

PART I: Snapshot appendicitis

CHAPTER 1

'Snapshot' research: a novel trainee-led study design

Abstract

'Snapshot' research is a new multicenter study method which is particularly suited to investigate a common condition or treatment. These (mostly observational) studies are primarily initiated and conducted by trainees. Because of a good research network of these trainees, a large amount of data can be collected in a short period while the workload for each participating hospital remains limited. This article explains and discusses the various aspects of a 'snapshot' study.

CHAPTER 2

Prospective nationwide outcome audit of surgery for suspected acute appendicitis

Abstract

Background

Studies comparing laparoscopic and open appendectomy are difficult to interpret owing to several types of bias, and the results often seem of limited clinical importance. National audits can be valuable to provide insight into outcomes following appendectomy at a population level.

Methods

A prospective, observational, resident-led, nationwide audit was carried out over a period of 2 months, including all consecutive adult patients who had surgery for suspected acute appendicitis.

Complications after laparoscopic and open appendectomy were compared by means of logistic regression analysis; subgroup analyses were performed for patients with complicated appendicitis.

Results

A total of 1975 patients were included from 62 participating Dutch hospitals. A normal appendix was seen in 3.3 per cent of patients. Appendectomy was performed for acute appendicitis in 1378 patients, who were analysed. All but three patients underwent preoperative imaging. Laparoscopy was used in 79.5 per cent of patients; the conversion rate was 3.4 per cent. A histologically normal appendix was found in 2.2 per cent. Superficial surgical-site infection was less common in the laparoscopic group (odds ratio 0.25, 95 per cent c.i. 0.14 to 0.44; $P < 0.001$). The rate of intra-abdominal abscess formation was not significantly different following laparoscopic or open surgery (odds ratio 1.71, 0.80 to 3.63; $P = 0.166$). Similar findings were observed in patients with complicated appendicitis.

Conclusion

Management of acute appendicitis in the Netherlands is preferably performed laparoscopically, characterized by a low conversion rate. Fewer superficial surgical-site infections occurred with laparoscopy, although the rate of abscess formation was no different from that following open surgery. A low normal appendix rate is the presumed effect of a mandatory preoperative imaging strategy.

CHAPTER 3

Outcome of appendectomy for acute appendicitis in children

Abstract

Background

A laparoscopic approach for emergency appendectomy is increasingly used, in pediatric patients as well. The aim of this study is to audit the current state of diagnostic work-up, surgical techniques and its outcome in children with acute appendicitis.

Methods

A prospective consecutive observational cohort study was carried out in a 2-month study period. All patients that were operated for suspected acute appendicitis were included. Patients under 18 years that underwent an appendectomy were analyzed in this study. Primary outcome was the infectious complication rate after open and laparoscopic approach; secondary outcomes were the use of preoperative imaging and the normal appendix rate.

Results

A total of 541 children were operated for suspected acute appendicitis in 62 Dutch hospitals, all pediatric hospitals participated. Preoperative imaging was used in 98.9% of the children, ultrasound as the only modality was used in 92%. The normal appendix rate was 3.1%. In 41.2% an alternative diagnosis was confirmed. In 523 children an appendectomy was performed for acute appendicitis. Laparoscopy was used in 61% of the patients; conversion rate was 1.7%. A laparoscopic appendectomy was performed in 35.7% of the children under 6 years of age. Complicated appendicitis was diagnosed in 29.4% of children. Overall 30 day complication rate was 11.9% and similar after open and laparoscopic approach (OR 1.064; 95%CI 0.620-1.828 p=0.462). No difference was found in superficial surgical site infections (OR 3.192; 95%CI 0.790-12.91 p=0.087) nor in intra-abdominal abscesses (OR 0.987; 95%CI 0.468-2079 p=0.560) between the open and laparoscopic approach. In complicated appendicitis more superficial surgical site infections were found after open appendectomy (OR 1.030; 95%CI 0.170-6.242; P=0.020), but no difference in intra-abdominal abscesses (OR 1.051; 95%CI 0.454-2.434; P=0.535). Complicated appendicitis is an independent risk factor for infectious complications.

Conclusion

The laparoscopic approach is most frequently used, except for the very young children. Superficial surgical site infections are more frequent after open surgery only in patients with complicated appendicitis. The normal appendix rate is low, most likely because of routine preoperative imaging.

CHAPTER 4

Diagnosing acute appendicitis; surgery or imaging?

Appendicitis is traditionally considered a clinical diagnosis. In the Netherlands, preoperative imaging is now standard used in the diagnostic work-up for patients suspected with acute appendicitis. Although cross-sectional imaging has an excellent accuracy for diagnosing or excluding acute appendicitis, this modality is still not frequently used in many other countries for various reasons. The outcomes of the prospective cohort from the United Kingdom conducted by the National Surgical Research Collaborative were compared to the Dutch Snapshot Appendicitis Study. The most distinctive results are the difference in use of preoperative imaging (32.8% versus 99.5%) and the histological normal appendectomy rate (20.6% versus 3.2%) between the UK and Dutch cohorts. The correlation of preoperative imaging and the normal appendectomy rate are remarkable and further discussed in this article.

PART II: Complicated appendicitis

CHAPTER 5

Duration of antibiotic treatment after appendectomy for acute complicated appendicitis

Abstract

Background

Antibiotic treatment after appendectomy for complicated appendicitis aims to reduce postoperative infections. However, available data on the duration of treatment are limited. This study compared the difference in infectious complications between two protocols, involving either 3 or 5 days of postoperative antibiotic treatment.

Methods

This was an observational cohort study of all adult patients who had an appendectomy between January 2004 and December 2010 at either one of two hospitals in the same region. At location A, the protocol included 3 days of postoperative antibiotic treatment, whereas at location B it specified 5 days. The primary outcome was the development of postoperative infections as either superficial wound infection or deep intra-abdominal infections.

Results

A total of 1143 patients with acute appendicitis underwent appendectomy, of whom 267 (23.4 per cent) had complicated appendicitis. The duration of postoperative antibiotic treatment was 3 days in 135 patients (50.6 per cent) and at least 5 days in 123 (46.1 per cent). No difference was found between antibiotic treatment for 3 or 5 days in terms of developing an intra-abdominal abscess (odds ratio (OR) 1.77, 95 per cent confidence interval 0.68 to 4.58; $P = 0.242$) or a wound infection (OR 2.74, 0.54 to 13.80; $P = 0.223$). In patients with complicated appendicitis, the laparoscopic approach was identified as a risk factor for developing an intra-abdominal abscess in univariable analysis (OR 2.46, 1.00 to 6.04; $P = 0.049$), but was not confirmed as an independent risk factor for this complication in multivariable analysis (OR 2.32, 0.75 to 7.14; $P = 0.144$).

Conclusion

After appendectomy for complicated appendicitis, 3 days of antibiotic treatment is equally effective as 5 days in reducing postoperative infections.

CHAPTER 6

Antibiotic duration after laparoscopic appendectomy for acute complicated appendicitis

Abstract

Importance

Optimal duration of antibiotic treatment to reduce infectious complications after an appendectomy for acute complicated appendicitis remains unclear.

Objective

To investigate the effect of antibiotic length on infectious complications after laparoscopic appendectomy for acute complicated appendicitis.

Design, setting and participants

National multicenter prospective, observational, surgical resident-led cohort study conducted in June and July 2014. This study involved academic teaching hospitals ($n = 8$), community teaching hospitals ($n = 38$), and community nonteaching hospitals ($n = 16$), and all consecutive patients ($n = 1975$) who underwent surgery for suspected acute appendicitis.

Exposure

Patients treated laparoscopically for whom the antibiotic regimens were prolonged postoperatively because of complicated appendicitis.

Main Outcome and Measure

Receiving either 3 or 5 days of antibiotic treatment as planned and additional variables were explored as risk factors for infectious complications using regression analyses.

Results

A total of 1975 patients were included in 62 participating Dutch hospitals; 1901 (96.3%) of these underwent an appendectomy for acute appendicitis and laparoscopy was used in 74.4% of these patients (n = 1415). In 415 laparoscopically treated patients, antibiotic treatment was continued for more than 24 hours because of acute complicated appendicitis (29.3%). The prescribed antibiotic duration varied between 2 and 6 days in all of these patients. In 123 patients (29.6%), the length of treatment was adjusted. A shorter duration of antibiotic treatment (3 days instead of 5) had no significant effect on any infectious complication (odds ratio [OR], 0.93; 95% CI, 0.38-2.32; *P* = .88) or on intra-abdominal abscess development (OR, 0.89; 95% CI, 0.34-2.35; *P* = .81). Perforation of the appendix was the only independent risk factor for the development of an infectious complication (OR, 4.90; 95% CI, 1.41-17.06; *P* = .01) and intra-abdominal abscess (OR, 7.46; 95% CI, 1.65-33.66; *P* = .009) in multivariable regression analysis.

Conclusions and Relevance

Lengthening of postoperative antibiotic treatment to 5 days was not associated with a reduction in infectious complications. Further restriction of antibiotic treatment can be considered in nonperforated complicated appendicitis.

CHAPTER 7

Scoring system to distinguish uncomplicated from complicated acute appendicitis

Abstract

Background

Non-operative management may be an alternative for uncomplicated appendicitis, but preoperative distinction between uncomplicated and complicated disease is challenging. This study aimed to develop a scoring system based on clinical and imaging features to distinguish uncomplicated from complicated appendicitis.

Methods

Patients with suspected acute appendicitis based on clinical evaluation and imaging were selected from two prospective multicentre diagnostic accuracy studies (OPTIMA and OPTIMAP). Features associated with complicated appendicitis were included in multivariable logistic regression analyses. Separate models were developed for CT and ultrasound imaging, internally validated and transformed into scoring systems.

Results

A total of 395 patients with suspected acute appendicitis based on clinical evaluation and imaging were identified, of whom 110 (27.8 per cent) had complicated appendicitis, 239 (60.5 per cent) had uncomplicated appendicitis and 46 (11.6 per cent) had an alternative disease. CT was positive for appendicitis in 284 patients, and ultrasound imaging in 312. Based on clinical and CT features, a model was created including age, body temperature, duration of symptoms, white blood cell count, C-reactive protein level, and presence of extraluminal free air, periappendiceal fluid and appendicolith. A scoring system was constructed, with a maximum possible score of 22 points. Of the 284 patients, 150 had a score of 6 points or less, of whom eight (5.3 per cent) had complicated appendicitis, giving a negative predictive value (NPV) of 94.7 per cent. The model based on ultrasound imaging included the same predictors except for extraluminal free air. The ultrasound score (maximum 19 points) was calculated for 312 patients; 105 had a score of 5 or less, of whom three (2.9 per cent) had complicated appendicitis, giving a NPV of 97.1 per cent.

Conclusion

With use of novel scoring systems combining clinical and imaging features, 95 per cent of the patients deemed to have uncomplicated appendicitis were correctly identified as such. The score can aid in selection for non-operative management in clinical trials.

CHAPTER 8

Laparoscopic appendectomy for chronic right lower quadrant abdominal pain

Abstract

Purpose

The appendix can be a rare cause for chronic right lower quadrant abdominal pain (RLQAP), even though no objective disorder can be determined to the appendix. This condition can be described as chronic appendicitis or (neurogenic) appendicopathy. After careful selection, elective appendectomy is performed in our centre for this group of patients.

Methods

All patients that underwent an elective appendectomy between 2006 and 2013 were prospectively analyzed. Inclusion criteria were chronic RLQAP without abnormalities seen on imaging. Exclusion criteria were pain after conservative treatment of (complicated) appendicitis or an abnormal appendix on imaging like a mass, mucocele or faecolith. Primary outcome was the effect on the pain postoperatively.

Results

In the period of the study 10 patients met the inclusion criteria and underwent an appendectomy for chronic RLQAP. Average preoperative pain score assessed with visual analogue scale (VAS) was 8.6. Pre-operative work-up showed no abnormalities. No macroscopic abnormalities were seen during surgery in any of the patients. Histopathological analysis was obtained and showed limited abnormalities in 8 of 10 patients, mostly suspicion of previous inflammation. Postoperatively, no complications occurred and at revision after 3 weeks average VAS was 1.0. Long-term follow up showed that patients remained free of symptoms, average VAS after a median of 33 month was 1.0.

Conclusions

A significant reduction of pain was achieved after an appendectomy in all patients suffering from chronic RLQAP in this series. Seven out of ten patients were completely free of pain.

PART III: Appendix stump closure

CHAPTER 9

Endostapler or endoloops for securing the appendiceal stump in laparoscopic appendectomy

Abstract

Introduction

Laparoscopic appendectomy is the treatment of choice for appendicitis provided sufficient laparoscopic expertise is available. The endostapler possibly provides an easier and safer closure of the appendiceal stump, but at greater expense. This study aimed to compare two strategies for closure of the appendiceal stump in a large retrospective cohort of patients.

Methods

This study reviewed patients who underwent laparoscopic appendectomy for acute appendicitis in three academic hospitals and two regional hospitals in The Netherlands during the period 1 January 2007 to 30 June 2011. The endostapler was routinely used in two hospitals and selectively used in the remaining three hospitals. Both strategies were compared for complications according to the Clavien–Dindo classification.

Results

A total of 1,036 patients were analyzed according to the strategy followed. The 571 patients in the first group were routinely treated with the endostapler. For the 465 patients in the second group, the intentional method of stump closure was with endoloops. The endostapler was used when indicated for 69 of these patients. The patient characteristics did not differ between the two groups. The groups also did not differ significantly in number of intra- and postoperative complications. In both groups, 4.3 % of the patients had complications classified as grade 3 or higher. There were no significant differences in the prevalence of intraabdominal abscesses (3.2 % vs. 4.3) or wound infections (0.4 and 1.5 %). In a multivariate analysis, the chosen strategy for stump closure was not a significant predictor for postoperative complications.

Conclusion

Routine use of the endostapler showed no clinical advantages over the use of endoloops with selective endostapler closure. The latter strategy is preferable because it is more cost effective.

CHAPTER 10

Endoloops or endostapler use in laparoscopic appendectomy for acute uncomplicated and complicated appendicitis

Abstract

Background

The most appropriate closure for the appendicular stump with either endoloops or an endostapler in laparoscopic appendectomy remains unclear and under debate because of limited and conflicting evidence.

Methods

In a 2-month prospective, observational, resident-led nationwide cohort study, patients undergoing laparoscopic appendectomy for both uncomplicated and complicated appendicitis were analyzed. Logistic regression analyses were performed for identifying the possible effect of stump closure type and other risk factors for infectious complications.

Results

Laparoscopic appendectomy for acute appendicitis was performed in 1369 patients in 62 hospitals; endoloops were used in 76.7% and an endostapler in other patients. Median operating time was not different between endoloop and endostapler use (42.0 versus 44.0 minutes, $P=0.243$). A superficial surgical site infection was seen in 2.0% after uncomplicated appendicitis and in 0.8% after complicated appendicitis. The intra-abdominal abscess rate was 1.9% after uncomplicated and 11.0% after complicated appendicitis. No significant effect of stump closure type was observed for any

infectious complication (OR 0.95; 95% CI 0.566-1.600, P=0.853) or an intra-abdominal abscess (OR 1.04; 95% CI 0.566-1.913, P=0.899). In multivariable analysis complicated appendicitis was identified as the only independent risk factor for an infectious complication (OR 3.20; 95% CI 1.994-5.145, P<0.001).

Conclusions

The infectious complication rate is not influenced by the type of appendicular stump closure with either endoloops or an endostapler in this study. If technically feasible, closure with endoloops is advised for cost considerations.