Laparoscopic versus open appendectomy in adults with complicated appendicitis: systematic review and meta-analysis
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CRD summary
This review concluded that when compared with open appendectomy, laparoscopic appendectomy may have a lower incidence of surgical site infections in complicated appendicitis, with no significant risk of intra-abdominal abscess (based on moderate to poor quality evidence). These conclusions reflect the data presented, but should be interpreted taking into consideration the possibility of language and publication bias (missed studies).

Authors' objectives
To evaluate the effectiveness of laparoscopic appendectomy compared with open appendectomy in patients with complicated acute appendicitis.

Searching
PubMed and EMBASE (1996 to November 2008), The Cochrane Library, Web of Knowledge and SCOPUS (search dates not reported) were searched for studies published in English. Search terms were reported. References of retrieved articles were examined for further studies.

Study selection
Randomised controlled trials (RCTs) and observational studies that compared laparoscopic appendectomy with open appendectomy in adult patients with complicated appendicitis were eligible for inclusion. Eligible studies has to report postoperative surgical site infection rates, postoperative intra-abdominal abscess rates, postoperative analgesia, time to oral intake, or length of hospital stay.

Most of the included studies defined complicated appendicitis as a perforated appendix, with or without abscess formation, with or without peritonitis; some studies included gangrenous appendix. In most cases, complicated appendicitis was initially confirmed based on clinical opinion. Most studies did not seek microscopic histological confirmation. Most included patients were adults with a mean reported age of 30 to 40 years across treatment groups; one study included paediatric patients. The experience of the surgeons was inconsistently reported between studies. For laparoscopic appendectomy, three trocars were used (where reported), although the size of these varied. The meso-appendix and appendix resection methods varied between studies For open appendectomy, McBurney's, Gridiron or paramedian procedures were used (where reported). Antibiotics were used preoperatively and postoperatively (where reported).

Study selection was performed independently by two reviewers; disagreements were resolved by discussion.

Assessment of study quality
Methodological quality was assessed independently by two reviewers using the Critical Appraisal Tools for RCTs and case-control studies, which assessed risk of selection bias, performance bias, attrition bias, selective reporting bias, detection bias, statistical bias (including intention-to-treat analysis) and external validity. The criteria assessed were classified as met, unclear or not met. An overall grade was assigned (A for low risk, B for moderate risk, and C for high risk).

Data extraction
Data were extracted independently by two reviewers to calculate odds ratio (ORs) and 95% confidence interval (CIs) for dichotomous variables or mean difference (MD) and standard deviation (SD) for continuous variables. Authors were contacted for missing data if necessary.

Methods of synthesis
Odds ratios and 95% confidence intervals were pooled using the Mantel-Haenszel method. Mean differences and standard deviations were pooled using the inverse-variance method. Heterogeneity was assessed using $I^2$ (over 30%...
indicated the presence of heterogeneity).

Subgroup analyses were performed to assess the influence of each category of risk of bias. The recommendations were graded based on the Oxford Centre of Evidence Based Medicine level of evidence and grades of recommendation guidelines.

If meta-analysis was not considered appropriate, a narrative synthesis was undertaken.

Funnel plots were used to assess publication bias.

**Results of the review**

Twelve retrospective observational/case-control studies were included in the review (n=16,566 patients; range 52 to 14,407). Overall study quality was considered moderate to poor; the absence of randomisation, blinding and allocation concealment were inherent to the included study designs and additional methodological flaws were present.

Laparoscopic appendectomy was associated with significantly smaller rates of surgical site infections than open appendectomy (OR 0.43, 95% CI 0.34 to 0.55; 11 studies), but this was associated with significant heterogeneity ($I^2 = 73\%$). This association remained, but heterogeneity was reduced ($I^2 = 61\%$) when only studies at moderate risk of bias were analysed (OR 0.23, 95% CI 0.14 to 0.37).

Laparoscopic appendectomy was associated with a significantly longer operating time than open appendectomy (MD 12.80 minutes, 95% CI 8.35 to 17.25; four studies), but this was associated with significant heterogeneity ($I^2 = 86\%$). Exclusion of one study yielded similar results.

Laparoscopic appendectomy was associated with significantly shorter time to oral intake than open appendectomy (MD 0.8 days, 95% CI 0.5 to 1.15; three studies) and shorter length of hospital stay (MD 1.1 day, 95% CI 0.5 to 1.6; four studies). The analysis for length of hospital stay was associated with significant heterogeneity ($I^2 = 92\%$).

Three studies found that laparoscopic appendectomy patients used significantly less analgesia postoperatively than open appendectomy patients.

There was no significant difference between groups for intra-abdominal abscess complication rates.

**Authors' conclusions**

When compared with open appendectomy, laparoscopic appendectomy may have a lower incidence of surgical site infections in complicated appendicitis, with no significant risk of intra-abdominal abscess (level 3a evidence; moderate to poor quality studies).

**CRD commentary**

The review question was supported by well-defined inclusion criteria. A range of relevant databases were searched, but only published studies in English were included, so publication and language bias were possible (some studies may have been missed). Two reviewers were involved in study selection, data extraction and quality assessment, which reduced the risk of reviewer bias and error.

Study quality was assessed using appropriate criteria. Details about individual studies, including study design, description of intervention, quality assessment and results were reported in tables. The studies available were generally of poor quality; this was reflected in the interpretation of the data. Heterogeneity was assessed and some potential sources were explored.

The authors' conclusions reflect the data presented, but their interpretation should take into consideration the possibility of language and publication bias (missed studies).

**Implications of the review for practice and research**

**Practice:** The authors stated that in current clinical practice laparoscopic appendectomy can be used in complicated appendicitis according to the surgeons discretion and laparoscopic experience. However, laparoscopy was a fairly new
intervention, which required significant surgical expertise and resources for maximum efficiency. Although industrial countries appeared to be meeting these criteria, developing and third world countries may find high level of practice difficult to achieve. In these circumstances open appendectomy should be the treatment of choice.

**Research:** The authors stated that the reported studies provided the initial framework for higher level studies and that blinded RCTs that compared laparoscopic appendectomy with open appendectomy were feasible.

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