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Comparative study of efficacy of monopolar electrocautery and ultrasonic shears in laparoscopic appendectomy

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Abstract

Aim: To compare efficacy of monopolar electro cautery and ultrasonic shears for laparoscopic appendectomy in terms of operating time, intraoperative hemostasis, post-operative pain, surgical site infection and post-operative hospital stay.

Methods: In this prospective comparative study conducted in R L Jalappa Hospital, Kolar, patients were divided into two groups using odd- even method (alternate method) to include similar type of cases in both groups. Each group included 22 patients, and underwent laparoscopic appendectomy using ultrasonic shears or monopolar electro cautery.

Results: Most of the patients were in the age group of 21 to 30 years. Majority was males. Significant differences were noted in terms of operating time, pain score on 24 hours postoperatively, intraoperative hemostasis and duration of post-operative hospital stay. These parameters were less in ultrasonic shears group compared to conventional Monopolar electro cautery group. Complications like surgical site infection were relatively same in both the groups.

Conclusion: Use of ultrasonic shears was found to be safe, effective and beneficial in reducing operative time and achieving better intraoperative hemostasis. Ultrasonic shears serves as an alternative to the Monopolar electro cautery in laparoscopic appendectomy. There is a decrease in the post-operative hospital stay in ultrasonic shear group. The intensity of pain perceived by patients in the ultrasonic shear group is less compared to monopolar electro cautery group. The cost of ultrasonic shear is more compared to monopolar electro cautery, which limits its regular use in laparoscopic appendectomy.

Keywords: Ultrasonic shears, Monopolar electro cautery, Laparoscopic Appendectomy INTRODUCTION

Acute appendicitis is commonest indication for abdominal emergency surgery with incidence of about $8\%^1$. It is associated with significant morbidity (10%) and mortality (1-5%) despite advances in diagnosis and treatment².

It commonly occurs in age group of 10-20 years with male preponderance, male to female ratio $(1.4:1)^3$.

Appendicitis is caused due to obstruction of lumen which leads to stasis and bacterial proliferation, commonest cause being fecolith, other causes include lymphoid hyperplasia, worm infestation³.

This remarkable laparoscopic surgery era has changed the approach for surgical diseases. Most of open surgeries are now being preferred for laparoscopic technique due to its advantages⁴.

First Laparoscopic appendectomy was performed on 30th May, 1980 by Dr. Semm, a gynaecologist. Laparoscopy can be utilized to diagnose conditions coexisting with appendicitis, in females for gynaecology and pelvis pathologies and in obese patients⁵.

Laparoscopic appendectomy is progressively accepted as treatment of choice for acute appendicitis. It offers advantages like faster recovery, less postoperative pain, reduced wound infection, short duration of stay in hospital and earlier return to work⁶.

In appendectomy, the most important step is closure of stump. Inadequate closure may lead to complications such as faecal fistula, peritonitis leading to sepsis causing severe morbidity⁷.

Newer methods for appendicular stump closure have been introduced like endoloop, double endoloop, ultrasonic shears, knotting, bipolar coagulation, slipknot tying, metal clip, hem o lock clip and linear endostaplers⁸.

Energy sources are indispensable for laparoscopic appendectomy. Electro cautery is the most popular energy source and ultrasonic shears is one of the latest additions.

Monopolar electro cautery is utilized because of its easy availability, affordability and easy maintenance, but it is associated with distant thermal damage which may inadvertently lead to perforation of bowel. Ultrasonic shears is the advanced and one of the latest energy sources which offers ease of usage like easy cut & coagulation and least complications but is expensive in terms of initial as well as maintenance costs.

Ultrasonic shears during laparoscopic surgery produces less lateral thermal damage and leads

to a shorter duration of surgery. Ultrasonic shears produce bioaerosols or very small particles and produces no smoke and no electric energy passage through patient's $body^{9,10,11}$.

The contemporary study is being contemplate to compare the efficacy of monopolar electro cautery with ultrasonic shears (harmonic scalpel) in laparoscopic appendectomy, the results of which may aid the surgeons to make objective choices in choosing the right energy source.

METHODOLOGY

Patients who satisfy inclusion criteria admitted to R.L. Jalappa Hospital and Research Centre, affliated to Sri Devaraj urs medical college, Tamaka, Kolar.

Sample size: - Total: 44. Patients will be stratified into two groups based on Odd & Even method.

Study period: - December 2018 to June 2020 (1 year 7 months)

INCLUSION CRITERIA:

Patients suffering from appendicitis aged between 21 years and 60 years undergoing laparoscopic appendectomy

EXCLUSION CRITERIA:

1) Patients with appendicular mass/ appendicular abscess.

2) Patients with comorbidities like cirrhosis, bleeding diathesis, severe cardiac or pulmonary disease falling in ASA grade 3 & 4.

3) Patients with previous abdominal surgery (where pneumoperitoneum cannot be created)

Statistical analysis:

Data was entered into Microsoft excel data sheet and was analyzed using SPSS 22 version software. Categorical data was represented in the form of Frequencies and proportions. **Chi-square test** was used as test of significance for qualitative data. Continuous data was represented as mean and standard deviation. **Independent t test or Mann Whitney U test** was used as test of significance to identify the mean difference between two quantitative variables and qualitative variables respectively ^{13,14,15}.

Graphical representation of data: MS Excel and MS word was used to obtain various types of graphs such as bar diagram^{13.14.15}.

p value (Probability that the result is true) of <0.05 was considered as statistically significant after assuming all the rules of statistical tests^{13.14.15}.

Statistical software: MS Excel, SPSS version 22 (IBM SPSS Statistics, Somers NY, USA) was used to analyze data^{13.14.15}.

The sample needed for our study was estimated and calculated by using mean difference in operating time from the study Alsayed A. Hamdy et.al. Dr. Atul Dua at al International Journal of Medical Science and Current Research (IJMSCR)

Considering a power of 80% and alpha error of 5%, to detect a difference of 8% in duration of surgery between the groups, sample size of 22 were included in each group.

$n=2S_{P}^{2}[Z_{1\text{-}\alpha/2}+Z_{1\text{-}\beta}]^{2}/\mu_{d}^{2}$
$S_p^2 = [S_1^2 + S_2^2] / 2$

Results

		Group			
	Monopolar Electro cautery Ultrasonic S			Shears	
		Count	%	Count	%
Surgical Site Infection	Absent	19	86.36%	20	90.91%
-	Present	3	13.64%	2	9.09%

TABLE 1: Surgical Site Infection Distribution between two groups

$\chi 2 = 0.226$, df = 1, p = 0.635

In Monopolar Electro cautery 13.64% had SSI and in Ultrasonic Shears 9.09% had Surgical Site Infection. No significant variation in Surgical Site Infection Distribution between two groups.

Table 2. Mean Operating Time in Minis Comparison between two groups

	Group						
	Monopolar Electro cautery Ultrasonic Shears						P value
	Mean	Median	SD	Mean	Median	SD	
Operating Time in Mins	45.77	46.50	4.21	38.14	38.00	3.41	< 0.001*

Mean Operating Time in Mins in Monopolar Electro cautery was 45.77 ± 4.21 and in Ultrasonic Shears was 38.14 ± 3.41 .

There was a significant difference in Mean Operating Time in Mins Comparison between two groups.



GRAPH 1: Bar Diagram Showing Mean Operating Time in Mins Comparison between two groups

Table 3: Mean Intra C	perative Hemostasis	Comparison	between tw	o groups
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	Group						
	Monopolar Electro cautery Ultrasonic Shears					P value	
	Mean	Median	SD	Mean	Median	SD	
Intra Operative Hemostasis (ML)	16.45	16.00	6.05	9.82	10.00	3.03	< 0.001*

Mean Intra Operative Hemostasis (ML) in Monopolar Electro cautery was 16.45 ± 6.05 and in Ultrasonic Shears was 9.82 ± 3.03 .

There was a significant difference in Mean Intra Operative Hemostasis Comparison between two groups.



GRAPH 2: Bar Diagram Showing Mean Intra Operative Hemostasis Comparison between two groups

 Table 4: Mean Post-Operative Pain Comparison between two groups

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	Group						
	Monopolar	Electro cautery	Ultrasonic Shears			P value	
	Mean	Median	SD	Mean	Median	SD	
Post- Operative Pain (VAS24 HR)	5.09	5.00	1.44	3.55	3.00	1.18	< 0.001*

Mean Post-Operative Pain in Monopolar Electro cautery was 5.09 ± 1.44 and in Ultrasonic Shears was 3.55 ± 1.18 .





GRAPH 3: Bar Diagram Showing Mean Post-Operative Pain Comparison between two groups

Table 5	5: Mean	Post-O	perative St	av Com	parison	between	two	grour)S
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	Group							
	Monopolar Electro cautery			Ultrasonic Shears			P value	
	Mean	Median	SD	Mean	Median	SD		
Post- Operative Stay in Days	4.55	4.00	1.74	3.55	3.00	1.18	0.031*	

Mean Post-Operative Stay in Days in Monopolar Electro cautery was 4.55 ± 1.74 and in Ultrasonic Shears was 3.55 ± 1.18 .

There was a significant difference in Mean Post-Operative Stay Comparison between two groups.



GRAPH 4: Bar Diagram Showing Mean Post-Operative Stay Comparison between two groups

DISCUSSION

The present study is a hospital based prospective comparative study undertaken to compare the outcomes of Laparoscopic appendectomy using two different energy sources i.e. monopolar electro cautery and ultrasonic shears, advantages and complications associated with their usage.

This study incorporated a total of 44 patients having appendicitis who underwent laparoscopic appendectomy in the Department of General Surgery at R.L. Jalappa hospital and research center attached to Sri Devaraj Urs Medical College, Kolar, during the period from December 2018 to July 2020.

The study was approved by the ethics committee of the institution. All the 44 patients were randomized using odd-even method (alternate method) and allocated for two groups equally (22 each) i.e. group A (Laparoscopic appendectomy using Monopolar electro cautery/odd group) and group B (Laparoscopic appendectomy using Ultrasonic shears/even group).

Patients suffering from appendicitis aged between 21 years and 60 years undergoing laparoscopic appendectomy are incorporated in study and patients with appendicular mass, appendicular abscess; comorbidities like cirrhosis, bleeding diathesis, severe cardiac or pulmonary disease falling in ASA grade 3 & 4; previous abdominal surgery (where pneumoperitoneum cannot be created) are excluded from the study.

The patients were assessed based on duration of surgery, intraoperative hemostasis, postoperative pain, surgical site infection and duration of hospital stay.

Demographic data of each patient was noted and all the patients were followed till three months after surgery.

1) AGE DISTRIBUTION: -

Each patient was comparable based on the demographic data studied, in both the groups. Patients studied with respect to age distribution showed no significant disparity in both groups. In our study, the mean age distribution in monopolar electro cautery group is 29.27 ± 8.19 years and ultrasonic shears group is 26.05 ± 4.87 . No significant variation was seen in patient's mean age distributed among the two groups (p value of 0.120).

Similarly, in a study conducted by Jun Sun Lee et al the mean age among patients with ultrasonic shears was 22.1 ± 4.8 years where as with monopolar electro cautery was 22.5 ± 5.8 years, suggesting similar demographic data for age for acute appendicitis disease among patients¹⁶.

In a study conducted by Saira Khalid et al, 74% patients were in age group of 15 to 25 years in both ultrasonic shears and monopolar electro cautery group¹⁷.

2) GENDER DISTRIBUTION: -

When the gender distribution is noted, in both the groups, it was almost equal and over all females are less affected compared to male population. In Monopolar Electro cautery group 45.45% were female and 54.55% were male whereas in Ultrasonic Shears group 22.73% were female and 77.27% were male. No significant variation in Sex Distribution between two groups was noted. (P value of 0.112).

In a study conducted by Jun Sun Lee et al, 98% patients were males similar to current study¹⁶, whereas the study conducted by Saira khalid et al had majority (60%) of females presented with acute appendicitis¹⁷.

3) MEAN OPERATING TIME: -

Mean operative time with ultrasonic shears is 38.14 ± 3.41 minutes and mean operative time with monopolar electro cautery is 45.77 ± 4.21 minutes. There is a significant difference (p value <0.001) in time of surgical procedure between the two groups. All these surgeries were performed by experienced surgeons and all were quite familiar with the instruments and the operative procedure and technique. There was a significant difference in the operative time among the two groups. However, the slightly longer operating time in the monopolar group might be due to extra time spent for hemostasis.

In the study conducted by Jun Sun Lee et al., which enrolled about 1178 patients, evaluated two laparoscopic appendectomy techniques: ultrasonic shears and monopolar electro cautery, the mean operating time was lesser with the ultrasonic shear group and it was statistically significant¹⁶.

In a study done by Saira khalid et al., the mean operative time for ligation of mesoappendix laparoscopic appendectomy with monopolar electro cautery was 17.7 ± 3.35 minutes; for ultrasonic shears patients, it was 17.6 ± 3.28 and was statistically not significant¹⁷.

4) INTRAOPERATIVE HEMOSTASIS: -

In Monopolar electro cautery group, mean intraoperative bleeding is 16.45 ± 6.05 ml where as it is 9.82 ± 3.03 ml in ultrasonic shears group as Ultrasonic scalpel coagulates the tissue before cutting and has vessel sealing property, which is not seen with conventional electro cautery. There was a significant difference in Mean Intra Operative Hemostasis Comparison between two groups.

In a study done by Saira khalid et al., the mean operative time for ligation of mesoappendix laparoscopic appendectomy with monopolar electro cautery was 3.4 ± 2.45 minutes; for Harmonic Scalpel (ultrasonic shears) patients, it was 3.3 ± 2.45 and was statistically not significant¹⁷.

5) POSTOPERATIVE PAIN: -

The post-operative pain is measured and quantified subjectively by using visual analogue scale (VAS), done 24 hours post-operatively i.e on post op day 1. The pain is not assessed on operative day, in our present study, as the post-operative pain can be altered or can be falsely low in the very immediate postoperative period. This can be due to the anaesthetic effect and time required for this effect to wear off. In our study the ultrasonic shear group showed better pain score 3.55 ± 1.18 on 24 hours post operatively. Monopolar group showed pain score of $5.09 \pm 1.44, 24$ hours post operatively. The use of ultrasonic scalpel during laparoscopic appendectomy minimizes detriment to the surrounding tissues and closure with a stitch is not required for achieving hemostasis.

6) SURGICAL SITE INFECTION: -

SSI was noted in three patients (13.64%) with monopolar electro cautery group as compared to two patients (9.09%) in ultrasonic shear group. No significant disparity was in Surgical Site Infection Distribution between two groups.

Similarly in a study conducted by Jun Sun Lee et al, 5 patients has SSI with ultrasonic shear group where 4 patients with monopolar electro cautery group and showed no statistical difference¹⁶.

7) DURATION OF HOSPITAL STAY: -

In general, the average hospital stays following a Laparoscopic appendectomy is 1-2 days. The average stay was slightly longer in our present study, 3.55 ± 1.18 days in the ultrasonic shear group and 4.55 ± 1.74 in the monopolar electro cautery group.

The reason for the longer hospital stay is due to the peculiarity that most of patients in the present study were rural population, who had to return to work and take part in their agricultural/household activities immediately after discharge, so they would not have been able to follow the postoperative instructions. There was a significant difference in Mean postoperative Stay Comparison between two groups.

In a study conducted by Jun Sun Lee et al, there was no statistical difference in duration of hospital stay between the two groups¹⁶.

Laparoscopic appendectomy using ultrasonic shears virtually created a bloodless surgery field with a decreased damage to tissue, this has been associated with a significantly lesser operating time, reduced postoperative pain with a quicker recovery for patient's normal daily activities.

In ultrasonic shears, the ultrasonic energy at the active blade is converted to mechanical energy. The active blade delivers a high-grade frictional force, whereas the inactive upper arm holds the tissue in proximity. Precise dissection, reliable hemostasis, less charring and decreased lateral thermal spread are the prime advantages. This device mainly works by applying a firm pressure while sealing with a denatured protein coagulum. The vibration causes denaturation of hydrogen bonds and leads to vessel coagulation. The ultrasonic shears may be superior to electro surgery as it can cut through thicker tissue, creating lesser toxic surgical smoke, and may offer greater precision.

CONCLUSION

Use of Ultrasonic shears was found to be safe, effective and beneficial in acheivinh intraoperative hemostasis. Ultrasonic shears serves as an alternative to the conventional procedure (Monopolar electro cautery) in laparoscopic appendectomy. There is a decrease in the operating time, post-operative hospital stay in ultrasonic shear group. The intensity of pain perceived by patients in the ultrasonic shear group is less compared to monopolar electro cautery group. The high cost of ultrasonic shears as compared to monopolar electro cautery limits its regular use in laparoscopic appendectomy.

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