

# Comparison of the non-absorbable polymer clips, knot-tying, and loop ligature appendiceal stump closure methods in laparoscopic appendectomy

*Comparación de los métodos de cierre del muñón apendicular con clips de polímero no absorbible, anudado y ligadura de bucle en la apendicectomía laparoscópica*

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## Abstract

**Objective:** In laparoscopic appendectomy (LA), closure of the appendix stump is important. This method must be safe and easy-to-use as well as an economical one. We compared three methods of the appendix stump closure in terms of safety, easiness, and financial cost. **Materials and methods:** Three-hundred and ten LA patients operated between January 2011 and December 2019 and appendix stump was closed using one of the three methods, namely, non-absorbable polymeric clips (Group 1,  $n = 126$ ), knot-tying group (Group 2,  $n = 101$ ), and laparoscopic loop ligature group (Group 3,  $n = 83$ ) were retrospectively analyzed in terms of stump leakage, infection, operation, and hospital stay duration. **Results:** There were 148 female and 162 male patients. The mean age was  $33.57 \pm 12.60$  years. There was not any appendiceal stump leakage nor intra-abdominal infection in none of the groups. Local trocar site infection in 11 patients was medically treated. Surgical site infection and hospital stay period did not show statistically important difference among the groups. The operation duration in Group 1 was found to be shorter compared to the other groups. **Conclusions:** All three techniques are safe in LA. Non-absorbable polymer clips provide a shorter operation time. Extracorporeal knot-tying with knot-pusher provides the cheapest closure of the stump.

**Keywords:** Appendectomy. Laparoscopy. Clips. Ligature.

## Resumen

**Objetivo:** En la apendicectomía laparoscópica (LA), el cierre del muñón del apéndice es importante. Comparamos tres métodos de cierre de tocones del apéndice en términos de seguridad, facilidad y costo financiero. **Materiales y métodos:** Se incluyeron 310 pacientes de AL intervenidos entre 2011-2019 con cierre del muñón del apéndice mediante uno de los tres métodos: clips poliméricos no absorbibles (grupo 1), grupo de anudado (grupo 2) y grupo de ligadura de asa laparoscópica (grupo 3). Se analizaron las complicaciones, la operación y la duración de la estancia hospitalaria. **Resultados:** Hubo 148 pacientes mujeres y 162 hombres. La edad media fue de  $33.57 \pm 12.60$  años. No hubo ninguna fuga del muñón apendicular ni infección intraabdominal en ninguno de los grupos. La infección local del sitio del trocar en 11 pacientes fue tratada médica mente. La infección del sitio quirúrgico y el período de estancia hospitalaria no mostraron diferencias estadísticamente importantes entre

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Date of reception: 25-12-2020

Date of acceptance: 26-01-2021

DOI: 10.24875/CIRU.20001419

Cir Cir. 2022;90(2):193-196

Contents available at PubMed

[www.cirugiaycirujanos.com](http://www.cirugiaycirujanos.com)

*los grupos. Conclusiones: Las tres técnicas son seguras en LA. Los clips de polímero no absorbible brindan un tiempo de operación más corto. El atado de nudos extracorpóreo con empujador de nudos proporciona el cierre más económico del muñón.*

**Palabras clave:** Apendicectomía. Laparoscopia. Clips. Ligadura.

## Introduction

Acute appendicitis (AA) is a common surgical emergency. Since its first use in 1983, laparoscopic appendectomy (LA) has become widely used<sup>1</sup>. There are lots of studies on the advantages of LA<sup>2-4</sup>. Among them, better cosmetic appearance, earlier return to daily life, and less pain feeling can be mentioned. Having been a safe and efficient method, LA is suggested as the first choice in the treatment of AA<sup>5</sup>.

In LA, closure of the appendix stump is an important step and various ligature methods have been used. Of course, this method must be safe and easy-to-use as well as an economical one. The most preferred ones in stump closure are non-absorbable polymeric clips, laparoscopic staplers, endoloop ligature, titanium endoclips, and knot-tying ligation<sup>6</sup>. Every center might use one closure method more frequently than others, depending on the habits of the surgeon and the preference of the center.

Certainly, the easiness to use and financial cost should be taken into consideration when choosing the technique. Despite knot-tying suture is of low cost, no absorbable polymer clips and end-loop ligature are preferred more due to their ease of use.

In this study, comparison of non-absorbable polymeric clips, knot-tying, and endoloop ligature closure of the appendix stump was aimed.

## Materials and methods

This retrospective study involved the AA patients older than 18 years of age who underwent LA between January 2011 and December 2019 and in whom the appendix stump was closed using one of three methods. Group 1 was non-absorbable polymeric clips (Click'a ligating clips, Grena, UK); Group 2 was knot-tying 0 polyglactin suture (Sterilactin, YU-CE, Turkey), and Group 3 was the endoloop ligature used patients, respectively. In Group 2, knot-pusher was used for ligation. In Group 3, laparoscopic loop ligature (Surgitie, Medtronics, US) was used.

The retrospective study approval was taken from the hospital education board. The informed consent of all patients was taken.

The data of 338 patients were analyzed and 28 of them were excluded as they could not be followed postoperatively.

The age, gender, surgical site infection, post-operative complication, and hospital stay periods were recorded.

SPSS 23.0 program was used for data analysis. Categorical parameters were number and per cent; continuous parameters were mean, standard deviation, minimum, and maximum.

The compatibility of parameters to normal distribution was analyzed using visual (histograms and possibility graphics) and analytic (Kolmogorov-Smirnov/Shapiro-Wilk Tests) methods. The categorical parameters were compared using the Chi-square test and Fischer's exact test. The parameters non-compatible to normal distribution were analyzed using the Kruskal-Wallis test. Bonferroni *post hoc* method was used to find the cause of difference among the groups.  $P < 0.05$  was significant for all tests.

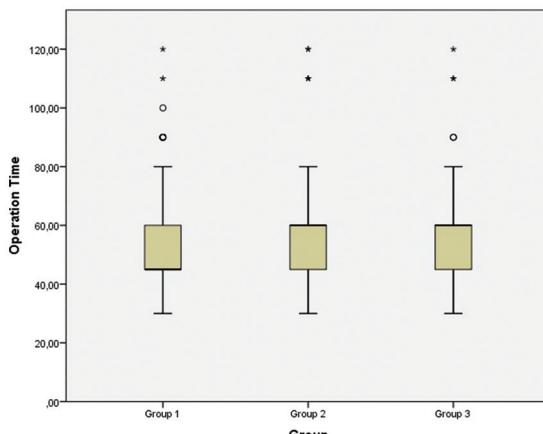
## Results

There were 310 patients of whom 148 (47.7%) were female and 162 (52.3%) were male. The mean age was  $33.57 \pm 12.60$  years. Group 1 was non-absorbable polymeric clips; Group 2 was knot-tying suture, and Group 3 was the endoloop ligature used patients, respectively. Non-absorbable polymeric medium and large clips were used in Group 1 and 2/0 coated polyglactin was used in Group 2, respectively. Endoloop ligature was 0 coated polyglactin.

There were 126, 101, and 83 patients in Group 1, 2, and 3, respectively (Table 1). There was neither appendiceal stump leakage nor intra-abdominal infection in none of the groups. There was a local trocar site infection only in 11 patients and was medically treated. There was not any statistically important difference in terms of surgical site infection among the groups (Table 2). Furthermore, hospital stay duration did not show any difference between the groups. However, operation duration in Group 1 was found to be shorter compared to the other groups (Table 3) (Fig. 1).

**Table 1. Patient demographics**

	Groups			Total	p
	Group 1	Group 2	Group 3		
Gender					
Female					
n	63	47	38	148	0.801
%	50.0%	46.5%	45.8%	47.7%	
Male					
n	63	54	45	162	
%	50.0%	53.5%	54.2%	52.3%	

**Table 2. Port-site infection**

	Group			Total	p
	Group 1	Group 2	Group 3		
Infection					
negative					
n	122	98	79	299	0.763
%	96.8%	97.0%	95.2%	96.5%	
positive					
n	4	3	4	11	
%	3.2%	3.0%	4.8%	3.5%	

**Table 3. Operation time and hospital stay period**

	n	Mean $\pm$ SD	p
Operation Time (min)			
Group 1	126	51.35 $\pm$ 16.95	
Group 2	101	55.99 $\pm$ 17.61	0.012
Group 3	83	54.94 $\pm$ 17.12	
Length of Hospital Stay (Day)			
Group 1	126	1.37 $\pm$ 0.55	
Group 2	101	1.30 $\pm$ 0.58	0.384
Group 3	83	1.36 $\pm$ 0.55	

## Discussion

The incidence of AA is said to be 8%<sup>7</sup>. Such a common cause of acute abdomen results in serious time and financial cost on emergency services and operation theatres. Having the advantages of decreasing hospital stay, post-operative pain, and return to daily life, LA should also be taken into consideration because of its cost. The closure of the appendix stump is an important step in LA<sup>1,8</sup>. The safety, cost-effectivity, and easy applicability of the closure technique are the reasons for preference. However, there is not a consensus on an optimum closure technique.

**Figure 1. Operation time graphics.**

The knot-tying suture is a more difficult technique to use and necessitates more experience compared to the others, which might prolong the operation time and results in less preference of it by the inexperienced surgeons<sup>6</sup>. It can be ligated either intracorporeally or extracorporeally using a knot-pusher. We used extracorporeal technique in our patients and it was easy to push and ligate it using the knot-pusher. We used 2/0 coated polyglactin and it was very cost-effective with its price of 0.48 US dollar and very advantageous.

Non-absorbable polymer clips have been reported to be preferred one as a safe, practical, and cost-effective method<sup>9-11</sup>. We detected that it was the most preferred method in our study with the number of 126 cases in Group 1. The lock system is its advantage making it safer.

It costs US\$ 16.9, and it is more expensive than that of the knot-tying suture. However, it shortened the operation duration significantly and seems to be its advantage<sup>6,10-12</sup>.

Endoloop ligature seems to be the most expensive technique with its cost of 24 US dollars in our study. Along with its cost, its easiness-to-use was found to be more difficult compared to that of clips; especially in extremely inflamed appendix tissue, its sliding from tip around the tissue to the base was reported not to be so easy<sup>13</sup>.

Another advantage of non-absorbable polymeric clips is the presence of five clips in one package compared to the one laparoscopic loop in a package, which enables us to re-try the closure using the content of the same package in clips use if any failure occurs or more ligatures are needed. However, we did

not find any superiority of the endoloop ligature to the clips in terms of operation duration in our study.

This study showed that all three techniques were safe in stump closure as any leakage or abscess formation was not observed in any of the groups. In light of this information, residents and inexperienced surgeons are better to use non-absorbable polymer clips or extracorporeal knot-tying during the learning period. The surgeons experienced in laparoscopic intracorporeal suture ligation might prefer intracorporeal tying. Still, the optimum one is extracorporeal knot-tying with knot pusher use in terms of financial cost and operation duration.

The shortest mean operation duration was found to be  $51.35 \pm 16.95$  min in Group 1 and it was significant in our study. This result reveals that non-absorbable polymer clips use provides a more practical and faster stump closure. This shorter operation duration means shorter operation room occupying, decreasing the operative cost per cases.

As a result, although all three techniques are safe in LA, having a shorter operation time, thus less general anesthesia exposure, less experience need, and being practical-to-use, non-absorbable polymer clips can be used. Another useful alternative, despite it prolongs the operation time, is extracorporeal knot-tying with knot-pushers use with the most economical cost.

## Conflicts of interest

The authors declare that does not exist conflicts of interest.

## Ethical disclosures

**Protection of human and animal subjects.** The authors declare that the procedures followed were in accordance with the regulations of the relevant Clinical Research Ethics Committee and with those of the

Code of Ethics of the World Medical Association (Declaration of Helsinki).

**Confidentiality of data.** The authors declare that they have followed the protocols of their work center on the publication of patient data.

**Right to privacy and informed consent.** The authors have obtained the written informed consent of the patients or subjects mentioned in the article. The corresponding author is in possession of this document.

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