

# ORIGINAL PAPERS

## ELECTIVE LAPAROSCOPIC CHOLECYSTECTOMY – IS IT SAFE IN THE HANDS OF RESIDENTS DURING TRAINING?

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**The aim of the study** was to assess safety of elective laparoscopic cholecystectomy (LC) performed by residents that are undergoing training in general surgery.

**Material and methods.** A retrospective analysis was conducted on 330 patients operated electively due to cholelithiasis. Patients with acute cholecystitis, choledocholithiasis, undergoing cholecystectomy as a part of more extensive operation and patients with gall-bladder cancer were excluded. Group 1 included patients operated by resident, group 2 – by specialist. Duration of operation, mean blood loss, number of major complications, number of conversions to the open technique and conversions of the operator, reoperations and length of hospital stay were analyzed.

**Results.** Mean operative time overall was 81 min (25 – 170, SD±28.6) and 71 min (30-210, SD±29.1) in groups 1 and 2 respectively ( $p=0.00009$ ). Mean blood loss in group 1 was 45±68.2 ml and in group 2 – 41±73.4 ml ( $p=0.23$ ). Six major complications has occurred (1.81%) – 2 (2%) in group 1 and 4 (1.7%) in group 2. 18 cases (15.5%) of conversion of the operator occurred in group 1, and 6 cases (2.6%) of conversion of the operator happened in group 2. Average LOS was 1.9 days in group 1 and 2.3 days in group 2 ( $p=0.03979$ ).

**Conclusions.** Elective LC performed by a supervised resident is a safe procedure. Tactics of “conversion of operator” allowed to prevent major complications. Longer LC by residents is natural during the learning curve. Modifications of residency program in the field of laparoscopy may increase its accessibility.

**Key words:** laparoscopic cholecystectomy, resident education, conversion of operator

Laparoscopic cholecystectomy (LC) was proved safe and became a golden standard technique for treatment of symptomatic cholelithiasis (1). Minimally invasive techniques (MIT) became more popular and available thus was included into training programs of surgery residents (2). However, it is still unclear whether residents who have limited experience with biliary surgery can perform LC in a similarly safe manner as specialists of general surgery.

The aim of the study was to assess safety of elective LC performed by residents that are undergoing training in general surgery.

### MATERIAL AND METHODS

We designed a retrospective study on a group of patients operated due to cholelithiasis in the 2<sup>nd</sup> Department of Surgery of Jagiellonian University Medical College in the period between January 2011 and December 2013.

Inclusion criteria were: patients with diagnosed cholelithiasis, elective operation, American Society of Anaesthesiologists grade (ASA) I or II.

Exclusion criteria were: acute cholecystitis or its complications, patients with suspected or confirmed choledocholithiasis, patients un-

dergoing cholecystectomy as a part of more extensive operation, gall-bladder cancer patients as recognized in postoperative histopathological result.

Patients were divided into two groups depending whether operating surgeon was a resident (group 1) or a specialist of general surgery (group 2).

Every novel resident training included 5 to 10 assistances in LC, after which he could perform procedure supervised and assisted by certified independent specialist in general surgery. After 50 LCs such resident could continue to operate assisted by specialist or another resident with similar experience.

Additionally every resident had a free access to a Jagiellonian University Didactic Center where laparoscopic training boxes were available and a resident could further improve laparoscopic skills.

One resident became a specialist during the analyzed period – acquired data was divided between two groups accordingly.

The end points of the study were: duration of operation, mean blood loss, number of major intraoperative complications, number of conversions to the open technique, number of conversions of the operator (see below), reoperations and length of hospital stay (LOS).

Not all operations that were started by resident as an operating surgeon were completed by him – in cases where there was lack of progress in procedure for more than 10 minutes, or if anatomical variants identified by assisting specialist could impose high risk of major complications or such complications had already occurred – specialist took over. Similarly among patients operated by specialists

conversion of the operator to the senior surgeon due to particularly difficult situation in the operating field were included into analysis.

Number and reasons for such conversions of the operator were assessed.

Major complications were defined as grade III or higher in Clavien-Dindo classification (3) and included biliary tree injury, bleeding causing blood loss  $\geq 250$  ml, perforation/damage of gastrointestinal tract. Blood loss was assessed postoperatively by the amount of blood in surgical suction pump reservoir. Minor complications (I and II grade in Clavien-Dindo classification), like postoperative wound infection or subcutaneous emphysema were not assessed due to lack of information.

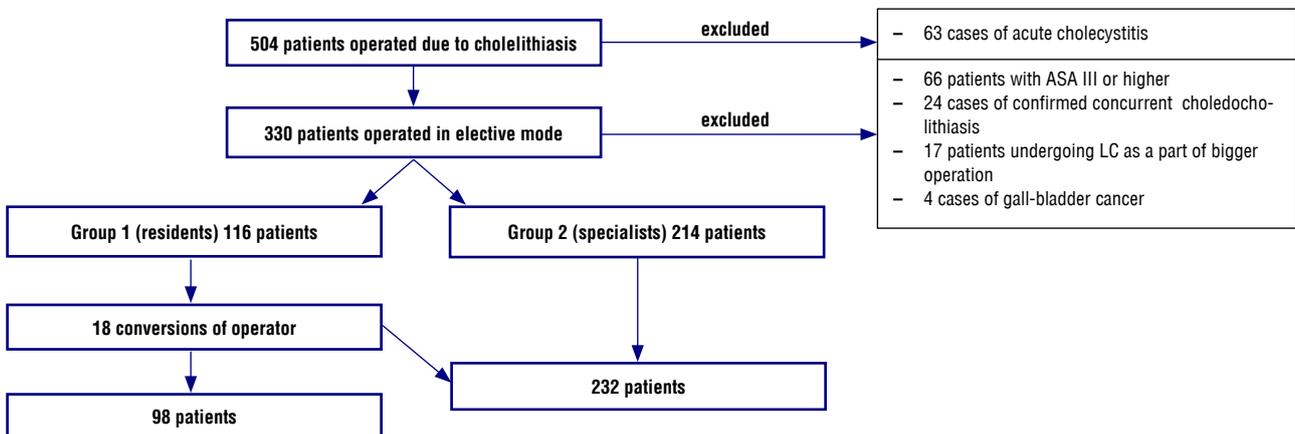
Diagram is a recruitment flow diagram that shows patient selection for the study.

Group characteristics are shown in tab. 1.

Statistical analysis was performed using the Statsoft STATISTICA v.10 program. Tests were used according to the type of variable. Groups were compared using the  $\chi^2$  test for categorical variables. Due to lack of normal data distribution, continuous variables were assessed by means of the Mann – Whitney U-test. Results were considered statistically significant when p-value was  $<0.05$ .

## RESULTS

Mean operative time overall was 74 minutes (range 25-210) – 81 min (range 25 – 170,  $SD\pm 28.6$ ) and 71 min (30-210,  $SD\pm 29.1$ ) in groups 1 and 2 respectively ( $p=0.00009$ ). Mean blood loss did not differ between groups in a



Recruitment flow diagram

Table 1. Characteristics of studied groups

Parameter	Group 1	Group 2	p value
Number of patients, n (%)	98 (29,7%)	232 (70,3%)	-
Females: males ratio (%)	86%: 14%	84%: 16%	p=0,63339
Mean age (years, $\pm$ SD)	52,2 $\pm$ 16,3	56,3 $\pm$ 16,8	p=0,07596

significant manner – in group 1 it was 45 $\pm$ 68.2 ml and in group 2 – 41 $\pm$ 73.4ml (p=0.23).

Overall 6 major complications has occurred (overall complication rate = 1.81%) – 2 (2%) in group 1 and 4 (1.7%) in group 2. Four episodes of serious bleeding occurred (1 in group 1 and 3 in group 2). One bleeding from cystic artery in group 2 was managed laparoscopically by application of additional clips. Another bleeding from the gallbladder bed in group 2 required conversion and hemostasis was achieved only by putting deep „Z” -type suture. Two cases of bleedings (one in each group) occurred from places of trocar insertion – patients were reoperated and hemostasis was effectively achieved by placing a deep “Z” -type suture. Two patients had complications associated with bile leakage – one case in each group. In group 1 postoperative biliary leakage was managed by endoscopic retrograde cholangiopancreatography with papillotomy and stent insertion. In group 2 one conversion from laparoscopic to classical “open” surgery was performed due to intraoperatively noticed common bile duct injury that was effectively managed by primary suture. One conversion in group 1 had place due to uncertain anatomy of biliary tree to provide safe differentiation of structures of Calot’s triangle. Number of major complications, conversions and reoperations in group 1 and group 2 did not differ in a statistical significant manner.

We have identified 18 cases (15.5%) of conversion of the operator – situation when resident could not safely complete LC. In 1 case conversion of the operator was due to cystic artery injury and problematic hemostasis requiring additional clipping. In 8 cases we have found description of anatomical anomaly in the operation report as the possible cause of conversion of the operator. In the remaining 9 cases lack of progress in the procedure due to chronic inflammation and fibrosis was a cause of conversion.

It is worth noting that in 6 cases (2.6%) a conversion of the operator from a specialist to the most experienced surgeon was required –

in 2 cases when a specialist took over from resident and in 4 cases when a specialist was a primary operator. The difference in conversion of the operator between two groups was statistically significant (p=0.00005).

Average length of hospital stay (LOS) after surgery for both groups was 2.09 days (1.9 days – group 1 and 2.3 days – in group 2, p=0.03979). End-points of study for groups 1 and group 2 are presented in tab. 2. IQR stands for inter-quartile range.

None of the patients was readmitted due to complications after discharge. No mortality cases were noted.

## DISCUSSION

In our study we observed that residents can perform elective LC in a similarly safe manner as specialists, without higher risk of complications, conversions or reoperations. Operating time is longer when a resident is an operating surgeon, but patients operated by residents have shorter LOS in hospital. Conversions of the operator is a useful maneuver to prevent complications, but it does not apply only to residents – conversions from specialist to senior surgeons also happen.

During last three decades laparoscopy has proved it’s indisputable advantages in many aspects when compared to open surgery (4, 5, 6). Throughout years common access to minimally invasive techniques had increased, but LC performed by supervised resident is still thought to be hazardous. This slows down MIT propagation generally and prevents young residents from acquiring basic laparoscopic skills that may allow them to approach more advanced minimally invasive surgery. According to Michalik only in 1.39% of all Polish surgical units advanced laparoscopic procedures (colorectal, bariatric, liver and pancreas surgery) are performed routinely (7).

Recent surveys showed that surgical residents even in highly developed countries are

Table 2. End points of the study

Parameter	Group 1	Group 2	p value
Mean operative time (min, $\pm$ SD)	81,0 $\pm$ 28,6	71,1 $\pm$ 29,1	p=0,00009
Mean blood loss (ml, $\pm$ SD)	25 $\pm$ 68,2	21 $\pm$ 73,4	p=0,23000
Complications, n (%)	2 (2%)	4 (1,7%)	p=0,84345
Conversion, n (%)	1 (1%)	2 (0,9%)	p=0,89037
Conversion of the operator, n (%)	18 (15,5%)	6 (2,6%)	p=0,00005
Reoperation, n (%)	1 (1%)	1 (0,4%)	p=0,54697
Mean length of hospital stay (days, $\pm$ SD)	1,9 $\pm$ 1,2	2,3 $\pm$ 1,5	p=0,03979

concerned about their training in MIT and conclude that majority is not prepared for autonomous operations from laparoscopic approach (8, 9).

With no doubt safe and prompt LC requires a lot of training. Learning curve for LC is not precisely established. According to some authors after 30 procedures the risk of major complications dramatically decreases (10), but in another opinion there are around 200 operations necessary to significantly shorten the duration of operation (11). At this moment Polish general surgery education program recommends at least 42 LC to be performed by resident with at least 10 assistances during 6-year long training.

Mean operating time of residents in our study was in average 10 minutes longer than mean operating time of specialists. Likewise-Fahrner and Uecker have stated that operation time in elective LC when a resident is an operator is significantly longer (12, 13). Longer duration of operation is somewhat natural in the course of learning curve and for the sake of safety no time pressure should be put on learning residents.

Recent study from Italy stated that LC performed by resident under supervision of specialist is safe procedure and is not associated with increased amount of perioperative complications (14). We also have shown that there were no significant difference between number of major complications in two groups. Blood loss during LC also didn't differ in a significant way between two groups and was similar to the reports of other researchers (15). Likewise, number of conversions and reoperations were no higher than in the reports of other authors (16).

Conversion of the operator (from resident to specialist) that occurred in 15.5% of cases was an effective tactics to prevent complications. However in 6 cases (2.6%) a conversion

of specialist to senior surgeon was required. This shows that even such a basic laparoscopic procedure as elective LC can sometimes be challenging, demands significant experience and skills and advocates supervision of a resident who has limited experience with MIT.

Length of stay in the hospital after surgery in a residents group was shorter when compared to the specialist group – 1.92 days vs 2.3 days. Similarly to our findings beforementioned publication by Fahrner (12) noted that residents participation as an operator has a positive effect on LOS. We believe this can be explained by subconscious selection of “easier patients” for residents, even though recognized factors of more difficult LC (like male sex or endoscopic retrograde cholangiopancreatography with papillotomy in past) were not assessed in our study (17).

Safety of LC performed by residents can be further improved if surgical training is augmented by the use of laparoscopy simulator boxes and/or virtual reality laparoscopic simulators. Even though Cochrane Database Systematic Review states that there is lack of studies of high quality, technical skills of surgical trainees appear to improve regardless of the training method used (18, 19, 20). Giannotti et al goes further and suggests that video gaming can be advantageous for eye-hand coordination and also improve spatial attention (21). In our study all residents had access to laparoscopic box trainer and reported its usefulness in improving their laparoscopic skills.

Our study has several limitations – it is a retrospective study conducted in a single center. No randomization was performed. The group of patients was quite homogenous and selection bias could impact the results. Moreover it is impossible to account for such individual factors influencing surgical performance as inborn talent and technical predisposition. Additionally it was not possible to calculate

the influence of previous experience of residents in MIT during analyzed period of time.

## CONCLUSIONS

Elective laparoscopic cholecystectomy in patient with uncomplicated cholelithiasis performed by a supervised resident is a safe procedure. Tactics of “conversion of operator”

when needed, allowed to avoid any increased risk of major complications. Longer operative time of residents group is natural in the course of learning curve during surgical training. Modifications of residency program requirements in the field of MIT may further enhance accessibility of it to residents. Residents should also be encouraged to use any sort of laparoscopic trainer to further improve their laparoscopic skills.

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