




# Does the stump knotting technique and specimen retrieval method effects morbidity in laparoscopic appendectomy?

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## ABSTRACT

**BACKGROUND:** Stump closure is the most important part of laparoscopic appendectomy (LA). Close the appendix base with knot tying is the most cost effective method. The defined risk factor for surgical site infection (SSI) after LA is the contamination of trocar entry area by inflamed appendicitis. The aim of this study is to compare the single and double knot technique for stump control and specimen removal methods in LA.

**METHODS:** Patients data, who underwent LA between January 2015 and January 2017 were obtained from prospectively collected database. Single and double knot technique, specimen removal method, operation duration, hospital stay and perioperative-postoperative complications were compared.

**RESULTS:** Extracorporeal double knot was used in 134 patients (63%) and single knot was used in 79 patients (37%). There was no difference between operation duration in groups ( $p=0.97$ ). No stump leakage was seen in any patient. Intraabdominal abscess was developed in 3 patients (1.4%). Appendix was removed from the abdomen directly in 101 patients (47%) and with using specimen retrieval bag in 112 patients (53%). SSI was developed in 5 patients (2.3%), all of these 5 patient's appendix were removed from abdomen without using specimen retrieval bag. No SSI was detected in using specimen retrieval bag group ( $p=0.02$ ).

**CONCLUSION:** Single or double knot(s) tying can be defined as, safe and cost-effective stump closure method. The risk of developing SSI can be reduced with using specimen retrieval bag.

**Keywords:** Extracorporeal knot tying; laparoscopic appendectomy; stump; surgical site infection; specimen retrieval bag.

## INTRODUCTION

Laparoscopic appendectomy (LA) was firstly performed by Semm in 1983 and since then it has been widely used for minimally invasive treatment for acute appendicitis<sup>[1]</sup> and nowadays LA is the standard method in many centers.

Laparoscopic appendectomy has advantages such as; less postoperative pain, shorter hospital stay, better cosmetic

results, lower wound infection risk and faster return to normal bowel function than open appendectomy.<sup>[2-4]</sup> Potential disadvantages are high cost<sup>[5]</sup>, long operation time, especially during the learning curve and encounter of more frequent intra-abdominal abscess.<sup>[2,3,6-8]</sup>

The most feared complication of LA is the fistula or intra-abdominal sepsis which develops secondary to stump leaks. Several methods have been described to close the appendix

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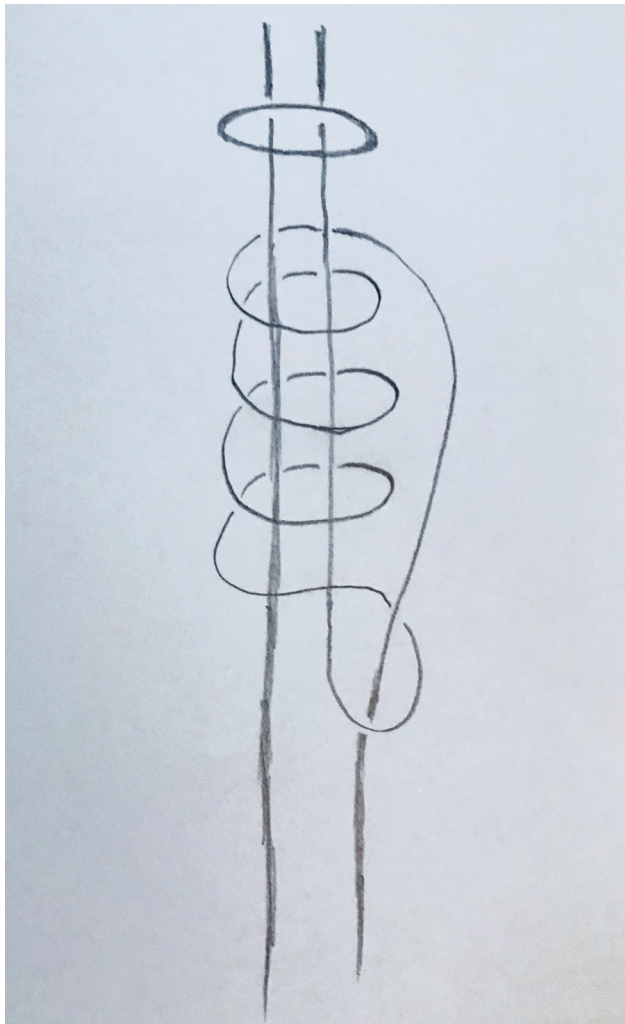
stump such as endo-stapler, endo-loop, clip, extracorporeal or intracorporeal knot tying, stump transection with bipolar or ligation devices. But these methods have not been demonstrated to be superior to each other in terms of effectiveness or safety.<sup>[4,9-17]</sup> Knot tying has cost advantages than other methods, but there is no consensus about tying method (single or double) in literature.

The defined risk factor for surgical site infection (SSI) after LA is the contamination of trocar entry area by inflamed appendicitis.<sup>[18-20]</sup>

The aim of this study is to compare the single and double extracorporeal knot technique for stump closure and specimen retrieval methods used in LA.

## MATERIALS AND METHODS

Patients, who underwent LA with diagnosis of acute appendicitis between January 1<sup>st</sup>, 2015 and January 1<sup>st</sup>, 2017 were included to the study. Patients with incomplete data and underwent interval or open appendectomy were excluded from study.



**Figure 1.** Duncan extracorporeal sliding knot.

Detailed information about laparoscopic and open appendectomy was given to all patients before surgery and their written informed consent was obtained. Approval was taken from Local Ethical Committee for this study (date: November 26, 2017; decision no: 2017/25-36).

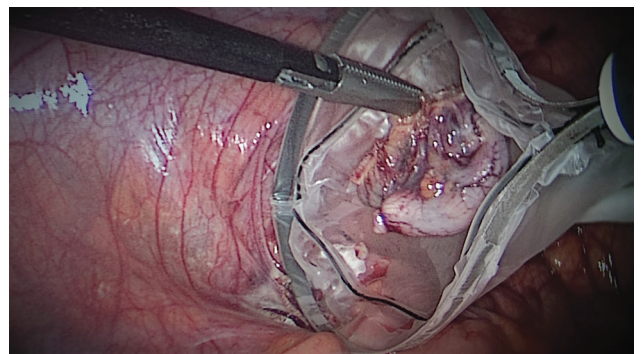
Acute appendicitis was diagnosed in patient who presented with abdominal pain to emergency service or polyclinic; with anamnesis, physical examination, complete blood test and if necessary, abdominal ultrasonography (US) or computed tomography (CT) was used.

Operations were performed under general anesthesia, all patients received a single dose of first generation cephalosporin prophylaxis. After Foley catheter insertion, three trocars were placed, 11 millimeters (mm.) below the umbilicus, 5 mm. above the pubis and depending on the surgeon's preference 5 or 11 mm to the left side of the patient. Reusable trocars and reusable laparoscopic hand instruments were used in all operations. Inflammatory appendicitis defined as uncomplicated, gangrenous or perforated appendicitis were defined as complicated appendicitis.<sup>[21]</sup> High frequency bipolar coagulation devices were used for dissection and sealing of the mesoappendix. The base of the appendix tied with single or double extracorporeal sliding knot and appendix was cut above the knot(s). Duncan sliding knot technique (Fig. 1)<sup>[22]</sup> and 150 centimeter (cm.) 2.0 polyglactin non-needle suture were used in each operations.

All participant surgeons used both single or double tying method, the choice of single or double knot method is determined randomly, regardless of the patient's clinic, complicated or uncomplicated appendicitis and the diameter of appendix base.

The specimen was removed from the abdomen through the umbilical trocar, with (Fig. 2) or without using specimen retrieval bag. The four quadrant abdominal irrigation was performed for patients with perforated appendicitis and silicon drain was placed to pelvis.

Patient's age, gender, radiologic examinations, severity of appendicitis (inflamed, gangrenous, perforated etc.), appendix



**Figure 2.** Specimen retrieval method with using specimen bag.

base diameter, stump closure method, specimen retrieval method, operation time, hospital stay, perioperative complications and histopathologic findings were analyzed from the prospectively collected database. Complications were classified according to Clavien–Dindo (C-D) classification system.<sup>[23]</sup>

All statistical analyses were performed with using SPSS 16.0 statistical package (SPSS, Chicago, Ill); independent samples T-test was used for comparing normally distributed continuous variables, non-normally distributed variables was compared with using Mann–Whitney U test. Chi-square test was used for comparison of categorical data.  $p < 0.05$  was considered as statistically significant.

## RESULTS

Between January 1<sup>st</sup>, 2015 and January 1<sup>st</sup>, 2017, 213 consecutive patients, 98 male (46%) and 115 female (54%) were included to the study. The median age of the patients was  $33.5 \pm 13.77$  (range: 16–82). Ultrasonography was used in 79 patients (37%), 109 patients were diagnosed with CT (51%) and 25 patients (12%) were diagnosed by only physical examination and complete blood count.

Complicated appendicitis was detected in 49 patients (23%), (30 perforated appendicitis (14%) and 19 (9%) gangrenous appendicitis); 156 patients (73%) had inflamed appendicitis and 8 patients (4%) had no inflammatory sign. The median appendix base diameter was  $86.4 \pm 24.7$  mm. (range, 40–170). Extracor-

poreal double knot was used in 134 patients (63%) and single knot was used in 79 patients (37%). The median duration of operation was recorded as  $44.5 \pm 10.2$  (range, 20–99) minutes. Single knot and double knot groups median operation duration were  $44.58 \pm 6.73$  minutes and  $44.53 \pm 11.94$  minutes respectively, There was no statistically significant difference between operation duration ( $p = 0.97$ , independent samples T-test). Appendix was removed from the abdomen directly in 101 patients (47%) and with using specimen retrieval bag in 112 patients (53%).

The median hospitalization time was  $2.7 \pm 1.9$  (range; 1–16) days. No stump leakage was seen in any patient during post-operative follow-up. Intraabdominal abscess was developed in 3 patients (1.4%), 2 patients were treated with interventional radiological methods and last patient underwent laparoscopic re-operation (2 C-D Grade IIIA; 1 C-D Grade IIIB), these 3 patients had perforated appendicitis, the rate of intraabdominal abscess in perforated group was 10% (3/30).

Surgical site infection was developed in 5 patients (2.3%), all of these 5 patient's appendix were removed from abdomen without using specimen retrieval bag. No SSI was detected in using specimen retrieval bag group ( $p = 0.02$ ; Fisher Exact Test). The mean hospital stay of patients with and without SSI were  $7.8 \pm 3.96$  days and  $2.8 \pm 1.69$  days, respectively, the hospitalization period of patients with SSI was found to be significantly longer ( $p < 0.001$ ; Mann-Whitney U test). Patient

**Table 1.** Patient demographics, operation and follow-up data

Stump Closure Method	Single Knot	Double Knot	All Patients
	79 (37%)	134 (63%)	213
Gender			
Male	36	62	98
Female	41	74	115
Age $33.91 \pm 14.78$	$33.32 \pm 13.2$	$33.5 \pm 13.77$	
Status of appendix			
Complicated	9 (11.4%)	40 (29.9%)	49 (23%)
Uncomplicated	67 (84.8%)	89 (66.4%)	156 (73%)
No inflammation	3 (3.7%)	5 (3.7%)	8 (4%)
Median appendix base diameter (mm)	$82.4 \pm 26.7$	$87.2 \pm 29.6$	$86.4 \pm 24.7$
Perforation	4 (5%)	26 (19%)	30 (14%)
Operation time (Minutes)	$44.58 \pm 6.73$	$44.53 \pm 11.94$	$44.5 \pm 10.2$
Using specimen retrieval bag			
No:	57 (72.2%)	44 (32.8%)	101 (47%)
Yes:	22 (27.8%)	90 (67.2%)	112 (53%)
Surgical site infection	1 (1.2%)	4 (3%)	5 (2.3%)
Intraabdominal abscess	0	3 (2.2%)	3 (1.4%)
Median hospital stay (Days)	$2.85 \pm 2.02$	$2.69 \pm 1.84$	$2.7 \pm 1.9$

demographics, operation and follow-up data are summarized, according to stump closure methods in Table I.

## DISCUSSION

The debate on two topics still continues in the stump closure methods at LA, the cost and the safety. The ideal method for the stump closure should be safe, technically easy and cost effective. Endostaplers, clips, commercial endoloops, intracorporeal or extracorporeal tying are the most commonly used methods in LA, several experimental and clinical studies about using bipolar coagulation devices for stump closure have been published,<sup>[24,25]</sup> but these devices have not been routinely used for stump control. Endostapler has some advantages such as ease of use and rapidity, which is especially preferred when the appendix base is necrotic and/or perforated,<sup>[4]</sup> the high cost and the 12 mm. Trocar requirement are seen as disadvantages.

Prospective studies about titanium and polymer clips were published, the stump closure with both types of clips has been evaluated as practical and safe but there are concerns about using clip when the appendix base is large and/or inflammation is intense.<sup>[26,27]</sup>

Tying the appendix base with standard non-needle suture is the most cost-effective method in all these stump-closure methods. Closing the appendix base with knots is considered as safe as other stump closure methods in various series.<sup>[9-11,14,28]</sup> Single knot,<sup>[9]</sup> and double knots technique<sup>[14]</sup> were used for closing the appendix stump in some studies, but there is no publication in the literature that compare the single or double knot(s). In our study, there was no difference in the median operation time and stump safety in single or double knot(s) tying methods. In the light of these data and the literature, single or double knot(s) tying can be defined as, safe and cost-effective stump closure method in the laparoscopic treatment of complicated or uncomplicated appendicitis.

The incidence of SSI after LA has been reported between 2.8% and 12.8%.<sup>[18,19]</sup> The use of specimen retrieval bag reduce the ratio of SSI after LA.<sup>[20]</sup> We obtained similar results with the literature; all of the 5 patients who developed SSI, their appendix were removed from the abdomen without using specimen retrieval bag, on the other hand, no SSI were seen in any of the patients in the specimen retrieval bag used group. The risk of developing SSI, which is one of the factors that reduces the advantages of laparoscopic method, extends the length of hospital stay can be reduced with use of specimen retrieval bag in LA.

The risk of developing intraabdominal abscess after appendectomy is related to the presence of perforation and it is more common in LA than open appendectomy,<sup>[8,29]</sup> patients with perforated appendicitis can be safely treated by LA, despite the risk of developing intraabdominal abscess. In our

series, intraabdominal abscess was detected in 3 patients, all of these patients had perforated appendicitis. The risk of intraabdominal abscess can be reduced by four-quadrant irrigation.<sup>[30]</sup> We performed routine four-quadrant washout in perforated patients, this may explain our 10% intraabdominal abscess rate after LA in patients with perforated appendicitis, which reaches 24% in the literature.<sup>[8]</sup>

The major limitations of our study are retrospective design, no cost analysis, and includes the results of single center with heterogeneous surgeon group.

## CONCLUSION

In conclusion, during LA single or double knot tying method can be safely used for stump-closure in complicated or uncomplicated appendicitis. Our study shows that using the specimen retrieval bag reduces the SSI in LA, but further prospective multicenter studies evaluating the costs are needed.

Conflict of interest: None declared.

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## ORIJİNAL ÇALIŞMA - ÖZET

### Laparoskopik apendektomide güdük bağlama tekniği ve spesimen çıkarma metodu morbiditeyi etkiliyor mi?

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**AMAÇ:** Güdük kapatılması laparoskopik apendektominin (LA) en önemli aşaması olarak görülmektedir. Güdüğün sutur ile kapatılması maliyet açısından en etkin yöntemdir. LA sonrası yara yeri enfeksiyonu gelişmesi için tanımlanmış risk faktörü, trocar giriş alanının inflame apendiks ile kontamine olmasıdır. Bu çalışmanın amacı apendiks güdüğü kapatılmasında tek - çift bağlama teknikleri ve spesimen çıkarma yöntemlerinin karşılaştırılmasıdır.

**GEREÇ VE YÖNTEM:** Ocak 2015 ve Ocak 2017 tarihleri arasında opere edilen hastalara ait bilgiler prospektif olarak doldurulan veritabanının retrospektif olarak incelenmesi ile elde edildi. Tek - çift bağlama teknikleri, spesimen çıkarma yöntemleri, operasyon süresi, hastane kalış süresi, perioperative postoperatif komplikasyonlar karşılaştırıldı.

**BULGULAR:** 134 hastada (%63) ekstracorporeal çift bağlama, 79 hastada (%37) ekstracorporeal tek bağlama ile güdük kapatıldı. 2 grupta operasyon süreleri arasında fark saptanmadı (p=0.97). hiçbir hastada güdük kaçağı gelişmedi. 3 hastada (%1.4) intraabdominal apse gelişti. 101 hastada (%47) apendiks direkt yöntemle çıkarıldı, 112 hastada (%53) ise spesimen torbası kullanıldı. 5 hastada yara enfeksiyonu gelişti (%2.3), bu 5 hastanın tümünde spesimen torbası kullanılmamıştı (p=0.02).

**TARTIŞMA:** Tek veya çift bağlama, güvenli ve uygun maliyetli güdük kapatma yöntemi olarak tanımlanabilir. Spesimen torbası kullanımı ile yara yeri enfeksiyonu gelişme riski azaltılabilir.

**Anahtar sözcükler:** Cerrahi alan enfeksiyonu; ekstracorporeal düğüm bağlama; güdük; laparoskopik apendektomi; spesimen torbası.

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