



The issues and the evidence: a brief review on laparoscopic appendectomy in 2010

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Abstract

Laparoscopic appendectomy in the adult, 25 years after its proposal, has gained wide acceptance, and has spread to most surgical centers. Its diffusion is strictly bound with the increasing indication to advanced laparoscopic surgery and to explorative laparoscopy, especially in an emergency setting. We can assert that the technique is to be considered the gold standard at least in women of childbearing age. After many meta-analyses and randomized controlled studies some issues are still debated; a lack of standardization in

the operative technique, together with scarce data related to the different grades of disease (ranging from uninflamed appendix to diffuse peritonitis, gangrene or perforation of the organ) have not contributed to identify precise indications or clear principles of behaviour. A complete review of the lay literature has been made in order to associate the levels of evidence and the grades of recommendation to the open questions concerning laparoscopic appendectomy.

Introduction

Still many issues concerning technical aspects and outcomes of laparoscopic appendectomy (LA) are debated 25 years after Kurt Semm first described the operation. The main questions regarding laparoscopic appendectomy today lay upon indications, outcomes, surgical technique, behaviour in case of "innocent appendix" after explorative laparoscopy, and learning curve. Since then more than a thousand articles, almost 60 RCTs and at least 10 meta-analyses have together built a solid background to the technique. A workout of papers, regarding the most common laparoscopic procedures (all accounting for similar numbers of cases both in central and district hospitals) indexed in Pubmed from 1985 up to 2010, give an idea about the diffusion of the techniques (Tab. 1). A plateau was reached by the most performed operation (laparoscopic cholecystectomy) in

the nineties, after its wide diffusion due to its early validation as the "gold standard" for cholelithiasis.

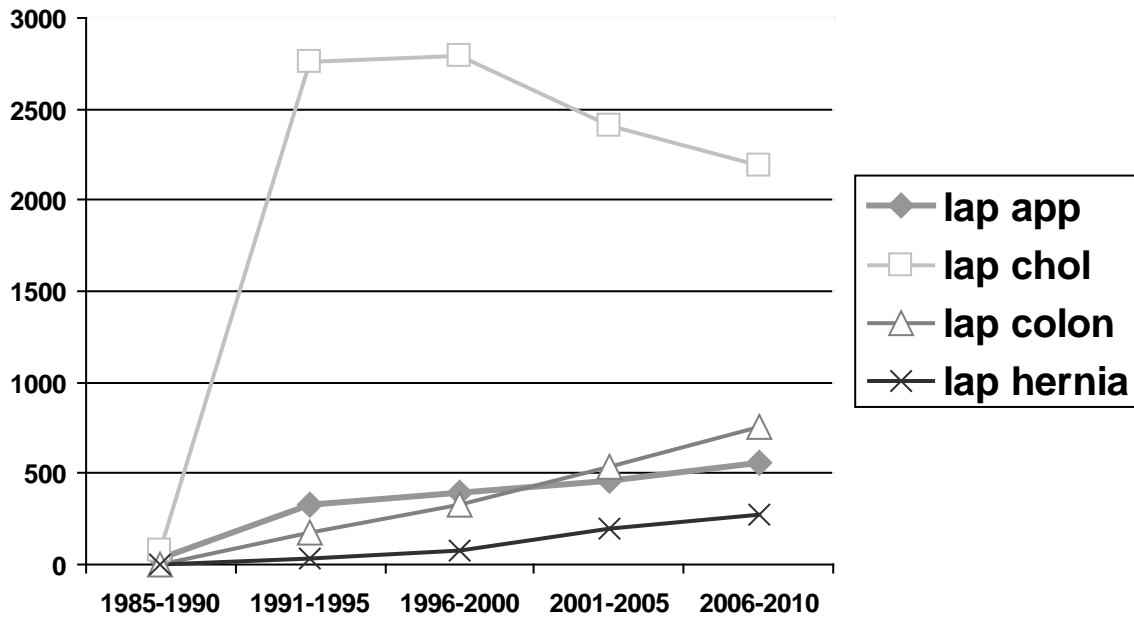
Other, more technically difficult, operations are still in expansion (laparoscopic ventral hernia repair, laparoscopic colectomies), and so is appendectomy; this is a hint of an increasing diffusion compromised by an acceptance not entirely shared by all surgeons.

Indeed, as pointed out in a recent meta-analysis¹, most of the literature's studies have pitfalls, and no consolidated findings on which to make recommendations. The fact is enhanced by a paper concerning statistical methodology in which an RCT on LA versus open appendectomy (OA) is cited as an example of errors in assessing power and sample size². These questions had already been aroused in the mid-term of LA history, and the author claimed great differences



between the “real world of appendicitis” compared to the atmosphere under which controlled trials comparing LA and OA had been performed, as if the statistical

significance ought to be contrary to the clinical significance of the results³.



Tab.1: number of Pub Med publications in the last 25 yrs

Methods

An internet research using key words “laparoscopic appendectomy” in Pubmed, Embase and Google Scholar research engines helped to find answers related to these questions, based upon surgical societies guidelines, meta-analyses and reviews, randomized controlled trials (RCTs), prospective studies and retrospective collections of large cohorts of patients taken from national health’s institutes databases; certain aspects related to technical variables have been outlined in smaller single-center’s collections or expert’s opinions. Levels of evidence (as stated by Oxford’s classification, Tab. 2) have directed the weight of studies in relation to single questions.

Level of Evidence	Grading Criteria	Grade of Recommendation
1a	Systematic review of RCTs including meta-analysis	A
1b	Individual RCT with narrow confidence interval	A
1c	All and none studies	B
2a	Systematic review of cohort studies	B
2b	Individual cohort study and low quality RCT	B
2c	Outcome research study	C
3a	Systematic review of case-control studies	C
3b	Individual case-control study	C
4	Case-series, poor quality cohort and case-control studies	C
5	Expert opinion	D

Tab. 2: Oxford’s classification of the levels of evidence for therapy, prevention, aetiology

Issues and evidence

In 2004, concurrently to the results of the COST⁴ study that started the spread of laparoscopic colectomy for cancer in the north-

american hospitals, similar results were awaited from the Cochrane Foundation meta-analysis on LA vs OA⁵. Instead, due to the



moderate to poor standard of the 54 collected RCTs, few statements became evident: a three-fold raise in intra-abdominal abscesses and a similar decrease in wound infections (in LA), a significant lowering of negative appendectomies, post-operative pain, hospital stay, return to normal activity and outside hospital costs, despite a higher operative time and cost; in conclusion the authors recommended LA for fertile women, obese and employed patients. Similar results were obtained by a German health technology assessment study group, which states that LA is "reasonable" in young women, despite minor benefits on negative appendectomy rates (if left in situ after laparoscopic exploration), quality of life, cosmesis, refeeding, stool passage and hospital stay, leaving the "decision to the physicians individually"⁶. At last, in 2009, the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES), produced guidelines for LA, in which the turn towards mini-invasiveness seems clear⁷. In fact, despite the fact that level Ia evidence remains limited to fertile women, several patient groups benefit of level II evidence, in which LA is considered the procedure of choice: complicated appendicitis, elderly, obese and pregnant.

Infectious complications in complicated appendicitis are evaluated in few studies. An interesting database collection, presented at the last ASCRS (American Society of ColoRectal Surgeons) meeting on a large case-matched group of patients, confirms a lower grade of overall and surgical site infections, but evidences a higher rate of intra-abdominal abscesses in LA (6.2% vs 4.1%)⁸ (level IIb). The conclusion, differently from other previous papers, is not to convert to open surgery in this sub-group, but the authors suggest wariness in performing a vigorous irrigation. This attitude reflects the increasing number of LA performed in United States' hospitals, where it is in fact considered the gold standard, despite the minor level of evidence. A recent alert of the American College of Surgeons⁹ informs that "treating appendicitis by laparoscopic surgery may not be worth the cost; analysis shows newer method results in high costs and increased complications"; despite this, the trend is toward mini-invasiveness in all fields, and also appendicitis falls in this strand, also because surgeons are more and more acquainted with this way of access.

Elderly and obese patients, the categories in which overall complications are higher (especially those related to post-operative impairment of pulmonary function and reprise

of normal activity), seem to benefit from laparoscopy and their rate of surgical complications don't exceed that of the normal male and female population (evidence level II-III)^{10,11}.

The defined statement concerning pregnancy is based on an American metanalysis¹² which comes to opposite conclusions regarding fetal risk of LA to those of another metanalysis from United Kingdom¹³, published in the same year; the conclusions might be in favour of a not significant increase in fetal risk, but the level of evidence IIb might not be considered sufficient to choose LA as the gold standard in this particular situations.

Two interesting arguments début in these guidelines. The first regards negative appendicitis at exploration and the second introduces an assertion regarding technique standardization. These are in fact, especially the former, key-points of discussion in the lay literature.

SSAT guidelines¹⁴, published in 2006, suggested to remove a normal appendix in absence of other significant pathology at exploration. This point of view is shared by the majority of authors and is based on two mainstays: the relatively low rate of complication for the surgical act, the significant number of "endoappendicitis" (macroscopically normal aspect of the serosa with an inflammation of the inner layers seen at histology) which states around 11-26%, and the percentage of re-operations (6%) for the same symptoms in those patients in which the appendix was left in situ¹⁵ (level IIIb). Indeed, if this attitude were to be standardized, the rate of negative appendectomies would not fall after laparoscopic exploration, thus nullifying one of the aspects which is advocated as favouring LA vs OA. Moreover, complications are very low but not absent, and non-surgical therapy may resolve up to 50% of the cases^{16,17} (level Ib). The behaviour alas, in these cases, should not be standardized, but evaluated on a case-to-case basis.

Technique standardization is introduced in SAGES guidelines as a standpoint to reduce the pitfalls of this operation: in fact retrospective and cohort studies have demonstrated a lowering of operative time, conversion rate, morbidity and surgeon's satisfaction in training centers where a standardized method is used and taught^{18,19} (level IIb). This might also be the problem in analysing different works in the literature, as procedures used to dissect, to close the stump, to wash the peritoneum or to position the trocars are quite different, and may lead to different results. The level of evidence



regarding technical aspects is quite scarce, and based principally on consensus statements and few limited RCTs. Let's analyse the few behaviours for which a defined trend is present in the literature.

Access to the peritoneum is generally performed through an umbilical incision, either by means of "open" access or by a Verress needle and a "close" technique. Different groups choose one or the other approach on the basis of their standard practice in laparoscopy, and both have advantages and pitfalls. Once the pneumoperitoneum is established another two trocars are required, in order to obtain the proper triangulation: LLQ and suprapubic, LLQ and RLQ, suprapubic and RLQ or both trocars in the suprapubic position (this last one particularly appreciated for cosmetics as scars become hidden by pubic hair). It depends on the surgeon's choice and habits whether to prefer a cranio-caudal or a caudo-cranial view. Attention must be paid not to injure the inferior epigastric vessels. The number of trocars might be lowered to two by using trans-abdominal threads passed through the appendix's top (puppeteer's technique)^{20,21}. Single port appendectomy (SPA) deserves a particular mention, as it forestalls natural orifice surgery and might have a rapid spread in the near future. At present there is only a retrospective study that compares SPA to LA, that seems to outline some advantages in terms of cosmetics and patient's satisfaction²²; alas, the technique is not particularly difficult, and the ease of access should bear success (differently from endoscopic-access natural orifice surgery, which is much more dangerous²³, is still experimental and requires a specific instrumentation), as soon as some category of patients (young females and males) will request a surgery "without scars"²⁴. Needlescopy (the use of 3mm instruments and a 5mm optic) has been suggested as an amelioration of mini-invasiveness, but the review of comparative studies evidences a similar morbidity together with a higher conversion rate and operative time²⁵ (level Ia). New ultrasonic or electrothermal dissection devices have been proposed for mesoappendix's section, but despite showing a reduction in operative time (41 vs 54 min) and rates of conversion (9.4 vs 11.1%) in a single RCT²⁶ the cost doesn't seem to outstand the benefits.

A similar argument can be held for the closure of the stump. The use of routine stapling seems to bring certain advantages: a reduction in post-operative infection, simplicity of usage, even by residents and at night-time, a lower operative time; the dis-advantages are

a higher cost (if compared to endo-loop) and the obligatory use of a 12mm trocar²⁷ (Level Ib). A protocol recruitment is now on course to establish, once for all, if a lowering of intra-abdominal abscesses' rate can be obtained by routine stapling, and that could effectively change the surgeon's custom to loops²⁸, even if a recent metanalysis doesn't enlight a significant difference between the two methods, apart from operative time²⁹.

Peritoneal lavage, when, how and where to do it, is a matter of debate. Opposite conclusions are gathered from two retrospective studies to the question if irrigation can diminish infectious intraabdominal complications after LA: one favours copious lavage of the entire abdominal cavity, and the other sustains that aspiration is enough and that irrigation might otherwise contribute to the contamination of the abdomen, especially in appendicitis without generalized peritonitis^{30,31} (level III). The answer might be found in a small experimental study conducted on children that tries to give an answer on the necessary quantity of saline to use in order to eradicate bacterial presence (5.8 l/m² of peritoneal surface – established 1.4m² as median surface³² we should use at least 8lt)³³. In my opinion (but no study has been made for referral) such an entity of lavage is seldom made in case of localized and even in generalized peritonitis (it takes about 3 minutes for every liter of saline to be finished without a peristaltic pump, and the time required is not compatible with the declared operative times, as lavage time should be half the entire time required for the operation).

Appendiceal extraction can be made in different ways: the most common is the use of an endo-bag, which permits a secure retrieval through a 10-12mm port³⁴. Alternative methods, more cheap and hand-made, are used, like the adaptation of a surgical glove to act as a bag. The skeletonization of the mesoappendix permits, in cases of limited inflammation, the extraction directly through the 10-12mm port, thus preserving the absence of contact with the abdominal wall. This can be helped by the use of a stitch (fisherman's technique³⁵) whenever a larger volume of the organ hampers the passage of a grasper, or in case of a single 10/12mm access. Even in SPA surgery the appropriate removal has to be assured, and the type of multiport device used gains importance in the performance of a correct operation. In fact the possible infection of the wound is one of the topics in favour of LA, and mixed techniques (i.e. the laparo-assisted appendectomy) in which the organ is mobilized outside the



abdomen and the appendectomy is performed by open fashion through the port-incision, carry a higher rate of wound contamination (4.6% of infections in a Saudi-arabian retrospective review)³⁶.

The use of drainages is unnecessary and might also be harmful in some cases (for the possible development of cecal fistulae) as suggested by a large meta-analysis³⁷ (level Ia). It is commonly accomplished in case of diffuse peritonitis or localized abscess cavities, even if a thorough peritoneal lavage is considered enough to preserve from recurrent abscesses. The surgeon must be aware that haemorrhagic complications, which are rare but might occur in the immediately post-operative period (but have dramatically ceased with the use of blunt tip trocars instead of the bladed ones³⁸), must be diagnosed indirectly by the frequent monitoring of the patient's conditions; this argument is frequently used by those endorsing the routine drain positioning³⁹.

As a last step in evaluation of the possible advantages of LA in comparison to OA we must cite the consistent progression that has

been made in the post-operative management. A lot of papers have enhanced the value of "fast-track" surgery, even if it is largely unaccomplished in most surgical units⁴⁰. Few papers have analyzed fast-track applied to OA, and the hospital stay was reduced to values similar to those who undergo LA⁴¹ (level Ic). This way of acting in colorectal surgery has improved outcomes of surgical patients, not only in laparotomic access but also in laparoscopy, and the possible improvements of traditional appendectomy will not outclass the advantages of minimal invasiveness.

A final word must be spent over training and learning curve. Appendectomy has traditionally been regarded as a fundamental step in the junior trainee's course. An analogous role must be claimed for LA, as it is fundamental for acquiring dexterity and skill in laparoscopy, necessary to tackle advanced minimally invasive operations⁴². Prospective studies on resident's outcomes in appendectomy operations have stated the learning curve as completed after twenty operations⁴³ (level III).

Conclusions

Laparoscopic appendectomy in the adult setting has gained acceptance in the last years as the gold standard especially in sub-categories of patients such as fertile women, working-class males, obese and elderly patients. The method has proved valid both in uncomplicated and complicated disease. Undoubtedly the supposed rise in the rate of intra-abdominal abscesses has not been consistently denied by further meta-analyses. This is the problem to face in the near future. The solutions might rest in high quality RCTs based on a fully standardized technique, which should comprehend an adequate washing, exploration and technical management. Another help might come from the stump closure by mechanical stapler, still too expensive at present. Moreover, a wider application of fast-track principles for

laparoscopy might further on ameliorate the results. The few articles concerning the training results and the learning curve must be tailored upon the single surgical context in which they are applied; differences arise between teaching and district hospitals, super specialized units and emergency surgery wards, young and experienced surgeons, day and night-time, basic or advanced previous laparoscopic experience. The feeling is that future trials should consider these differences, and together with a correct sample size and power assessment, they should focus on the answers to those questions which still lack an adequate level of evidence. The point should no longer be if LA is better than OA, but how to perform a correct laparoscopic appendectomy and in which situations it should be contraindicated.

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