Original article

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LAPAROSCOPIC VERSUS OPEN APPENDECTOMY FOR IN THE TREATMENT OF ACUTE APPENDICITIS: OUR EXPERIENCE

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Acute appendicitis is one of the most common urgent abdominal interventions. Open appendectomy has been a standard procedure for acute appendicitis for more than 100 years. However, in the last 20 years, after many studies, laparoscopic appendectomy has become a gold standard in solving acute appendicitis. The main goal of our study was to compare results of open and laparoscopic appendectomies with regard to in-hospital stay, time of operation, postoperative complications and postoperative pain.

All patients underwent open or laparoscopic appendectomy in the Center of Minimally Invasive Surgery and Emergency Center of the University Clinical Center Niš, Serbia in the period of one year. A total of 126 patients were enrolled and submitted to retrospective analysis.

One hundred and twenty-six patients who underwent laparoscopic or open appendectomy surgery were retrospectively analysed. A laparoscopic appendectomy was performed in 58 patients, while 68 patients underwent an open appendectomy. Groups were demographically similar and there was no significant difference between the age structure and gender distribution ($t = 0.927$; $p = 0.057$). Average height ($p = 0.123$), weight ($p = 0.200$) and BMI ($p = 0.425$) were mostly similar. Previous surgical operations were more common in patients with open appendectomy, but with no statistical significance ($p = 0.141$). Percentage of patients with WBC > 10 were the same in both groups ($p = 0.927$).

Diabetes mellitus was more common in patients with open appendectomy, but with no statistical significance ($p = 0.563$). Acute and perforated appendicitis were similar in both groups ($p = 0.490$).

Average time of operation was the same in both groups ($p = 0.751$). Number of days of in-hospital stay was shorter in patients who underwent laparoscopic appendectomy ($p < 0.001$).

The analysis of administration of parenteral and oral analgesics showed that postoperative pain was less in the group of patients who underwent laparoscopic appendectomy than in the group of patients with open appendectomy.

There was no statistically significant difference with respect to postoperative complications between two groups ($p < 0.001$).

The treatment of appendicitis by using laparoscopic surgery in comparison to open approach provides a better result in terms of duration of hospital stay, recovering time, postoperative complications and postoperative pain.

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Key words: *open appendectomy, laparoscopic appendectomy, acute appendicitis*

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Introduction

Acute appendicitis is the most common abdominal emergency worldwide, and it is the most common cause of abdominal surgeries in all the age groups (8).

Approximately 7-10% of the general population develops acute appendicitis with the maximal incidence in the second and third decades of life (9).

Appendicitis has an overall lifetime risk of 8.6% in men and 6.7% in women (10, 11).

A definitive preoperative diagnosis of acute appendicitis is still a challenge and a possibility of

appendicitis must be considered in any patient presenting with an acute abdomen (12, 13)

Since its first description by McBurney in 1894, open appendectomy has become the procedure of choice for acute appendicitis (14).

For more than a century, open appendectomy has been the gold standard for treating patients with acute appendicitis, but the efficiency and superiority of laparoscopic approach compared to the open technique is the subject of many studies nowadays (15-16).

With the introduction of minimally invasive endoscopic surgery, laparoscopic appendectomy, which was first introduced by Kurt Semm, a German gynaecologist in 1981 (10), has become increasingly popular and is claimed to be more safe and superior to open appendectomy in terms of hospital stay, postoperative pain, wound complications, diagnostic abdominal exploration, return to normal activities and cosmetic result (17, 18).

The aim of our study was to compare results of open and laparoscopic appendectomies in regard to in-hospital stay, time of operation, postoperative complications and postoperative pain.

Materials and methods

A retrospective study of patients with the diagnosis of acute appendicitis was conducted.

This retrospective study was carried out on the basis of medical data of patients who were subjected to open or laparoscopic surgery for acute appendicitis in the period of one year. Patients underwent surgery in the Emergency Center and Center of Minimally Invasive Surgery of the University Clinical Center Niš, Serbia.

Data were collected regarding demographics, preoperative assessment, intraoperative findings, operative time, length of hospital stay, and occurrence of postoperative complications, including wound infection, intraperitoneal collection, paralytic ileus.

The diagnosis of appendicitis was determined by clinical examination (pain after deep palpation in right iliac fossa, status febrilis, leukocytosis, nausea,…). If we had had any doubt in establishing the diagnosis, the next step would have involved abdominal ultrasound or CT. In addition, an increase in white blood cell count and increase in C reactive protein were indicators for an acute appendicitis.

All patients received general endotracheal anaesthesia. In majority of cases, there was no need for nasogastric tube insertion.

Irrigation of abdominal cavity and drainage placement depended on surgeon's decision and were used mostly in perforation. All specimens were sent for histopathology.

All patients subjected to open and laparoscopic appendectomies received antibiotics and analgesics intravenously. Commonly, if the drain bag was empty, it was removed one day after surgery.

The oral feeding of patients whose peristalsis recovered was started after 2 or 3 days. It was started with fluids and liquid diet. On discharge, the patient underwent pain control, had normal body temperature and good physical condition.

In this study, the duration of performing surgery was measured from the first skin incision to the last skin stich excluding the time of anaesthesia and preparation.

The number of hospital days were counted as nights spent in hospital after surgery. Symptoms of wound infection were determined as wound leakage of consistent purulent content. In that case, red tissue margins could be seen around wound along with wound warmness. Prolonged paralytic ileus could be present in some patients and appeared as lack of bowel peristalsis within 72 h after surgery.

The same team of surgeons performed all surgeries.

Results of statistical data analysis are shown in tables. Statistical data were analysed by using SPSS software package version 22.

Standard statistical methods for quantitative and qualitative analysis were used: absolute numbers, relative numbers (%), arithmetic mean ( ), standard deviation (SD), mediana (Me), interquartile range (Iq). Probability distribution was analysed with Kolmogorov-Smirnov test.

For comparison of groups, Student-t test and Mann Whitney U test were used.

For testing statistical difference of absolute frequencies among samples Chi square test was used.

Statistical hypotheses were tested on the level of significance for risk of $\alpha = 0.05$.

Statistical difference between samples was considered significant at $p < 0.05$.

Results

Our study included 126 patients who underwent appendectomy surgery. Gender distribution was 70 (55.6%) male patients and 56 (44.4%) female patients.

Age structure was 43.38 ± 17.48 age, where the youngest patient was 18 years old and the oldest patient was 85 (median age 37 years) There was no significant difference between age structure and gender distribution, $p = 0.780$ (Table 1).

Open appendectomy was performed in 68 (53.96%) patients, while laparoscopic appendectomy was done in 58 (46.04%) patients.

Intraoperative and pathological findings of phlegmonous appendix were recorded in 90 (71.4%) patients, while gangrenous appendix with perforation was seen in 36 (28.6%) patients. There were no significant differences regarding intraoperative and pathohistological findings between the groups.

Average time of open appendectomy was 32 minutes. Average time of in-hospital stay was 5.1 days, with minimal in-hospital stay of 2 days and maximum in-hospital stay of 14 days (Table 2).

Table 1. Age, gender and anamnesis structure in open appendectomy

	LA	OA
No of patients	58	68
Sex (male/female)	33/25	37/31
Age (years)	35.05 ± 15.93	40.95 ± 17.75
Weight (kg)	79.77 ± 15.23	75.63 ± 14.32
Height (cm)	175.16 ± 10.48	172.82 ± 9.52
BMI	25.88 ± 3.52	25.33 ± 3.68
Previous surgeries n (%)	7 (12.1)	15 (22.1)
WBC > 10 n (%)	50 (86.2)	59 (86.8)
Diabetes mellitus n (%)	5 (8.6)	8 (11.8)
Acute appendicitis n (%)	41 (70.7)	49 (72.1)
Perforated appendicitis n (%)	14 (24.1)	18 (26.5)

LA - Laparoscopic appendectomy; OA - open appendectomy;
WBC - white blood cell count; BMI - body mass index

Table 2. Clinical data for the laparoscopic appendectomy (LA) and open appendectomy (OP) groups

Clinical data	LA	OA	p-value
Operating time (min)	32.63 ± 15.96	31.76 ± 14.50	0.751
Hospital stays (days)	4.12 ± 1.09	5.97 ± 1.26	< 0.001
CRP	42.46 ± 52.71	55.38 ± 67.39	0.242
WBC	13.55 ± 3.49	13.33 ± 3.14	0.706
Bowel movements (first day)	25	5	< 0.001
Bowel movements (second day)	33	66	< 0.001

The results of bowel movements were as follows: the highest number of patients, i.e. 96 (76.2%) showed bowel movements on the second postoperative day, on the first postoperative day, bowel movements were present in 30 (23.8%) patients. Most of the patients who had laparoscopic appendectomy showed bowel movements on the first postoperative day. There was a significant difference between two groups, it showed faster bowel movements in patients treated by laparoscopic approach ($p < 0.001$).

The most frequent postoperative complication was wound infection present in 5 (3.96%) patients. Prolonged postoperative ileus was present in 10 (7.9%) patients, and 2 (1.6%) patients had paralytic ileus (Table 3). All wound infection were in patients after open appendectomy, while there were only six abdominal abscesses as a complication of laparoscopic appendectomy.

Table 3. Postoperative complications

Clinical data	LA n (%)	OA n (%)	p-value
Abdominal abscess	6 (10.3)	4 (5.9)	0.551
Paralytic ileus	0 (0.0)	2 (2.9)	0.499
Wound infections	0 (0.0)	5 (7.4)	0.061
Total	6 (10.3)	11 (16.2)	0.435

As for postoperative pain, analysing the usage of parenteral and oral analgesics showed that the patients subjected to laparoscopic appendectomy had less pain than the patients subjected to open appendectomy did. The group of patients treated with laparoscopic appendectomy was administered parenteral analgesics (doses/day) 1.4 ± 0.5 and oral analgesics (doses/day) 2.00 ± 2.26. The group of patients treated with open appendectomy was administered parenteral analgesics (doses/day) 1.0 ± 0.4 and oral analgesics 1.79 ± 1.9 (Table 4).

Table 4. Parenteral and oral analgesics use during hospital stay

Clinical data	LA	OA	p-value
Parenteral analgesics (doses/day)	1.4 ± 05	2.00 ± 2.26	0.049
Oral analgesics (doses/day)	1.0 ± 0.4	1.79 ± 1.9	0.002

Univariate regression analysis (Table 5) showed that age (OR = 1.151; p=0.001), WBC (OR = 1.471; p < 0.001), CRP (OR = 1.022; p < 0.001), surgery duration (OR = 1.078; p < 0.001) and hospital stay (OR = 2.017; p = 0.001) could be risk factors for complications.

However, when we included all these variables in multivariable model, there was no statistical significance.

Table 5. Univariate and multivariate regression analysis for postoperative complications
OR- Odds ratio; CI-Confidence interval for OR

Factor	Univariate regression				Multivariate regression model			
	OR	95% CI		p	OR	95% CI		p
		Lower	Upper			Lower	Upper	
ex	0.644	0.222	1.865	0.417				
Age	1.151	1.021	1.082	0.001	1.151	1.021	1.082	0.255
Type of operation	1.673	0.578	4.844	0.343				
BMI	1.073	0.932	1.235	0.330				
Previous operations	2.255	0.704	7.226	0.171				
DM	1.188	0.239	5.893	0.833				
Le	1.471	1.207	1.793	< 0.001	1.294	0.904	1.852	0.160
CRP	1.022	1.012	1.032	< 0.001	1.012	1.000	1.024	0.051
Operating time	1.078	1.041	1.116	< 0.001	1.030	0.975	1.089	0.289
Hospital stays	2.017	1.343	3.030	0.001	1.384	0.748	2.558	0.301

Discussion

Acute appendicitis is the most common abdominal emergency condition worldwide.

Nowadays, many studies compare open to laparoscopic appendectomy in relation to advantages and possible complications. Several studies (15, 19-25) have described laparoscopic appendectomy as a more safe procedure. Patients were back to work very soon, sooner than after open appendectomy. Further, there were less wound infections due to small skin incision versus McBurney incision. Several studies underlined this approach as better, because of the clear laparoscopic exploration and abdominal inspection in finding some other surgical problem (camera position, flexible movement, far distance cavity approach, camera view extension) (26, 27). In some older studies, few authors claimed that there were not any benefits of using laparoscopic versus open appendectomy (9, 28-31).

Systematic review of meta-analyses of randomized controlled trials comparing laparoscopic versus open appendectomy concluded that both procedures were safe and effective for the treatment of acute appendicitis (30).

The aim of this study was to retrospectively evaluate the results such as time of operation, postoperative hospital stays, and postoperative complications of laparoscopic appendectomy in the treatment of acute appendicitis in comparison with the open approach.

Length of hospital stay represents a critical factor that directly influences the economy and the well-being of the patient. We found that hospital stay was significantly shorter in the laparoscopic group ($p < 0.001$) with a concomitant earlier bowel movement in patients managed laparoscopically, leading to earlier feeding and discharge from hospital. Our findings are in agreement with several studies that demonstrated a significantly shorter hospital stay after the laparoscopic approach (24, 32, 33).

By analysing the immediate postoperative recovery, our study showed that in majority of the laparoscopically treated patients peristalsis occurred faster, and oral feeding was initiated earlier. These results, which indicate a statistically significant difference between the two groups of patients, definitely confirm the advantage of the laparoscopic approach in resolving acute appendicitis.

Duration of operation was very close, in laparoscopic (32.63 ± 15.96) and open approach (31.76 ± 14.50).

When we calculate the duration of surgery, our conclusion is that there was no much difference between the two approaches. Some studies show that the time for laparoscopic appendectomy is longer (34). This depended on the case difficulty, surgeon's skills and experience.

Today, most of surgeons in the beginning of their careers have many training hours which provide them with good laparoscopic skills. The result of this, according to several meta-analyses, is the reduction in operation time compared to early open technique (35, 36).

Almost all studies found that patients who underwent laparoscopic appendectomy had less postoperative pain and discomfort. These randomized prospective studies usually used visual analogue scales and other tabulated doses or days of narcotic use to record pain and pain control. Since our study was a retrospective one, we were not able to use visual analogue scales to assess the degree of pain and discomfort.

Great variability exists in the literature (27) partly due to heterogeneity in definition and assessment of pain and variety of analgesics.

However, our findings on dose usage of analgesics postoperatively retrieved from patients' medical records are in agreement with studies which showed that patients who had laparoscopic appendectomy needed significantly less analgesia, suggesting that they suffered less pain and discomfort (37, 38).

Considering postoperative complications given in Table 4, there was a statistical difference in wound infection between patients who underwent laparoscopic versus open appendectomy.

It can be due to smaller skin incision in laparoscopic approach.

In addition, our study showed difference of time of paralytic ileus between two different techniques. All patients who had laparoscopic appendectomy, has faster recovery and peristaltic function getting to normality (majority of patients regained bowel movements on the first postoperative day while the patients with open approach recovered bowel movements on the second postoperative day). Further, prolonged postoperative ileus was seen in patients with open appendectomy. We can conclude that minimal operative trauma, less pain, lack of wound infection, less number of hospital days give this results (36, 39).

Wound infection can be a factor of long hospital stay, late hernia appearance in incision place, increasing recovering time and finally, cost benefit of operation. Fewer cases of wound infection are a big benefit of laparoscopic appendectomy (36). In our study, there were no wound infections after performing laparoscopic techniques.

The use of endobag, and avoiding direct contact between the remaining appendix and surrounding tissue, especially the skin, are reasons for less wound infection.

There are still some studies claiming there is a bigger risk for intra-abdominal abscess after performing laparoscopic appendectomy techniques versus open approach (7, 23).

In addition, there were claims that several factors could contribute to the spread of bacterial infection into abdomen: carbon dioxide insufflation, extensive use of surgical irrigation, and detached appendix abdominal manipulations (40, 41).

The results of our study showed that there were no significant differences in regard to abscess formation between the two techniques.

Conclusion

This study presents laparoscopic appendectomy approach as a gold standard in treatment of acute appendicitis. Also, this technique provides better cost-benefit for the patient and our social and health system. Less hospital days, less postoperative pain, reduced number of wound infection, reduced number of postoperative hernias at incision sites, are facts why we should perform laparoscopic approach instead of open appendectomy.

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LAPAROSKOPIJA NASPRAM OTVORENE APEDEKTOMIJE U TRETMANU AKUTNOG APENDICITISA – NAŠE ISKUSTVO

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Akutni apendicitis je jedno od najčešćih abdominalnih stanja koji zahtevaju hiruršku intervenciju. Više od jednog veka otvorena apendektomija je bila zlatni standard kao bezbedna i efikasna procedura za tretman akutnog apendicitisa. U mnogim studijama laparoskopska apendektomija je dokazana kao bezbedna i superiorna metoda . Cilj našeg rada je poređenje rezultata laparoskopske i otvorene apendektomije u smisku trajanja operacije, intrahospitalnog boravka, postoperativnih komplikacija i postoperativnog bola.

Svi bolesnici koji su imali otvorenu ili laparoskopsku apendektomiju u periodu od godinu dana u Centru za minimalno invanzivnu hirurgiju i u Urgentnom centru Univerzitetskog Kliničkog centra u Nišu. Ukupan broj od 126 bolesnika je uključen u retrospektivnu studiju.

Istraživanje je uključilo 126 bolesnika kod kojih je izvršena apendektomija. Laporaskopska apendektomija je urađena kod 58 bolesnika, a otvorena apendektomija kod 68 bolesnika. Prema polnoj distribuciji ispitivane grupe su bile homogene (p = 0,780). Bolesnici od kojih je urađena laporaskopija su nešto mlađi u poređenju sa bolesnicima sa otvorenom apendektomijem, ali bez statističke značajnosti (p = 0,057). Prosečna visina (p = 0,123), težina (p = 0,200) i BMI (p = 0,425) su ujednačeni u obe ispitivane grupe.

Prethodne hirurške operacije su zastupljenije kod OA, ali bez statističke značajnosti (p = 0,141). Procenat bolesnika sa vrednostima WBC > 10 je isti u obe ispitivane grupe (p = 0,927).

Dijabetes mellitus je češći kod pacijenata sa OA, ali bez značajne razlike (p = 0,563).

Akutni i perforirani apendicitisi su podjenako zastupljeni u obe ispitivane grupe (p = 0,490).

Trajanje operacije se nije značajno razlikovalo između ispitivanih grupa (p = 0.751). Hospitalizacija je značajno kraća kod bolesnika kod kojih je urađena laporaskopska apendektomija (p < 0.001).

Tretman akutnog apendicitisa laparoskopskom hirurgijom u poređenju sa otvorenim pristupom daje bolje rezultate u smislu intrahospitalnog boravka, vremena oporavka, postoperativnih komplikacija i postoperativnog bola.

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Ključne reči: *otvorena apendektomija, laparoskopska apendektomija, akutni apendicitis*