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Appendiceacal Stump Closure Clip vs Ligature in Laparoscopic Appendectomy

Mostafa A. A. M. Abdelmoghis^{1*}

¹General Surgery Department, Faculty of Medicine, Fayoum University, Fayoum, 63514 Egypt.

*Correspondence: Mostafa A. A. M. Abdelmoghis, <u>dr.mostafa.adel10@gmail.com</u>, Tel: (002) 01069891907.

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Abstract:

Introduction: Acute appendicitis is a widely practiced surgical procedure around the globe. It has been recommended to do the procedure by laparoscopy rather than an open approach.

Aim of the study: To compare stump ligation versus clip application in cases having laparoscopic appendectomy.

Subjects and Methods: This comparative study was performed at the General Surgery department, Fayoum University Hospitals, from January 2023 to March 2024. The study recruited participants recognized with acute appendicitis and were scheduled for laparoscopic excision of the appendix. They were assigned to two groups according to the method of stump closure: ligation group and titanium clip application group. The participants had routine postoperative care and regular follow-up after surgery. Outcome measures included duration of surgery, postoperative complications, and absence time from work.

Results: The demographic data of both groups were matched. The inflammatory pattern and gross picture of the appendix between the two groups were closely similar. The mean surgical duration in the intracorporeal ligation group and the titanium clips group was 55.39 ±4.5 min. and 44.57 ±4.79 min., respectively (p < 0.001). The mean hospital stays and absence time were significantly shorter in the titanium clip group (p < 0.001) and 0.011, respectively). Both groups reported almost the same postoperative complications with no significant difference.

Conclusion: Titanium clip application was associated with decreased operative time, shorter hospital stays, and earlier recovery.

Keywords: Acute Appendicitis; Laparoscopic Appendectomy; Stump Ligation; Clip Application.

1. Introduction

Appendicitis is considered widely practiced surgical procedures in general

surgery. It is practiced at an incidence of 100/100,000 cases per year. At least 1

million hospital stays are due to appendicitis. The surgical management has been evolving from the traditional open to the minimally invasive approach laparoscopic appendectomy, first described by Semm in 1983 [1]. The establishment of acute appendicitis depends on signs, symptoms, and the clinical evaluation of the patient. The patient commonly has right lower quadrant (RLQ) pain, periumbilical pain that transfers to the RLQ, fever, nausea, and vomiting. Upon evaluation, symptoms include abdominal stiffness, pain to touch, and spring back tenderness on the right iliac fossa [2].

Laparoscopic surgery has resulted in a great advancement in the field of surgery. Almost any surgical procedure can be done by laparoscopy, provided the presence of good equipment and skillful hands [3]. Laparoscopic appendectomy (LA) was first recommended for female patients of

2. Subjects and Methods

2.1. Study setting

This comparative study was performed at the General Surgery department, Fayoum University Hospital, from January 2023 to March 2024.

2.2. Subjects

childbearing age. This was rendered to the decreased hospital admission and earlier recovery [4]. However, the European Association of Endoscopic Surgeons (EAES) has recommended LA as the first approach for any patient [5]. There are multiple ways to secure the appendiceal stump. One of them is by using a stapler to cut the stump (Endo- GIA), however, it is very expensive and might not be available in every hospital. Some surgeons secured the stump using suturing (endoloops). Others used metallic clips, although it is not widely practiced, and its safety is doubted by surgeons [6]. However, metallic clips were reported to be safe, providing less surgical duration, and a simple alternative to intracorporeal sutures [7]. Accordingly, this study was conducted to juxtapose between inside the abdomen suturing versus titanium implementation clip in fixing the appendiceal clip after laparoscopic appendectomy.

The study recruited 60 patients diagnosed with acute appendicitis, according to predetermined rolling in and out criteria.

Inclusion criteria

• Patients aged 18-38 years.

• All cases with acute appendicitis who had a laparoscopic appendectomy.

Exclusion criteria

- Failed laparoscopic approach with revision to open surgery.
- Contraindications to laparoscopic surgery as large appendiceal mass, hemodynamically unstable patients, and pregnant women in the third trimester.

2.3. Study design

Eligible patients were randomly allocated by simple randomization using computer-generated numbers into two groups:

- Ligation group: including patients who had laparoscopic appendectomy with securing the appendiceal stump with intracorporeal ligation. An endoloop (Ethicon Endoscopy Endoloop Ligature PDS® II or Serag Wiessner Serafit®) was applied to the appendix base. Another loop was applied 10 mm away. Also, it was done using conventional suturing by passing a needle and a suture through the appendix base and tying a knot using 2-0 Vicryl suture.
- Titanium clip group: including patients who had a laparoscopic appendectomy with application of titanium clips to secure the

stump. The titanium double-shanked clip (DS-Clip) was manufactured by Aesculap AG (Tuttlingen, Germany). It is a clip, synthesized from unalloyed titanium, with two shanks, aligned to each other and connected at the tip. The clip was applied using a certain clip-applier device. The closure procedure was started at the extremity, which reduces tissue slippage

All patients were evaluated by:

- Complete history taking
- Proper clinical examination.
- Routine laboratory investigations.
- Radiological investigations: ultrasound was performed for all participants to confirm the diagnosis. Computed tomography (CT), with contrast (oral and intravenous), was requested for patients with improper diagnosis by ultrasound study.
- Dehydrated patients were rehydrated properly. Any electrolyte imbalance was corrected before surgery.
- Preoperative prophylactic antibiotics were given (1.5 g of ampicillin, sulbactam and 500 mg of Metronidazole).
- Aral fluids were allowed after ensuring proper intestinal motility.

All patients were completely educated about the risks and benefits of the

research, and signed a corresponding permission. Patients were discharged afebrile, on oral diet, and after detachment of the intraperitoneal drain. Postoperative antibiotics were continued according to the results of culture and sensitivity. Antibiotics were continued for 7-10 days.

2.4. Statistical Methods

Data was gathered, coded, and scrutinized using IBM Statistical Package for Social Sciences software (SPSS), 25th edition, IBM, United The States. Kolmogorov-Smirnov test was applied to ensure normal distribution of data. Incessant data was presented in the form of mean \pm standard deviation, median and IQR, while absolute data was presented as figures and Results were considered percentages. statistically significant at a p-value of less than or equal to 0.05. The Chi-square test was applied for absolute modifiability. Student-t-test was used for numerical modifiable.

3. Results

In the intracorporeal ligation group, the mean age was 26.43 ± 4.67 years, 53.3%of them were females, and the group had a median BMI of 25.85 Kg/m². In the titanium clips group, the mean age was 25.83 ± 5.05 years, 53.3% of them were males, and the group had a median BMI of 26.09 Kg/m². The participants in each group were matched regarding age, gender and BMI (p > 0.05) as shown in **Table 1**.

Variables		Intracorporeal ligation group (N=30)		Titanium clips group (N=30)		Test value	<i>P</i> -value
		No.	%	No.	%	-	
Gender	Male	14	46.7%	16	53.3%	$x^2 - 0.267$	0.606
	Female	16	53.3%	14	46.7%	$- \Lambda - 0.207$	
Age	Mean± SD	26.43	± 4.67	25.83 ± 5.05		- T = 0.540	0.635
(years)	Range	18 -	- 36	18 - 38		= 1 - 0.349	0.035
	Mean± SD	25.31 ± 2.65		$26.08{\pm}2.69$		_	
BMI	Median	25.85 (22.27- 27.08) 21.42 - 30.71		26.09 (23.72-		$Z_{MWU} =$	0.270
(Kg/m^2)	(IQR)			28.5)		4.683	0.270
	Range			21.72 - 30.71			

Table 1: Demographic characteristics among the two studied groups.

*P < 0.05 is statistically significant. SD: Standard deviation, X2: Chi-Square Test, T: Student T Test, ZMWU: Z value of Mann-Whitney U Test.

In the intracorporeal ligation group, edematous appendicular base was reported in 26.7% of cases with a median size of 9 mm, and 40 % of them had a suppurative appendix. In the titanium clips group, edematous appendicular base was reported in 36.7% of cases with a median size of 9

mm, and 46.7 % of them had catarrhal appendix. The participants in each group were matched regarding condition of the base, gross pathology of the appendix and size of the appendix base (p > 0.05) (**Table** 2).

Variables		Intracorporeal ligation group (N=30)		Titan g (N	ium clips roup N=30)	Test value	<i>P</i> -value
		No.	%	No.	%		
Condition	Normal	22	73.3%	19	63.3%	$\mathbf{v}^{2} = 0.602$	0.405
of the base	Edematous	8	26.7%	11	36.7%	$-X^{2}=0.093$	
Evaluation	Normal	6	20.0%	2	6.7%		
of the	Catarrhal	10	33.3%	14	46.7%	$ \mathbf{V}^2$ 2.04	0 295
appendix	Gangrenous	2	6.7%	1	3.3%	- X = 3.04	0.383
by eye	Suppurative	12	40.0%	13	43.3%	_	
Size of	Mean± SD	8.73±1.72		8.70 ± 2.10		Z	
appendix	Median (IQR)	9 (8- 10)		9 (7-10)		${MWU} = 0.000$	0.928
base (mm)	Range	5	5-12 $5-12$		-12	- 0.090	

Table 2: Appendix data among the two studied groups.

*P < 0.05 is statistically significant. SD: Standard deviation, X2: Chi-Square Test, T: Student T Test, ZMWU: Z value of Mann-Whitney U Test.

The conveyed operative time in the intracorporeal ligation class and the titanium clips class was 55.39 ±4.5 min. and 44.57 ± 4.79 min. respectively. Time elapsed during surgery was greatly lower in the titanium clips class contrast the to intracorporeal ligation class (p < 0.001)(Table 3).

Table 3: Time elapsed during surgery for both classes.

Variables		Intracorporeal ligation class (N=30)	Titanium clips class (N=30)	Test value	<i>P</i> -value
Operative	Mean± SD	55.39±4.5	$44.57{\pm}\ 4.79$	T =	<0.001*
time (min)	Range	48.21 - 65.01	37.69 - 55.60	9.014	~0.001 [·]

*P <0.05 is statistically significant. SD: Standard deviation, T: Student T Test.

The mean duration of inpatient admission in the inside the abdomen tying class and titanium clips class was $19.37\pm$ 3.10 days and 13.87± 2.64 hours, respectively. The mean absence from work in the inside the abdomen tying class and the titanium clips class was 6.44± 1.21 hours and 5.67 ± 1.03 days, respectively. Hospital

stay was greatly down in the titanium clips class compared to the intracorporeal ligation class (p < 0.001). In addition, time to return to work was markedly down in the titanium clips class compared to the intracorporeal ligation class (p = 0.011), as presented in Table 4.

Variables		Intracorporeal ligation class (N=30)	Titanium clips class (N=30)	Test value	P-value
Hospital stay	Mean± SD	$19.37{\pm}3.10$	13.87 ± 2.64	T = 7.413	<0.001*
(hours)	(hours) Range		9.95 - 18.40	1 = 7.413	<0.001
Absence from	Mean± SD	6.44 ± 1.21	5.44 ± 1.21 5.67 ± 1.03		0.011*
work (days) Range		4.21 - 8.39	21 - 8.39 $3.83 - 7.21$		0.011
work (days) Range		$\frac{4.21 - 8.39}{1000}$	$\frac{3.83 - 1.21}{4.77}$		

Table 4: Hospital stay and return to work for the participants in each class.

*P <0.05 is statistically significant. SD: Standard deviation, T: Student T Test.

In intracorporeal ligation group, 10% patients had intraoperative intestinal injury who repaired intraoperative, 6.7% of them had postoperative pelvic abscess treated by tube drain insertion, 6.7% of them had postoperative port site infection, 3.3% cases had postoperative superficial wound infection who managed conservatively and 3.3% of them had persistent pain who subsided by NSAID medications. While in the titanium clips group, 3.3% of patients had intraoperative intestinal injury who were repaired intraoperatively, 3.3% of cases had postoperative superficial wound infection that was managed conservatively, and 3.3% of them had persistent pain that subsided with NSAID medications. The participants in each class were matched regarding post-operative complications (p > 0.05) (Table 5).

Obstacles	Intracorporeal ligation class (N=30)		Titanium clips class (N=30)		Chi-Square Test	
	No.	%	No.	%	Test value (X ²)	<i>P</i> -value
Bowel affection	3	10.0%	1	3.3%	1.071	0.612 ^{FET}
Pelvic abscess	2	6.7%	0	0.0%	2.069	0.492^{FET}
Port site infection	2	6.7%	0	0.0%	2.069	0.492^{FET}
Failure of technique	0	0.0%	0	0.0%	-	-
Re-admission	0	0.0%	0	0.0%	-	-
Re-operation	0	0.0%	0	0.0%	-	-
Port site hernia	0	0.0%	0	0.0%	-	-
Adhesions	0	0.0%	0	0.0%	-	-
Superficial wound infection	1	3.3%	1	3.3%	0.00	>0.999 ^{FET}
Appendicular stump leak	0	0%	0	0%	-	-
Persistent pain	1	3.3%	1	3.3%	0.00	>0.999 ^{FET}
Hematoma wound	0	0%	0	0%	-	-
Abdominal bleeding	0	0%	0	0%	-	-

Table 5: Obstacles among the two studied groups.

X2: Chi-Square Test, FET: Fisher Exact Test

4. Discussion

Acute appendicitis is a commonly practiced surgical procedure worldwide. The definitive cause is not elucidated, but an obstructive theory is the most proposed one. This theory entails lumen obstruction with the accumulation of bacteria leading to acute inflammation [8].

The current study reported no difference between the groups in their demographic data. This agreed with a previous study where the ligation group (20 participants) matched the titanium clip group (20 participants) [9]. Another one reported a matched group concerning age, sex, and BMI [10]. We reported matched groups concerning the inflammatory pattern, edema, and suppuration. This was in accordance with previous results as acute appendicitis was presented with edema at the base of the appendix, suppuration, and evidence of catarrhal inflammation [9]. This was confirmed by additional studies [10, 11].

The average time required for the surgery was markedly lower in the titanium clip class. This was by previous results, where the time taken for surgery was greatly more in the ligation class [9, 11, 12].

The average time of inpatient admission was significantly lower in the titanium clip class. Also, the average absence from work was significantly lower in the titanium clip group. This agreed with previous results reported by Ibrahim et al [9]. Contradictory results were reported by another study, as there was no apparent change in the period for inpatient admission for both methods [12]. Additionally, an earlier study reported no difference in the hospitalization time between the groups [13]. This difference would be reflected in different institutional protocols for postoperative care.

The reported postoperative complications were intestinal injury (the **5. Conclusion**

In the comparison between intracorporeal ligation and titanium clips for appendiceal bottom fixation in laparoscopic appendectomy, the study suggests that the

most prevalent one in the ligation group), pelvic abscess, port site infection, and superficial wound infection, which were identical in both classes. An earlier study reported intestinal injury and port site infection as the most common postoperative complications with no significant difference between the ligation and the titanium clip groups [9]. Another one reported the occurrence of additional postoperative complications as ileus, with no significant difference between the two groups [10]. Other complications were reported as fever, pelvic collection, bleeding, and intestinal obstruction. However, no difference was noted between the studied groups [12].

titanium clips group outperforms the intracorporeal ligation group in terms of key outcome measures.

Ethics approval and consent to participate: The current research was approved by the research ethics committee at the Faculty of Medicine, Fayoum University, before commencement of the study. The investigators obtained consent to participate from each participant before recruitment.

Competing Interests: All authors declare no conflict of interest

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public, commercial, or not-for-profit sectors.

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