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# UTILIZATION OF LAPAROSCOPIC APPENDECTOMY – A THREE-YEAR EXPERIENCE

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## ABSTRACT

In spite of the fact that many of the studies give advantage to laparoscopic appendectomy (LA) opposite open appendectomy (OA), LA is still not recognized as the basic approach in the surgical treatment of acute appendicitis (AA) worldwide.

The goal of the study is to provide some conclusions that could be useful in the successful implementation of LA by overviewing the utilization of this surgical procedure for a period of three years.

The study is conducted on the Clinic for Digestive Surgery in Skopje, where 361 patients with AA were operated in the period from 1 January 2012 till 31 December, 2014. A comparison was made between OA, LA and the cases with conversion by using the exact chosen parameters. The statistical processing showed which parameters significantly influenced the choice for the operative approach and the choice for conversion.

Taking into account the recent recommendations regarding the indications and contraindications for LA, the utilization of LA was selective and it referred to a limited number of younger patients, predominantly female, without comorbidities, mostly with American Society of Anesthesiologists' (ASA) score IE or IIE and with a less advanced stage of appendicitis. The results regarding whether this approach is safe are excellent and in accordance with the results in the worldwide literature.

**Keywords:** laparoscopic appendectomy, utilization, indications, contraindications.

## АПСТРАКТ

И покрај фактот што најголем дел од студиите и даваат предност на лапароскопската апендектомија (ЛА) во однос на отворената апендектомија (ОА), сеуште ЛА не може да се наметне како основен пристап во хируршкиот третман на акутниот апендицитис (АА) ширум светот.

Целта на оваа студија е со разгледување на користењето на ЛА во период од три години да се дојде до одредени заклучоци кои би биле корисни во успешната имплементација на оваа хируршка процедура.

Студијата е спроведена на Клиниката за Дигестивна Хирургија во Скопје каде од 1-ви Јануари, 2012 г. до 31-ви Декември, 2014 г. се оперирани вкупно 361 пациент со АА. Користејќи точно утврдени параметри направена е споредба помеѓу случаите со ЛА, ОА и случаите со конверзија. Статистичката обработка покажа кои параметри имале сигнификантно влијание на изборот на хируршкиот пристап и одлуката за конверзија.

Земајќи ги во предвид современите препораки за индикациите и контраиндикациите за ЛА примената на ЛА во споменатиот период била селективна и се однесувала на ограничена бројка на помлади пациенти, претежно од женски пол, без коморбидитети, повеќето со Американско Здружение на Анестезиолозите (ASA) скор IЕ и IIЕ и со понизок степен на апендицитис. Резултатите од ваквиот пристап во поглед на безбедноста се одлични и во согласност со резултатите од светската литература.

**Клучни зборови:** лапароскопска апендектомија, користење, индикации, контраиндикации

## INTRODUCTION

Acute appendicitis (AA) is by far the most common reason for acute abdomen. Overall the lifetime risk of getting appendicitis is 8.6% in males and 6.7% in females with a peak in the second and in the third decade. Appendectomy is the most frequent emergency operation in the world. In the United States, more than 300 000 appendectomies are performed annually.

The first appendectomy was performed in 1880 by the British surgeon Lawson Tait in London. In 1884, Charles McBurney promoted the McBurney's laparotomy for the surgical extraction of the appendix, which to this day is the basic approach of the so-called open appendectomy (OA). In 1983, after performing several gynecologic laparoscopic procedures, the German gynecologist Kurt Semm performed the first laparoscopic appendectomy (LA). The first LA was performed about 4 years before the first laparoscopic cholecystectomy (LC).

Most of the studies preferred LA to OA mostly because of shorter hospital stay, less postoperative pain, better cosmetics, quicker return to the normal professional and everyday activities and less surgical site infections (SSI). Even though OA is more expensive at the start, considering the quicker return to professional activities, the overall cost is smaller with LA. Laparoscopic approach enables wide exploration of the abdominal cavity and definitive confirmation or rejection of the diagnosis of AA, which offers the possibility not to remove a healthy appendix. The removal of the appendix is obligatory with OA regardless of the condition, which traditionally led to 15-30% of negative appendectomies or removal of a healthy appendix. The so-called negative appendectomies are related to about 4% chance of unnecessary complications. The contemporary approach in the diagnosis of AA aims to reduce the percentage of negative appendectomies and various diagnostic tools are now used in such instances. These tools are various scoring systems such as: Alvarado, AIR (appendicitis inflammatory response)

and RIPASA (Raja Isteri Pengiran Anak Saleha Appendicitis score) scoring system, and imaging methods such as ultrasonography, computed tomography (CT) and magnetic resonance imaging (MRI). All tools are with high sensitivity and specificity but laparoscopic exploration can be used as the gold standard in proving their efficacy. In contrast to these positive characteristics, the rising number of postoperative intraabdominal abscesses and the slightly extended operative time (about 10 minutes) maybe the only negative sides of LA [1,2,3].

Despite all the advantages, even after 30 years of promotion, LA still cannot impose itself as the gold standard of surgical treatment of AA worldwide. On the other hand, there is a trend of gradual increase in the utilization of LA throughout the world opposed to OA. This was acknowledged by Hove et al. in the United States where the usage of LA was increased from 19.7% in the year 1997 to 37.9% in 2003 [4]. In 2005, 58% of appendectomies in the United States annually were done laparoscopically [5]. In 2009, one German study reported that in Germany 46% of the appendectomies annually were performed openly, which means that 54% of them were performed laparoscopically [6, 7].

In our country, even though in most of the health care institutions one can find the necessary equipment and trained personal and LC is widely used, LA is still struggling for more frequent usage. On the Clinic for Digestive Surgery in Skopje LA is used as a routine surgical procedure for a long time.

## **THE GOAL OF THE STUDY**

The goal of this study is to provide some conclusions that could be useful in the successful implementation of LA by overviewing the utilization of this surgical procedure as opposed to OA for a period of three years.

## **MATERIALS AND METHODS**

This is a retrospective clinical study that includes all patients with AA operated on the Clinic for Digestive Surgery in Skopje, the Republic of Macedonia from 1 January 2012, till 31 December 2014. All data were collected from the patients' medical files. The cases with other reasons for the condition and with chronic appendicitis were excluded from the study. The data about the patients were grouped according to sex, birth year, existence of comorbidities, American Society of Anesthesiologists' (ASA) score for emergency operation [8], surgical approach, intraoperative assessment of the stage of appendicitis, conversion and reason for conversion, intraoperative complications, early postoperative complications and hospital stay duration. Injuries to any hollow or solid organ and vascular injuries were noted, if present as intraoperative complications. The early postoperative complications were mainly various kinds of wound complications commonly called surgical site occurrence (SSO) that includes SSI divided into superficial, deep and organ/space, seroma and hematoma formation, wound dehiscence and fistula formation [9,10]. The other early postoperative complications noted were

pleural effusion, thrombophlebitis, mesenteric thrombosis, bowel obstruction and complications with lethal consequence. A histopathological classification of the grade of appendicitis was used and the appendicitis was categorized as catarrhal, phlegmonous, gangrenous and gangrenous with perforation. The first two grades were considered uncomplicated forms and the last two grades were considered as complicated forms of appendicitis. In most cases, the intraoperative assessment of the histopathological grade of appendicitis done by the surgeon was identical to the postoperative histopathological finding by the pathologist. In cases where postoperative histopathologic examination undoubtedly showed different grade from the intraoperative assessment, a correction was made in accordance with the finding by the pathologist. The comparison was made between the groups with open and laparoscopic approach and between the cases operated laparoscopically and the cases with conversion to open approach.

Descriptive statistic was presented by using mean value (MV) and standard deviation (SD) for numerical variables and frequency distribution for attributive variables. Regarding the analytic statistics, the difference between the groups with open and laparoscopic approach as well as the group with LA and the group with conversion according to the numerical variables was examined by using the 2-sample (two-tailed) t-test. The difference between the groups according to the attributive variables was examined by using the  $\chi^2$  and Fisher exact test. The Fisher exact test was used in the cases where values were less than 5. The P-value  $\leq 0.05$  was considered a statistically significant result.

Laparoscopic appendectomy was performed in general anesthesia with the patient in supine position and the left arm tucked at the side. The pneumoperitoneum was established with the patient in Trendelenburg position through a little supra or infraumbilical incision with a Veres needle or by using an open technique according to Hasson. After that a 10 mm port was set in this incision and a 0° or 30° 10 mm laparoscope (STORZ – Karl Storz) was introduced in the abdominal cavity through the port. A routine exploration of the whole of the abdominal cavity was now made including gallbladder, stomach and duodenum, sigmoid colon, ascending and descending colon, inner genital organs in women and appendix vermiformis. The healthy appendix was not removed. The diseased appendix demanded LA, which started first by rotation of the table 30° to the left to better expose the periappendicular region. Now the second 5mm port was set through the supraumbilical incision and then the third 5 mm port through the incision in the left lower quadrant medial from the superior anterior iliac spine with caution not to harm the inferior epigastric vessels. The ileum was then extracted from the operative field by using an atraumatic forceps and the appendix was mobilized by grasping the apex of the mesoappendix with a forceps and, if needed, by cutting the pericoecal and periappendicular adhesions with a hook. The critical view of safety was established by exposing the appendix and mesoappendix, the connection of the ileum to the caecum and the tennia libera of the caecum with the base of the appendix. The mesoappendix was cut retrograde or anterograde with ligasure atlas device (COVIDIEN – Forcetriad) and if needed the appendicular artery was additionally clipped. The base of the appendix was secured with an endoloop (COVIDIEN –

Surgitie, ligating loop with delivery system) and the extracted appendix was removed from the abdominal cavity through the 10 mm port by using an endobag or surgical glove if demanded. Now the ileocecal region was washed with saline solution and a drain was set through the suprapubic incision. Then the pneumoperitoneum was deflated, the fascia was closed on the level of supra or infraumbilical incision. All removed appendices were sent to histopathological examination.

## RESULTS

From 1 January 2012 till 31 December 2014, there were 361 patients with AA operated on the Clinic of Digestive Surgery in Skopje, Republic of Macedonia. Out of this number, there were 196 (53.99%) females and 165 (45.45%) males with a mean age of  $32.44 \pm 16.92$  years at operation. The mean duration of hospitalization was  $5.20 \pm 4.27$  days. There were 71 (19.67%) cases with some kind of comorbidities and 290 (80.33%) without comorbidities. The ASA score for 285 (78.95%) patients was IE, for 48 (13.30%) IIE, for 24 (6.65%) IIIE, and in 4 (1.11%) of them it was IVE. In 216 (59.83%) cases the initial approach was open and in 145 (40.17%) the approach was laparoscopic. In the laparoscopic group, there were 18 (12.41%) conversions. The reasons for conversion were retrocecal appendices in 6 (33.33%) cases, extensive adhesions in 4 (22.22%), failed mobilization of the appendix in 2 (11.11%), diffuse peritonitis in 2 (11.11%), perforated base in 1 (5.56%), other conditions in 1 (5.56%), accompanying disease in 1 (5.56%) and advanced local finding in 1 (5.56%) patient. The uncomplicated form of appendicitis was found in 209 (57.89%) cases and the complicated form was found in 152 (42.11%) cases. Overall, there were 15 (4.43%) cases with some form of intraoperative or early postoperative complication and 5 (1.39%) deaths. Of the complications only 1 (0.28%) was intraoperative and it was a perforation of the small intestine. The postoperative complications were overall 5 (33.33%) SSO with 4 SSI, all in the group of superficial SSI and 1 dehiscence of the operative wound, 5 (33.33%) complications with lethal consequences and 1 (6.67%) case with bilateral pleural effusion, thrombophlebitis of the lower extremity, mesenteric thrombosis and bowel obstruction respectively.

A univariate analysis of the factors associated with the specific operative approach (Table 1) showed that young age:  $25.72 \pm 10.50$  vs.  $36.95 \pm 18.80$  years, female sex: 60.69% vs. 50%, absence of comorbidities: 9.66% vs. 26.39%, ASA score:  $\leq$  IIE 98.62% vs. 87.96%, and uncomplicated forms of appendicitis: 73.10% vs. 47.69%, are in a statistically significant relationship with the choice of the laparoscopic approach. This attitude led to significantly less complications: 1 (0.69%) vs. 15 (6.94%), and shorter hospital stay:  $3.70 \pm 1.84$  vs.  $6.22 \pm 5.06$  days.

Table 1. Factors associated with the operative approach

Table 2. Factors associated with conversion



The analysis of the factors associated with conversion to open approach (Table2) showed that only the complicated form of appendicitis is significantly related to conversion: 66.67% vs. 21.26%. The duration of hospitalization in cases with conversion was significantly longer:  $6.39 \pm 2.29$  vs.  $3.31 \pm 1.40$  days.

In the year 2012 only in 21 (22.58%) out of 93 cases with AA the initial approach was laparoscopic and the conversion rate was 28.57%. In the year 2013 in 52 (44.44%) out of 117 cases with AA the initial approach was laparoscopic and the conversion rate was 11.54% and in 2014, these numbers were 71 (47.02%) out of 151 with the conversion rate of 8.45% (Figure1). This is a sign of approximation to the worldwide trends.

Fig. 1 Utilization of LA as opposed OA by year.

## DISCUSSION

Even though LA is not widely accepted as LC, its usage is continuously spreading. This is in close relation with the improvements in training, experience, technical equipment, patients' demands and certainly with narrowing the contraindications for LA. In the decision to approach laparoscopically one should consider the general contraindications for laparoscopic approach. These can be divided into a group of anatomical restrictions and a group of physiological restrictions. The former consists of conditions that disable the safe setting of the ports such as previous laparotomies, cirrhosis and portal hypertension. Furthermore, there are conditions that narrow the intraperitoneal space such as generalized peritonitis, bowel obstruction and gravid uterus. In the end, there are conditions that could lead to scattering of malignancy. In the group of physiological restrictions, there are conditions that can lead to CO<sub>2</sub> retention and hypoventilation, to decreased venous return, coagulopathies, etc. Pregnancy was considered a contraindication for a long time, especially in the first and third trimester because of the possible toxicity of the CO<sub>2</sub> to the embryo. However, the recent recommendations allow the use of laparoscopy in every trimester. A unique group of contraindications is related to the training and the experience of the surgical and anesthesiology team. Most of the mentioned contraindications are now becoming relative contraindications, which is opening a wide gate to increased usage of laparoscopy [11].

When we make a decision for LA, many of the previously mentioned conditions are rarely seen because most patients are young, otherwise healthy individuals. The indications for LA in essence are defined by the contraindications and all the conditions that are not contraindications are in fact indications for LA. The contraindications could be divided into absolute and relative. The former are hemodynamic instability and lack of surgical training. The latter comprise extreme bowel distension, generalized peritonitis, previous laparotomies, advance pulmonary disease, pregnancy and extreme obesity [12].

According to the last recommendation of the society of the gastrointestinal and endoscopic surgeons of United States of America – SAGES, the indications for LA and OA are identical and the decision whether to approach laparoscopically should only depend on the availability of the equipment, trained personal and the ability of the patient to tolerate general anesthesia and pneumoperitoneum [13].

The European Association of Endoscopic Surgeons – EAES recommends that every patient with symptoms and diagnostic findings that suggest the presence of appendicitis should undergo laparoscopic exploration and LA in the case of diseased appendix. If the appendix is healthy, it can be left “in situ”. There are several groups of patients that could benefit from this approach, such as young women in the fertile period, elderly, immunocompromised and obese patients, who can avoid the risk of infection of the big operative wound [14].

In literature there can be found more conservative standings about the usage of LA recommending that laparoscopy should be left aside when preoperative examinations suggest complicated appendicitis that includes gangrenous, perforated appendicitis, periappendicular phlegmon or abscess and diffuse peritonitis. This approach is especially recommended at the beginning of the utilization of this procedure. Siewert at al. concluded that CT signs that suggest complicated appendicitis are in relation with conversion to open approach [15]. In this manner, some other preoperative parameters that suggests complicated appendicitis like the results from various scoring systems, high values of CRP and details from ultrasonography examination could be used in making such a decision [16, 17].

One of the more important moments during laparoscopic procedures is the decision of the surgeon when to convert to open approach, which is mostly in close relation to the endangerment of the patient’s safety. The world average conversion rate in LA is around 10%. The reasons for conversion are mainly divided into two groups. The first group consists of the reasons related to local findings such as extensive inflammation on and around the appendix, excessive adhesions, periappendiculaire abscess or diffuse peritonitis and appendicular tumor. The second group consists of technical reasons: inability to identify the appendix, inability to fully remove the appendix, excessive hemorrhage, damage to the bowel, inability to obtain the pneumoperitoneum and hypotension as a result of the Trendelenburg's position. In our study, the reasons for conversion and conversion rate of 12.41% are in concordance with the worldwide reports [18, 19, 20].

Mortality after appendectomy is extremely low worldwide, mainly because the patients are otherwise healthy young individuals. It is between 0.8 ‰ in non-perforated AA and 5.1 ‰ in complicated AA with perforation. Mortality is mostly related to the presence of comorbidities and the grade of the appendicitis and not to the surgical approach. One study reports the mortality of 0.05% in LA and 0.3% in OA, which is not a significant difference [21, 22]. In our study in the group with open approach, the mortality is 2.31% and in the laparoscopic group there is no mortality. The overall mortality rate is 1.66%. The reason for this high percentage is

the fact that the study is conducted in a tertiary healthcare institution where the most difficult cases are treated.

The morbidity or complications in the surgical treatment of AA can be divided into intraoperative, early postoperative and late postoperative complications. The intraoperative complications mainly consist of bleeding and damage to the nearby abdominal structures. Early postoperative complications are intra-abdominal bleeding, diffuse peritonitis, bowel damage presented postoperatively, early postoperative bowel obstruction, intra-abdominal abscess, fecal fistula and SSI as the so-called abdominal complications. In this group, there are extraabdominal early postoperative complications: phlebothrombosis and thrombophlebitis, pulmonary thromboembolisms, cerebrovascular accidents, myocardial infarction, basal pneumonia, pleural effusion etc. In the group of late postoperative complications there are mainly incisional hernia, bowel obstruction and stump appendicitis. Most of the studies concluded that there is no difference between the quantity of complications with laparoscopic and open approach and, like mortality, morbidity is in close relation more to the comorbidities and the grade of appendicitis than to the surgical approach. The difference is mostly that in OA there is a greater number of SSI and in LA there is a greater number of intraabdominal abscesses. Among late complications in OA, development of incisional hernia and bowel obstruction are more common, while in LA stump appendicitis is more frequent. In our study, the morbidity in the laparoscopic group is 0.69%, in the open group it is 6.94% and the overall morbidity is 4.43% [23, 24].

From our results, it can be concluded that the laparoscopic approach was used in younger patients, more females, predominantly without comorbidities, with good physical status according to ASA score and with lower appendicitis grades. With this selective approach, morbidity was almost 0% and the conversion rate as well as the reasons for conversion are almost identical to the data in the worldwide literature. There is a strong increase in the utilization of LA from 22.58% in the year 2012 to 48.02% in the year 2014. It is also important that all this is in relation with the dramatic decrease of the conversion rate from 28.57% in the year 2012 to 8.45% in the year 2014.

## **CONCLUSION**

The utilization of LA after the slow start at the beginning is constantly rising throughout the world and it is on a good path to become the gold standard for the treatment of AA. The recent recommendations present almost no boundaries in the usage of LA. In the health care institutions throughout our country in the given period, LA was not widely used or it was used selectively in younger patients, mostly females, without comorbidities, mostly with ASA scores IE or IIE and with less advanced appendicitis grade. The results of such selective utilization regarding the safety of the procedure was excellent and in concordance with the worldwide reports. Health care institutions throughout our country with trained personal and adequate equipment should consider starting a selective usage of LA in the treatment of AA.

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**Table 1. Factors associated with the operative approach**

Characteristic	Laparoscopic	Open	P-value
No. Patients (%)	145 (40.17%)	216 (59.83%)	
Mean age at operation, years ± SD	25.72 ± 10.50	36.95 ± 18.80	2.3 · 10 <sup>-10</sup>
Sex, n (%)			
Female	88 (60.69%)	108 (50.00%)	0.0456
Male	57 (39.31%)	108 (50.00%)	
Patients with comorbidity, n (%)	14 (9.66%)	57 (26.39%)	0.00009
ASA score ≤ IIE, n (%)	143 (98.62%)	190 (87.96%)	0.0002
Mean duration of hospitalization, days ±SD	3.70 ± 1.84	6,22 ± 5.06	2.1 · 10 <sup>-8</sup>
Cases with intraoperative complications, n (%)	0	1 (0.46%)	
Cases with early postoperative complications, n (%)	1 (0.69%)	14 (6.48%)	
SSI superficial, n	1	4	
Dehiscence of the wound, n	0	1	
Bilateral pleural effusion , n	0	1	
Thrombophlebitis, n	0	1	
Mesenteric thrombosis, n	0	1	
Bowel obstruction, n	0	1	
Comp. with lethal consequence, n	0	5	
Mortality, n (%)	0	5 (2.31%)	
Grade of appendicitis, n (%)			
Uncomplicated appendicitis	106 (73.10%)	103 (47.69%)	0.000002
Complicated appendicitis	39 (26.90%)	113 (52.31%)	

**Table 2. Factors associated with conversion**

Characteristic	Laparoscopic	Conversion	P-value
No. Patients (%)	127 (87.59%)	18 (12.41%)	
Mean age, years $\pm$ SD	25.66 $\pm$ 10.74	26.11 $\pm$ 8.56	0.8661
Sex, n (%)			
Female	80 (62.99%)	8 (44.44%)	0.1316
Male	47 (37.01%)	10 (55.56%)	
Patients with comorbidity, n (%)	12 (9.45%)	2 (11.11%)	0.6858
ASA score $\leq$ IIE, n (%)	126 (99.21%)	17 (94.44%)	0.2336
Mean duration of hospitalization, days $\pm$ SD	3.31 $\pm$ 1.40	6.39 $\pm$ 2.29	7.86 $\cdot$ 10 <sup>-13</sup>
Cases with intraoperative complications, n	0	0	
Cases with early postoperative complications, n (%)	1 (0.79%)	0	
SSI superficial, n	1	0	
Mortality, n	0	0	
Grade of appendicitis, n (%)			
Uncomplicated appendicitis	100 (78.74%)	6 (33.33%)	0.000048
Complicated appendicitis	27 (21.26%)	12 (66.67%)	

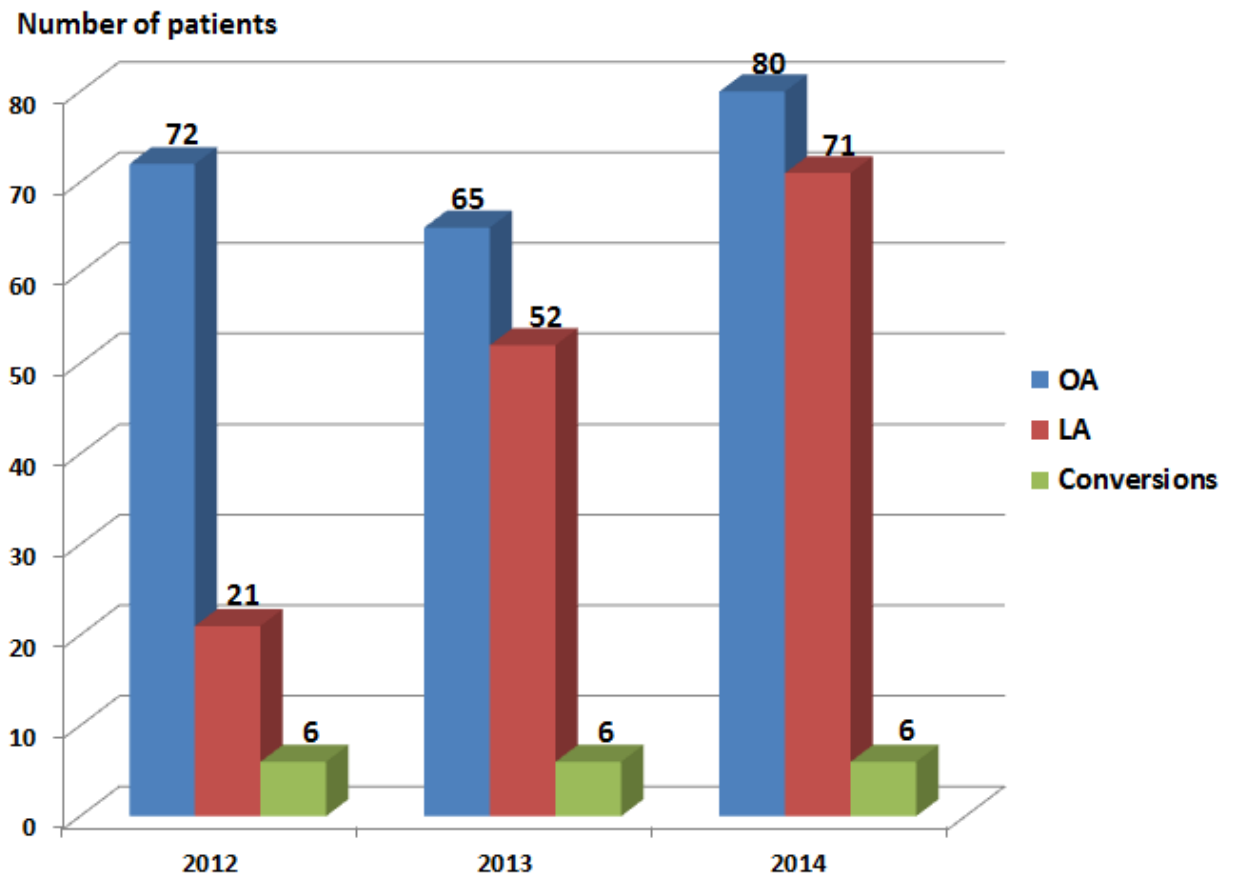


Figure 1. Utilization of LA as opposed OA by year