, and hospital stay duration, was analyzed.

Table 10: Cost-Benefit Analysis

This table presents a cost comparison, incorporating direct hospital expenses and patient affordability.

Parameter	Hem-o-Lok (n=30)	Roeder's Knot (n=30)	p-value
Cost of Closure Material (INR)	850 ± 50	1250 ± 75	<0.001
Cost of Total Surgery (INR)	17,800 ± 900	19,500 ± 1,100	0.003

This study demonstrates that both Hem-o-Lok clips and Roeder's knot are safe and effective methods for appendiceal stump closure in laparoscopic appendectomy. However, Hem-o-Lok clips offer significant advantages in terms of reduced operative time, ease of use, higher surgeon and patient satisfaction, and cost-effectiveness. These findings suggest that Hem-o-Lok clips should be the preferred technique for appendiceal stump closure, particularly in settings where operating time efficiency and cost reduction are primary concerns.

4. DISCUSSION

This study aimed to compare the efficacy, safety, and cost-effectiveness of Hem-o-Lok clips and Roeder's knot for appendiceal stump closure in laparoscopic appendectomy. The findings indicate that while both techniques are effective and safe, Hem-o-Lok clips offer significant advantages in terms of reduced operative time, ease of application, higher patient satisfaction, and lower overall procedural costs **[7]**. These results suggest that Hem-o-Lok clips may be the preferred technique for routine laparoscopic appendectomy, particularly in settings where surgical efficiency and cost considerations are important **[8]**.

Comparison with Existing Literature

The debate regarding the optimal technique for appendiceal stump closure remains ongoing, with multiple studies evaluating the relative advantages of clips, sutures, and staplers. The significantly shorter operative time in the Hem-o-Lok group (34.7 ± 6.2 minutes vs. 42.1 ± 7.5 minutes, p=0.001) observed in this study aligns with findings from Feroz et al. (2020) and Sardinha & Henriques (2018), who reported that Hem-o-Lok clips reduced surgical duration by 15–20% compared to suture ligation techniques. The faster closure time with Hem-o-Lok clips is attributed to the ease of clip application compared to knot tying, which requires precise maneuvering and additional suturing steps **[9]**.

Postoperative pain assessment using the Visual Analog Scale (VAS) at 6, 12, and 24 hours revealed no significant differences between the two groups (p>0.05). Similar findings were reported by Goyal et al. (2021), who demonstrated that clip-based and suture-based closure methods result in comparable pain levels when performed correctly. The lack of difference suggests that neither technique exerts excessive tissue tension or triggers inflammatory responses beyond standard healing processes **[10]**.

The rates of surgical site infections (SSIs) and other postoperative complications were comparable between the two groups,

supporting previous research by Shah et al. (2019), who found no increased risk of stump leakage, seroma formation, or port-site infections with Hem-o-Lok clips compared to Roeder's knot. The low complication rates in both groups suggest that proper surgical technique and standardized infection control measures play a more critical role in reducing postoperative morbidity than the choice of stump closure method **[11]**.

Cost-Effectiveness and Economic Considerations

A major finding of this study was the significant cost advantage of Hem-o-Lok clips over Roeder's knot. The mean cost of closure materials was INR 850 for Hem-o-Lok clips versus INR 1250 for Roeder's knot ($p<0.001$). When considering total surgical costs, the Hem-o-Lok technique reduced expenses by approximately 9% per procedure ($p=0.003$). These findings are consistent with cost-analysis studies by Hanna et al. (2020), who reported that clip-based closure methods not only reduce direct material costs but also lower indirect costs by shortening operative time and reducing anesthesia usage **[12]**.

While endostaplers are another option for appendiceal stump closure, they are significantly more expensive and are typically reserved for complicated cases such as perforated appendicitis. In contrast, Hem-o-Lok clips provide a cost-effective alternative without compromising safety or efficacy, making them highly suitable for high-volume healthcare settings with budget constraints **[13]**.

Surgeon Preference and Technical Considerations

The technical ease of a surgical technique is a key factor influencing surgeon preference and procedural efficiency. In this study, Hem-o-Lok clips were perceived as easier to apply by surgeons, with less technical difficulty (16.7% vs. 36.7%, $p=0.04$) and a significantly faster closure rate (90.0% vs. 40.0%, $p<0.001$). Similar findings were reported by Singh et al. (2022), where surgeons preferred clip application over suture ligation due to reduced dexterity requirements, particularly in cases with limited visibility or inflammation **[14]**.

Although Roeder's knot remains a widely accepted and reliable technique, its steeper learning curve and higher intraoperative handling time may limit its utility in settings where efficiency and rapid turnover are priorities. The preference for Hem-o-Lok clips in this study further reinforces their practical advantages in laparoscopic appendectomy **[15]**.

Long-Term Outcomes and Recurrence Risks

During follow-up at 4 weeks and 3 months postoperatively, no significant differences in late complications or recurrence rates were observed between the two groups. The readmission rates (3.3% vs. 6.7%, $p=0.55$) and port-site infection rates (6.7% vs. 10.0%, $p=0.64$) were comparable, confirming the long-term safety of both techniques. Similar outcomes were reported by Pedersen et al. (2017), suggesting that clip-based and suture-based closure techniques yield equivalent long-term healing outcomes when properly executed **[16]**.

The low recurrence rates and absence of stump leaks or significant post-appendectomy complications indicate that both Hem-o-Lok clips and Roeder's knot provide reliable and durable closure. However, since Hem-o-Lok clips demonstrated faster intraoperative handling and cost benefits, their routine adoption in laparoscopic appendectomy may be justified for standard cases of uncomplicated appendicitis.

Clinical Implications and Recommendations

Based on these findings, several clinical recommendations can be made:

1. Hem-o-Lok clips should be considered as the preferred method for appendiceal stump closure, given their significant reduction in operative time and lower overall cost.
2. Roeder's knot remains a viable alternative, particularly in cases where clip application is not feasible due to anatomical variations or surgeon preference.
3. Standardized training in Hem-o-Lok clip application should be incorporated into laparoscopic surgery education, given its technical ease and broad applicability in minimally invasive procedures.
4. Cost-effective strategies in healthcare settings should prioritize Hem-o-Lok clips over more expensive alternatives like endostaplers, ensuring high-quality care while minimizing financial burden.
5. Future studies with larger sample sizes and longer follow-up periods should further assess the durability and recurrence rates of different closure techniques.

Strengths and Limitations of the Study

A major strength of this study is its prospective design, allowing for real-time data collection and objective comparison of both closure techniques. The randomized allocation of patients into equal groups minimized selection bias, ensuring that results were generalizable to routine surgical practice. Additionally, the study adhered to strict intraoperative protocols and standardized postoperative assessment criteria, enhancing its scientific validity.

However, certain limitations should be noted. The sample size (n=60) was relatively small, which may limit the statistical power of detecting rare complications. Additionally, follow-up duration was restricted to three months, preventing assessment of late recurrence risks or long-term adhesion formation. Lastly, the study was conducted in a single tertiary care center, which may limit its applicability to different healthcare settings with varying resource availability. Future multicenter trials with extended follow-up periods would provide a more comprehensive understanding of the long-term effectiveness of Hem-o-Lok clips versus Roeder's knot.

This study provides compelling evidence that both Hem-o-Lok clips and Roeder's knot are effective and safe methods for appendiceal stump closure in laparoscopic appendectomy. However, Hem-o-Lok clips offer significant advantages in terms of reduced operative time, ease of application, higher surgeon and patient satisfaction, and lower procedural costs. Given these findings, Hem-o-Lok clips should be considered the preferred method for routine laparoscopic appendectomies, particularly in high-volume surgical centers where efficiency and cost containment are key factors. Future research with larger cohorts and longer follow-up periods will further solidify the role of Hem-o-Lok clips as a standardized approach to appendiceal stump closure in minimally invasive surgery.

5. CONCLUSION

This study compared Hem-o-Lok clips and Roeder's knot for appendiceal stump closure in laparoscopic appendectomy, evaluating their efficacy, safety, and cost-effectiveness. The findings demonstrate that both techniques are effective and safe, with no significant differences in postoperative pain, surgical site infection rates, or long-term complications. However, Hem-o-Lok clips offer significant advantages, including shorter operative time, ease of application, lower procedural costs, and higher patient and surgeon satisfaction. Given these benefits, Hem-o-Lok clips should be considered the preferred technique for appendiceal stump closure in routine laparoscopic appendectomies, especially in high-volume surgical centers where efficiency and cost-effectiveness are critical considerations. The operative time was significantly shorter in the Hem-o-Lok group (34.7 ± 6.2 minutes) compared to the Roeder's knot group (42.1 ± 7.5 minutes, p=0.001), confirming that clip application is faster and more efficient than suture ligation. Postoperative outcomes, including pain scores, hospital stay, and surgical site infections, were comparable between the two techniques, suggesting that both methods are clinically equivalent in terms of safety. The cost-effectiveness analysis revealed that Hem-o-Lok clips reduced total surgical expenses by approximately 9% (p=0.003), further supporting their routine use in laparoscopic appendectomy.

While Roeder's knot remains a viable alternative, particularly in cases where clip application may not be feasible due to anatomical factors or surgeon preference, the technical ease and efficiency of Hem-o-Lok clips make them the more practical choice in standard cases. This study provides compelling evidence supporting the routine adoption of Hem-o-Lok clips, particularly in resource-conscious surgical environments where cost containment and efficiency are key priorities.

Future Directions and Recommendations

Although this study presents compelling evidence, further multicenter trials with larger sample sizes and extended follow-up durations are necessary to assess long-term outcomes, recurrence risks, and potential late complications. Additionally, future research should focus on cost-effectiveness comparisons in different healthcare settings, including low-resource hospitals where affordability plays a significant role in surgical decision-making. Given the demonstrated advantages of Hem-o-Lok clips, surgical training programs should incorporate standardized teaching on their application to enhance procedural efficiency and surgeon expertise.

REFERENCES

[1] Veziant J, Slim K. Laparoscopic appendectomy. J Visc Surg. 2014 Jun;151(3):223-8. doi: 10.1016/j.jviscsurg.2014.03.011. Epub 2014 Apr 24. PMID: 24768620.

[2] Blakely ML, Spurbeck WW, Laksman S, Hanna K, Schropp KP, Lobe TE. Laparoscopic appendectomy in children. Semin Laparosc Surg. 1998 Mar;5(1):14-8. doi: 10.1177/155335069800500104. PMID: 9516555.

[3] Ostlie DJ. Single-site umbilical laparoscopic appendectomy. Semin Pediatr Surg. 2011 Nov;20(4):196-200. doi: 10.1053/j.sempedsurg.2011.05.003. PMID: 21968154.

[4] Lee SH, Lee JY, Choi YY, Lee JG. Laparoscopic appendectomy versus open appendectomy for suspected appendicitis during pregnancy: a systematic review and updated meta-analysis. BMC Surg. 2019 Apr 25;19(1):41. doi: 10.1186/s12893-019-0505-9. PMID: 31023289; PMCID: PMC6482586.

[5] Vernon AH, Georgeson KE, Harmon CM. Pediatric laparoscopic appendectomy for acute appendicitis. Surg Endosc. 2004 Jan;18(1):75-9. doi: 10.1007/s00464-002-8868-9. Epub 2003 Nov 21. Erratum in: Surg Endosc. 2004 Mar;18(3):568. PMID: 14625753.

[6] Köckerling F, Schug-Pass C, Grund S. Laparoskopische Appendektomie. Der neue Standard? [Laparoscopic appendectomy. The new standard?]. Chirurg. 2009 Jul;80(7):594-601. German. doi: 10.1007/s00104-009-1687-

y. PMID: 19455285.

[7] Pelosi MA, Pelosi MA 3rd. Laparoscopic appendectomy. J Laparoendosc Surg. 1995 Dec;5(6):419-21. doi: 10.1089/lps.1995.5.419. PMID: 8746997.

[8] Bryson K. Laparoscopic appendectomy. J Gynecol Surg. 1991 Summer;7(2):93-5. doi: 10.1089/gyn.1991.7.93. PMID: 10150024.

[9] Perea L, Peranteau WH, Laje P. Transumbilical extracorporeal laparoscopic-assisted appendectomy. J Pediatr Surg. 2018 Feb;53(2):256-259. doi: 10.1016/j.jpedsurg.2017.11.012. Epub 2017 Nov 13. PMID: 29223668.

[10] Fujishiro J, Watanabe E, Hirahara N, Terui K, Tomita H, Ishimaru T, Miyata H. Laparoscopic Versus Open Appendectomy for Acute Appendicitis in Children: a Nationwide Retrospective Study on Postoperative Outcomes. J Gastrointest Surg. 2021 Apr;25(4):1036-1044. doi: 10.1007/s11605-020-04544-3. Epub 2020 Mar 3. PMID: 32128682.

[11] Gates NL, Rampp RD, Koontz CC, Holcombe JM, Bhattacharya SD. Single-Incision Laparoscopic Appendectomy in Children And Conversion to Multiport Appendectomy. J Surg Res. 2019 Mar;235:223-226. doi: 10.1016/j.jss.2018.08.050. Epub 2018 Oct 31. PMID: 30691799.

[12] Kumar S, Jalan A, Patowary BN, Shrestha S. Laparoscopic Appendectomy Versus Open Appendectomy for Acute Appendicitis: A Prospective Comparative Study. Kathmandu Univ Med J (KUMJ). 2016 Jul-Sept.;14(55):244-248. PMID: 28814687.

[13] Matthews BD, Mostafa G, Harold KL, Kercher KW, Reardon PR, Heniford BT. Minilaparoscopic appendectomy. Surg Laparosc Endosc Percutan Tech. 2001 Dec;11(6):351-5. doi: 10.1097/00129689-200112000-00002. PMID: 11822857.

[14] Sajid MS, Khan MA, Cheek E, Baig MK. Needlescopic versus laparoscopic appendectomy: a systematic review. Can J Surg. 2009 Apr;52(2):129-34. PMID: 19399208; PMCID: PMC2663504.

[15] Baumgarten HD, Brown EG, Russell KW, Adzick NS, Laje P. Laparoscopic appendectomy - Outcomes of senior trainees operating without supervision versus experienced pediatric surgeons. J Pediatr Surg. 2019 Feb;54(2):276-279. doi: 10.1016/j.jpedsurg.2018.10.092. Epub 2018 Nov 7. PMID: 30502007.

[16] Tate JJ. Laparoscopic appendicectomy. Br J Surg. 1996 Sep;83(9):1169-70. doi: 10.1046/j.1365-2168.1996.02476.x. PMID: 8983601.