



Comparison of Ultrasonic Dissection and Suture Ligation for Mesoappendix in Laparoscopic Appendectomy

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KEYWORDS

Laparoscopic Appendectomy, Ultrasonic Dissection, Suture Ligation

ABSTRACT:

Background: Laparoscopic appendectomy (LA), preferred for minimal invasiveness, requires effective mesoappendix dissection methods to avoid complications like massive bleeding or surgery conversion. This study compares ultrasonic dissection with suture ligation regarding operative time, per-operative bleeding, and post-operative complications. Methods: In this prospective randomized controlled trial at KIMS Hospital, Bengaluru, from January to July 2024, 90 patients with acute appendicitis were randomly assigned to ultrasonic dissection (n=44) or suture ligation (n=46). Key outcomes measured included operative time, per-operative bleeding, and post-operative complications, analyzed using SPSS 23.0. Results: The mean operative time was significantly less for ultrasonic dissection (63.568 ± 9.896 minutes) compared to suture ligation (84.788 ± 11.239 minutes; $p < 0.001$). There was no significant difference in per-operative bleeding between the groups. Post-operative complications were similarly low and not statistically different between the groups. Conclusion: Ultrasonic dissection offers a more time-efficient method for mesoappendix management in laparoscopic appendectomy compared to suture ligation, with comparable safety outcomes.

INTRODUCTION

Since its introduction by Kurt Semm in 1983, Laparoscopic appendectomy (LA) has become a popular alternative to open appendectomy due to minimal incision, a better view of the peritoneal cavity, safe exploration, better wound healing, reduced postoperative pain, and earlier return to normal activities.⁽¹⁾

Dissection of the meso appendix is a very crucial step in LA due to the risk of massive bleeding and conversion to open surgery in case of instrument failure at this stage.⁽²⁾

Various methods have been described for mesoappendix dissection which include endostapler, Liga Sure (Covidien, Boulder, CO), endoclip (EC), Harmonic (Ethicon Endo Surgery, Cincinnati, OH) scalpel (HS), LigaSure (Covidien, Mansfield, MA), and monopolar electrocautery (ME).^(2,3)

The HS employs ultrasound technology to create high-frequency mechanical vibrations in the range of 20,000Hz to 60,000Hz to cut and cauterize tissue simultaneously. It uses protein denaturation instead of heat and seals vessels at lower temperatures than electro-surgery.⁽⁴⁾



Suture ligation on the other hand is very time-consuming as it involves cutting the appendix mesentery with laparoscopic scissors and then suturing it. It also has a very steep learning curve. ⁽³⁾ In this study, we wish to compare these two techniques of mesoappendix dissection in terms of operative time, per-operative bleeding, and post-operative complications.

MATERIALS AND METHODS

This prospective randomized controlled trial was carried out in the Department of Surgery in KIMS Hospital, Bengaluru, India from Jan to July 2024. A total of 90

presenting with acute appendicitis (diagnosed with Alvarado score ≥ 5 and positive ultrasound findings), in the age group of 15-45 years, willing to undergo a laparoscopic procedure were included in this study. Patients declared unfit for laparoscopic procedures and those with intraabdominal procedures other than acute appendicitis were excluded. After obtaining written informed consent from the patients, they were randomly allocated to two groups using computer-generated random numbers. Group A consisting of 44 patients underwent mesoappendix dissection using an ultrasonic dissector.



Figure 1: picture of ultrasonic dissector

Group B consisting of 46 patients underwent suture ligation.

The total time needed for ligation of mesoappendix, per operative bleeding, and postoperative complications were recorded in both groups and analyzed.

Surgical procedure:

All patients were given pre-operative analgesics and intravenous antibiotics (Piperacillin and Tazobactam). Surgeries were performed by a single surgeon using the same laparoscopic technique in both groups. Preoperative assessment for surgical fitness was done a day before the surgery. In the operation theatre, patients were positioned supine in the Trendelenburg position, and under aseptic measures Foley's catheter was

introduced for voiding of the bladder to provide better visualization by bladder decompression. Trocar (10 mm) was placed in the umbilicus. Additional 5 mm two ports were placed in the suprapubic place (2 cm above pubic symphysis) and left lower quadrant (3 cm superior and medial to the anterior superior iliac spine). Ultrasonic dissector (Group A) or extracorporeally prepared knots (Group B) were introduced through the port in the left lower quadrant. The appendix stump was closed in both groups by the endoloop method. The appendix was transected and retrieved (grasper) using a similar technique in both groups. Post-operative appendix sample was sent for histopathological analysis and pathologies other than acute appendicitis were excluded from the study before final data analysis.



Figure 2: intraoperative steps collage



Suture Ligation Technique



Figure 3

Ultrasonic Dissection Technique



Data analysis: Statistical analysis of the data was performed using SPSS 23.0. The Categorical variables were presented as frequency and percentage. The continuous variables were presented as mean ± SD. Comparisons between the groups were done using the unpaired t-test. Categorical variables were analysed using the Chi-square test. A p-value <0.05 was considered statistically significant.

Operative time in minutes was defined as the time taken to separate the mesoappendix. It was measured as soon as the ultrasonic dissector or suture was introduced through the port and was noted down till the mesoappendix was separated by either technique.

Per-operative bleeding was qualitatively defined as either blood loss occurring or not (yes/no) according to the principal investigator’s visual assessment. Blood loss occurring only while dealing with mesoappendix was considered.

RESULTS

Statistical analysis of the data was performed using SPSS 23.0. The categorical variables were presented as frequency and percentage. The continuous variables were presented as mean ± SD. Comparisons between the groups were done using the unpaired t-test. Categorical variables were analyzed using the Chi-

square test. A p-value <0.05 was considered statistically significant.

Demographic data

The mean age in group A was 29.386±8.905 years (IQR: 22–37), and in group B was 33.695±13.518 years (IQR: 21–44.2), with p <0.079 showing no significant difference between the two groups. Group A comprised 37.7% females and 62.3% males, while Group B comprised 33.3% females and 66.7% males (p = 0.872), indicating a similar gender distribution across both groups. (Table 1)

Table 1: Showing distribution of age and gender

		Ultrasonic Dissection	Suture Ligation	p value
Age		29.386±8.905 (22-37)	33.695±13.518 (21-44.2)	0.075
Gender	Female	17(37.7%)	15(33.3%)	0.872
	Male	28(62.3%)	30(66.7%)	

In this study, the age in the Ultrasonic Dissection group was 29.386±8.905 years (IQR: 22–37), and in the Suture Ligation group, it was 33.695±13.518 years (IQR: 21–44.2) and the p-value <0.079, showing no



significant difference between the two groups. Regarding gender, the Ultrasonic Dissection group consisted of 37.7% females and 62.3% males, while the Suture Ligation group had 33.3% females and 66.7% males ($p = 0.872$), indicating a similar gender distribution across both groups.

Operative time:

The mean operative time for group A was 63.568 ± 9.896 minutes (IQR: 56.5–77.5 minutes), while for group B was 84.788 ± 11.239 minutes (IQR: 77.0–96.0 minutes). Thus, operative time was significantly longer in group B with a p-value of <0.001 . (Table 2)

Table 2: Comparison of operative time

	Ultrasonic Dissection	Suture Ligation	p value
operative_ time	63.568 ± 9.896 (56.5-77.5)	84.788 ± 11.239 (77.0-96.0)	$P < 0.001$

The operative time for the Ultrasonic Dissection group was 63.568 ± 9.896 minutes (IQR: 56.5–77.5 minutes), while for the Suture Ligation group, it was 84.788 ± 11.239 minutes (IQR: 77.0–96.0 minutes). Operative time was significantly more in Suture Ligation with a p-value of <0.001 .

Per-operative bleeding:

The occurrence of preoperative bleeding was 0.9 % in group A and 17.8 % in group B. The p-value for this comparison was 0.135, indicating no statistically significant difference between the two groups. (Table 3)

Table 3: Comparison of pre operative bleeding

		Ultrasonic Dissection	Suture Ligation	p value
Preoperative bleeding	No	41(91.1%)	37(82.2%)	0.135
	Yes	4(0.9%)	8(17.8%)	

Preoperative bleeding was absent in 91.1% of patients in the Ultrasonic Dissection group and 82.2% of patients in the Suture Ligation group. The occurrence of preoperative bleeding was 0.9% in the Ultrasonic Dissection group and 17.8% in the Suture Ligation group. The p-value for this comparison was 0.135, indicating no statistically significant difference between the two groups regarding preoperative bleeding.

The mean Alvarado score in group A was 7.133 ± 1.53 (IQR: 6.0–8.0), while for group B was 7.213 ± 1.352 (IQR: 7.0–8.0). (Table 4)

Table 4: Comparison of Alvarado score

	Ultrasonic Dissection	Suture Ligation	p value
Alvarado score	7.133 ± 1.53 (6.0-8.0)	7.213 ± 1.352 (7.0-8.0)	0.954

The Alvarado score for the Ultrasonic Dissection group was 7.133 ± 1.53 (IQR: 6.0–8.0), while for the Suture Ligation group, it was 7.213 ± 1.352 (IQR: 7.0–8.0). The p-value >0.05 , indicating no statistically significant difference in the scores.

In the suture ligation group, complications such as slippage of ligature ($n=1$, 2.3%), and mechanical bowel obstruction ($n=2$, 4.4%) were seen. In the ultrasonic dissector group, 2 cases were complicated by mechanical bowel obstruction (4.4%). This difference in postoperative complications between the 2 groups was not statistically significant (Chi-square test= 0.846, $p = 0.359$). (Fig-3 bar graph titled representation of complications)

Patients were followed up for 3 months.

Table 5

Postoperative Complication	Group		Chi square	p value
	Ultrasonic Dissection	Suture Ligation		
No	43	42	0.846	0.359
	95.5%	93.3%		
Yes	2	3		
	4.6%	6.7%		

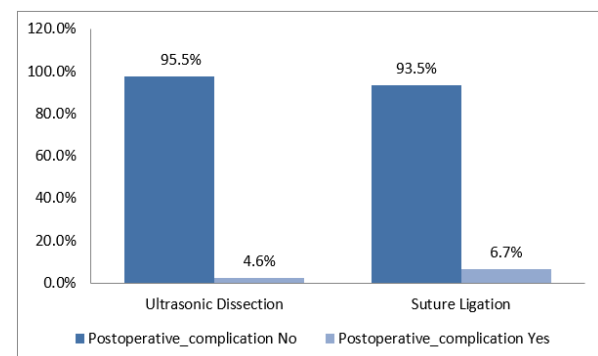


Figure 4: Representation of post OP complications



The chi-square test comparing postoperative complications between the Ultrasonic Dissection and Suture Ligation groups shows no statistically significant difference (Chi-square = 0.846, $p = 0.359$). While 4.6% of patients in the Ultrasonic Dissection group and 6.7% in the Suture Ligation group experienced complications.

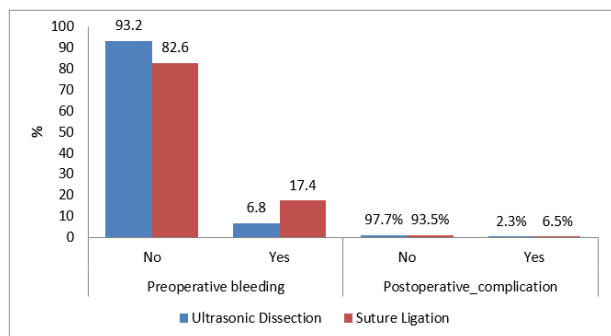


Figure 5

Table 6: Cross tabulation for complication

	No complication	Caecal perforation	Mechanical Bowel obstruction	Slippage of ligature	Total
Ultrasonic Dissection	43	0	2	0	45
	95.6%	0.0%	4.4%	0.0%	100.0%
Suture Ligation	42	0	2	1	45
	93.3%	0%	4.4%	2.3%	100.0%
Total	86	0	2	1	90
	95.6%	0%	2.2%	1.1%	100.0%

In the Ultrasonic Dissection group, 95.6% of cases experienced no complications, while 4.4% had mechanical bowel obstruction. In contrast, in the Suture Ligation group, 93.3% of cases had no complications, with 4.4% each experiencing mechanical bowel obstruction and 1.1% with slippage of the ligature.

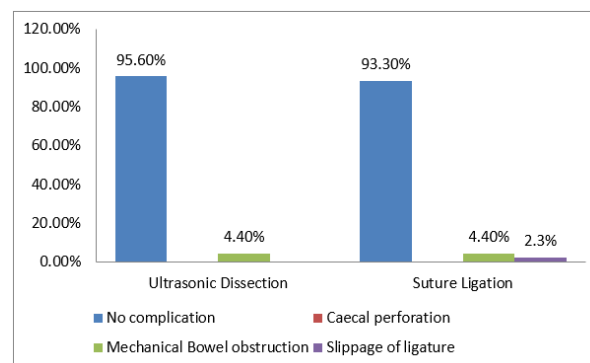


Figure 6: Representation of Complications

DISCUSSION

The HS is an ultrasonic dissector that can cut through thicker tissue with high precision and low surgical smoke production. Owing to its high frequency of vibration - 55,000Hz, it can coagulate and cut vessels up to 7 mm in diameter producing negligible collateral damage.^(5,6) Compared to other electrosurgical instruments it carries minimal risk of electrical injury as it doesn't rely on the use of electrical current in the patient's body.⁽⁷⁾

HS has found a special place in several conventional and laparoscopic procedures such as mastectomy, thyroidectomy, and hemorrhoidectomy. It has been associated with reduced post-operative pain, pre-operative bleeding, and overall operating time.^(8,9,10)

Several methods for the dissection of mesoappendix and closure of the appendicular stump in LA have been described in the literature. A study done in 2018 compared titanium clips and monopolar diathermy and showed that the former was associated with longer operating time due to the need for applying multiple clips to secure hemostasis, and more intraoperative and postoperative bleeding. Further, they were also not found to be very cost-effective.⁽¹¹⁾

Another study done in Croatia compared the use of harmonic scalpel (Ultracision™), bipolar coagulation (LigaSure™), and thermal fusion technology (MiSeal™) in LA in pediatric patients. They found that the lateral thermal damage to the mesoappendix with HS and MiSeal was significantly lesser than LigaSure. The latter was also reported to be the least cost-effective among the three.⁽¹²⁾

Gupta *et al.* had employed the harmonic scalpel to secure the base of the appendix in LA. They suggested that this "sutureless" appendectomy was easier to



perform, minimized instrument change, eliminated the risk of foreign body contamination (as seen with titanium clips, staples, and sutures), was less time-consuming, and had comparable recovery and postoperative course as compared to conventional knotting.⁽¹³⁾

A study done by Yuvaz *et al.* demonstrated no difference in the appendicular stump pressure between the Harmonic scalpel, LigaSure, and the conventional suturing with silk sutures, further establishing the safety of the harmonic scalpel in appendicular lumen operations.⁽¹⁴⁾

In our study, the operating time with the use of the ultrasonic dissector was significantly lesser than that with suture ligation. Similar results were seen in a study by Qaiser *et al.* They also found the ultrasonic dissector superior to suture ligation in terms of per-operative bleeding. We found no significant difference between the 2 groups for this parameter.⁽¹⁵⁾

Another study showed shorter operating time with harmonic scalpel than loop knots with no significant difference in overall complication rate.⁽¹⁶⁾ In our study, the incidence of post-op complications was lesser in the ultrasonic dissector group compared to the suture ligation group, albeit with no statistical significance.

We suggest additional research with longer follow-ups to fill in the lacunae in knowledge regarding late complications, post-operative, recovery, conversion rates, and cost-effectiveness, which can be filled by additional research with longer follow-ups.

CONCLUSION

The ultrasound dissector is a safer and more time-efficient alternative to conventional sutures for dealing with the mesoappendix in laparoscopic appendectomy. We found no significant difference in the per-operative bleeding between the two techniques.

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