

# MASTERING THE LEARNING CURVE SIGNIFICANTLY REDUCES OPERATIVE TIME FOR LAPAROSCOPIC TREATMENT OF COMPLICATED APPENDICITIS

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## Abstract

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**Key words:** complicated appendicitis, laparoscopic appendectomy, operative time, learning curve

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Laparoscopic appendectomy is the preferred operative method for acute appendicitis treatment. In terms of complicated appendicitis it can be effective in hands of an experienced laparoscopist that overwhelmed the learning curve for the method. Aim: This retrospective study examines whether the operative time for laparoscopic appendectomy for complicated appendicitis is shortened after mastering the learning curve. Material and methods: A total number of 196 patients were operated for the diagnosis of acute appendicitis, of whom 77 were diagnosed with complicated appendicitis. They were subsequently divided in two groups (laparoscopic and open). Operative time in both groups was measured and the conversion and postoperative complications were noted. Results: Conversion rate was 2.3%. Operative time was shorter in the laparoscopic group ( $67.4 \pm 22.9$  vs.  $77.9 \pm 17.9$  minutes;  $p = 0.033$ ). Overall postoperative morbidity was 25.97% with wound infection present only in the open group ( $p = 0.018$ ). Intraabdominal abscess occurred in one patient from the laparoscopic group (0.38%). Length of hospital stay was shorter in the laparoscopic group ( $4.3 \pm 2.2$  vs.  $5.7 \pm 2.1$ ,  $p = 0.0052$ ).

## Клинички истражувања

# СОВЛАДАНАТА КРИВА НА УЧЕЊЕ ЗНАЧИТЕЛНО ГО СКРАТУВА ОПЕРАТИВНОТО ВРЕМЕ ЗА ЛАПАРОСКОПСКИ ТРЕТМАН НА КОМПЛИЦИРАН АПЕНДИЦИТИС

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## Извадок

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**Клучни зборови:** комплициран апендицитис, лапароскопска апендектомија, оперативно време, крива на учење

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**Печатарски права:** ©2021 Андреј Николовски, Александар Отљански, Реџеп Селмани, Светозар Антовиќ, Никола Јанкуловски. Оваа статија е со отворен пристап дистрибуирана под условите на нелокализирана лиценца, која овозможува неограничена употреба, дистрибуција и репродукција на било кој медиум, доколку се цитираат оригиналните(ите) автор(и) и изворот.

**Конкурентски интереси:** Авторот изјавува дека нема конкурентски интереси.

Лапароскопската апендектомија е преферирана оперативна метода во третманот на акутен апендицитис. Во услови на комплициран апендицитис таа може да биде ефикасна во рацете на искусен лапароскопист кој ја има совладано кривата на учење за методата. Цел: Оваа ретроспективна студија имаше за цел да испита дали совладаната крива на учење го скратува оперативното време. Материјал и методи: Вкупно беа оперирани 196 пациенти со акутен апендицитис. Од нив, 77 беа дијагностицирани со комплициран апендицитис и беа поделени во две групи (лапароскопска и отворена). Беа мерени оперативното време за двете групи, стапката на оперативни конверзии и постоперативните компликации. Резултати: Стапката на конверзии беше 2,3%. Оперативното време беше пократко во лапароскопската група ( $67,4 \pm 22,9$  наспроти  $77,9 \pm 17,9$  минути;  $p = 0,033$ ). Вкупниот постоперативен морибидет беше 25,97% и притоа инфекција на оперативна рана се јави само во групата оперирана со отворена метода ( $p = 0,018$ ). Интраабдоминален апсцес беше нотирен кај еден пациент во групата оперирана со лапароскопска метода (0,38%). Бројот на лежечки денови беше пократок во групата оперирана со лапароскопска метода ( $4,3 \pm 2,2$  наспроти  $5,7 \pm 2,1$ ,  $p = 0,0052$ ).

## Introduction

Laparoscopic appendectomy is the current proposed treatment for all grades of complicated appendicitis (CA)<sup>1</sup>. It is well established that laparoscopic appendectomy (LA) has advantages over the open appendectomy (OA) in terms of shorter operative time, low rate of operative conversions, acceptable rate of postoperative complications and shortened length of hospital stay<sup>2-5</sup>.

The aim of this study was to examine whether the operative time of the laparoscopic appendectomy in the treatment of CA after mastering the learning curve for the technique was significantly shortened.

## Material and methods

### Patients

Our retrospective tertiary single center study analyzed patients operated for complicated appendicitis in terms of intraoperative adverse effects, operative time, conversion rate and length of hospital stay. Patients operated for acute appendicitis (AA) in the period of May 2019 – February 2021 were included.

### Methods

A standard three-port laparoscopic appendectomy was used for the LA, and Mc Burney muscle-splitting technique for the OA. Operative time for

both procedures was measured from incision to the last skin suture at the end of surgery. One surgeon performed the laparoscopic procedure with experience with more than 50 laparoscopic appendectomies and the other two surgeons (with more than 100 open procedures performed) used the open method.

The grades of complicated appendicitis noted intraoperatively were divided into 4 categories:

- Gangrenous appendicitis;
- Perforated appendicitis;
- Periappendicular abscess and
- Secondary diffuse peritonitis.

SPSS for Windows v. 23.0 software was used. Kolmogorov-Smirnov test was used for normality check. The Student and Mann-Whitney tests were used for numerical data and Chi-square test for quantitative variables.

## Results

A total number of 196 patients were operated for the diagnosis of acute appendicitis. One hundred and nineteen (60.7%) had simple appendicitis and 77 (39.3%) patients were diagnosed intraoperatively with some grade of complicated appendicitis and only those were subsided for further statistical analysis. Fifty-two of them were males and the rest 25 were females (Table 1).

**Table 1.** Age of subjects (months)/ Age (in months) at cochlear implantation

n	Simple	Complicated
Male (%)	62 (52.1%)	52 (67.5%)
Female (%)	57 (47.9%)	25 (32.5%)
Total	119	77

Patients with complicated appendicitis were subdivided into two groups (laparoscopic – A, open - O). Forty-four were operated laparoscopically and the rest 33 with OA. The most common intraoperative finding in

the Group A was perforated appendicitis (18 patients), followed by peritonitis (12), gangrene (8) and abscess (6). In the open group, appendicular perforation was also the most common finding (16 patients) ( $p = 0.81$ ) (Table 2).

**Table 2.** Demographic and surgical data

	Group A	Group O	p
<b>Sex</b>			
Male (%)	31 (70.45)	21 (63.64)	p = 0.53
Female (%)	13 (29.55)	12 (36.36)	
<b>Age (mean ± SD)</b>	39.4 ± 16.2	41.6 ± 16.3	p = 0.56
<b>ASA (%)</b>			p = 0.36
1	25 (56.82)	14 (42.42)	
2	12 (27.27)	14 (42.42)	
3	7 (15.91)	5 (15.15)	
<b>Intraoperative finding (%)</b>			p = 0.81
Gangrene	8 (18.18)	6 (18.18)	
Perforation	18 (40.91)	16 (48.48)	
Abscess	6 (13.64)	5 (15.15)	
Peritonitis	12 (27.27)	6 (18.18)	
<b>Operative time (mean ± SD)</b>	67.4 ± 22.9 min.	77.9 ± 17.9 min.	p = 0.033
<b>Length of stay (mean ± SD)</b>	4.3 ± 2.2 days	5.7 ± 2.1 days	p = 0.0052

SD – standard deviation, min. - minutes

The overall range for operative time was 24 – 112 minutes in both groups. The laparoscopic procedures were shorter ( $67.4 \pm 22.9$  minutes) than the open ones ( $77.9 \pm 17.9$  minutes), which presented with significance ( $p = 0.033$ ) (Table 2).

In one patient, converted appendectomy was performed (2.3%) due to a significant inflammatory process.

Length of hospital stay was shorter in the laparoscopic group ( $4.3 \pm 2.2$  vs.  $5.7 \pm 2.1$ ,  $p = 0.0052$ ).

### Discussion

More than 90% of the cases with acute appendicitis are treated with appen-

dectomy. Continuous growth in laparoscopy use is reported from 43.4% in 2007 up to 75% in 2011<sup>3</sup>. Since 2001 when the first series of complicated appendicitis treated laparoscopically was reported, the success of the method was reported in another publication from 2006<sup>6</sup>.

One of the factors with direct impact on the postoperative complications rate is the operative time over 90 minutes<sup>7</sup>. Prolonged surgery is expected in terms of any grade of complicated appendicitis due to additional adhesiolysis, partial omental resection, irrigation and suction of the abdominal cavity and the need for additional position changes of the operating ta-

ble<sup>4</sup>. Jeon reported the following factors for prolonged operative time: age over 65 years, body mass index over 25, elevated serum C-reactive protein values, comorbidities and computerized tomography finding in favor of appendicular abscess<sup>8</sup>.

Regardless of the intraoperative finding, the surgeons' skills are also an important factor that influences on the operative time. Mastering the learning curve for laparoscopic appendectomy reduces it<sup>2,4</sup>.

The European Association for Endoscopic Surgeons (E. A. E. S.) Consensus Development Conferences on laparoscopic cholecystectomy, appendectomy, and hernia repair recommends performance of at least 20 laparoscopic appendectomies for gaining accreditation<sup>9</sup>. On the other hand, Kim's analysis on the surgical residency reported 30 procedures needed for mastering the learning curve<sup>10</sup>.

Different series report differences in the operative time for the examined groups. Li, Biondi, Wang and Takami presented shorter operative time for the open appendectomy procedure<sup>11-14</sup>, contrary to Park and Yau that proved significantly shorter operative time in the laparoscopic groups<sup>15,16</sup>.

Our study was conducted on the basis of more than 50 laparoscopic appendectomies performed by the principal investigator, which resulted in a statistically shorter operative time in the laparoscopic group.

## Conclusion

Current recommendations and statements on the laparoscopic treatment for complicated appendicitis demand availability of an experienced laparoscopic team in order to provide safe and successful laparoscopic appen-

dectomy on basis of complicated appendicitis. This will result in a positive postoperative outcome in terms of low conversion rate, short operative time and acceptable rate of postoperative morbidity.

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