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Preoperative C-reactive protein predicts the severity and likelihood of complications following appendicectomy

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ABSTRACT

INTRODUCTION Diagnostic laparoscopy with appendicectomy (LA) has become the accepted method of investigation and treatment of appendicitis. However, concerns remain in cases of complicated appendicitis when many advocate conversion to an open procedure (LCOA) owing to the risk of complications. The aim of this study was to look for factors that could predict complications occurring in patients undergoing appendicectomy.

METHODS Data inclusive of all consecutive appendicectomies over a two-year period were retrieved from the computerised theatre database. Clinical details including admission inflammatory markers, complications, severity (final pathology) and length of stay were collected from the discharge letter. Readmissions were identified as those hospital identifiers had a second set of admission dates and/or a second discharge letter.

RESULTS During the 2-year study period, 517 appendicectomies were performed. Of these, 429 patients (83%) had LA and the remaining 88 (17%) had LCOA. The LA group had a mean age of 28 years (range: 2–86 years) and a mean C-reactive protein (CRP) level of 71mg/l (range: 0–480mg/l) while the LCOA group had a mean age of 46 years (range: 11–92 years) and a mean CRP level of 162mg/l (range: 3–404mg/l). These differences in age and CRP were significant ($p<0.001$). LA patients were less likely to have complications overall (22% vs 52%, $p=0.015$). Complications were independently more than twice as common with established inflammation with a CRP level of >150mg/l ($p<0.05$).

CONCLUSIONS A high preoperative CRP level predicts an increased rate of postoperative complication due to established inflammation and/or infection. This raises the question of whether we should be offering primary open appendicectomies to patients with a CRP level of >150mg/l.

KEYWORDS

Appendicectomy – Complications – C-reactive protein – Pathology – Morbidity

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Appendicitis is a common surgical emergency.[1] Laparoscopy is our accepted method of diagnosis as no other test is 100% reliable; diagnosis often depends on the clinical skills of history taking and examination, and on inflammatory markers on routine testing.[2–7] Cross-sectional imaging with computed tomography (CT) may help in diagnostic dilemmas but this is expensive and involves a large radiation dose to a predominantly younger population, and it is not the routine method of diagnosis in the UK.[8–13] As with a number of other centres, our hospital actively uses laparoscopy to diagnose suspected appendicitis in cases with a high clinical index of suspicion for acute appendicitis[14] and laparoscopic appendicectomy is routine if the laparoscopy is positive. Conversion to an open procedure is dependent on the surgical findings but may occur if there is significant contamination, if the procedure is difficult (eg difficult retrocaecal appendix, appendicular abscess) or with unexpected complications.

Methods

All patients who underwent laparoscopy and appendicectomy were identified from the computerised theatre database in a busy teaching hospital (no primary open appendicectomies performed). Patients who underwent only a laparoscopy and those who proceeded directly to an exploratory laparotomy for what was, ultimately, appendicitis were excluded. Data regarding operation type (laparoscopic appendicectomy [LA] or laparoscopy converted to open appendicectomy [LCOA]), admission blood results, length of admission, complications, and pathology results including perforation and abscess formation were recorded.

Table 1 Complications following appendicectomy

	LA (*n*=429)	LCOA (*n*=88)
'Minor' complications		
Prolonged intravenous antibiotics delaying discharge (>48h)	56 (13.0%)	32 (36.4%)
Ileus	11 (2.5%)	5 (5.7%)
Pain	16 (3.7%)	0
Slow progress	7 (1.6%)	5 (5.7%)
Chest infection	3 (0.7%)	3 (3.4%)
Collection	10 (2.3%)	3 (3.4%)
'Major' complications		
Reoperation	4 (0.9%)	0
Readmission	16 (3.7%)	0
Percutaneous drain	3 (0.7%)	0

LA = laparoscopic appendicectomy; LCOA = laparoscopy converted to open appendicectomy

Readmissions were identified as a second set of admission dates and/or a second discharge letter was retrieved from the hospital computer system. Multivariate logistical regression analysis was performed using Stata® 12 (StataCorp, College Station, TX, US).

Results

A total of 517 diagnostic laparoscopies proceeding to appendicectomy were performed in the 2-year study period (1 October 2008 to 1 October 2010). The mean age was 32 years (range: 2–92 years) and there were 298 male patients (57%). Complete data were available for 503 patients (98%); 429 (83%) had LA and the remaining 88 (17%) had LCOA.

The LA group had a mean age of 28 years (range: 2–86 years), a mean white cell count (WCC) of 12.9 $\times$ 10^9/l (range: 2–32 $\times$ 10^9/l) and a mean C-reactive protein (CRP) level of 71mg/l (range: 0–484mg/l). The LCOA group had a mean age of 46 years (range: 11–92 years), a mean WCC of 13.9 $\times$ 10^9/l (range: 5.0–27.3 $\times$ 10^9/l) and a mean CRP level of 162mg/l (range: 3–404mg/l). The differences in age and CRP were statistically significant (p<0.001) but the difference in WCC was not.

Overall, 141 patients (27%) had a complication (Table 1). LA patients were less likely to have complications (22% vs 52%, p<0.015). The overall mean hospital stay from time of admission to discharge was 4.8 days. The mean length of stay was longer for the LCOA than for the LA groups at 7.4 days (range: 2–23 days) versus 4.3 days (range: 1–23 days) (p<0.001). Despite this, the complications for LCOA mainly related to prolonged intravenous antibiotics preventing discharge secondary to wound infection or post-procedural pyrexia whereas the LA group had a small but important incidence of major complications such as reoperation, percutaneous drain or unplanned readmission.

Of the 16 patients who were readmitted, abdominal pain was the most common cause (n=11). Other reasons included pyrexia (n=2), vomiting (n=1), deranged liver function test results (n=1) and back/leg pain (n=1). Most had imaging (CT or ultrasonography) and were treated with analgesia only but four required intravenous antibiotics. One patient had a laparotomy and limited right hemicolectomy owing to possible caecal perforation seen on CT. However, this was not found either surgically or pathologically.

The risk of complications was assessed independently for sex, age, perforation on pathology and preoperative WCC but this did not show any statistical changes. In contrast, preoperative CRP was strongly significant at over 150mg/l (Table 2).

Discussion

This study confirms the high prevalence of appendicitis requiring surgical intervention in all age groups and also the finding of many other studies that LA is superior to LCOA with regard to hospital stay and overall complications.[15–19] Nevertheless, complications differ between the groups. LCOA had immediate complications resulting in a prolonged admission whereas with LA, there were delayed as well as immediate complications.

It could be argued that only a small number of these complications could be classified as major (readmission, reoperation or percutaneous drain), with 7 patients (1.6%) requiring a percutaneous drain or reoperation and 16 (3.7%) requiring readmission. There were no readmissions, returns to theatre or percutaneous drains in the LCOA group. Despite readmission, the majority of patients simply received analgesia and imaging (either CT or ultrasonography) to ensure there was no active problem. Unfortunately, the low number of major complications (23/429 patients) was deemed insufficient for formal statistical analysis although it does show an interesting trend. Given the numbers analysed within a two-year period, it would be possible for this outcome criterion to be included in a future prospective study.

Complicated appendicitis (perforation/abscess) was not a statistically significant risk factor for complications. We believe the inflammatory response at time of operation does impact on the technical ease of the operation and, consequently, the likelihood of complications. Despite this, we accept that complications classified as major only happen in a small proportion of patients and the benefits of LA seen in other studies remain.[20–23] In our study, the surgeon (and the surgeon's experience) varied considerably from junior registrar to senior registrar and consultant. However, consultant cover was available 24 hours a day in the event of difficulties. It is our belief that LA represents a valuable laparoscopic training opportunity and complication rates are similar to those described in other studies even though surgeon skill is widely quoted as a determining factor.[15,20,24] It is noted that the patient with the highest CRP level (484mg/l) had a LA without any complications.

Table 2 Multivariate risk analysis of any complication controlled for other variables

Grouping	Variable	Odds ratio (range)	*p*-value
Sex	Male	1.000	0.416
	Female	0.834 (0.539–1.291)	
Age		1.006 (0.994–1.018)	0.304
Operation	Laparoscopic	1.000	**0.015**
	Open	2.084 (1.152–3.771)	
White cell count (x 10^9/l)	<11	1.000	
	11–14.9	0.822 (0.491–1.375)	0.455
	15–19.9	0.565 (0.309–1.034)	0.064
	20–24.9	0.873 (0.367–2.077)	0.758
	25+	2.660 (0.733–9.725)	0.137
C-reactive protein (mg/l)	<50	1.000	
	50–99.9	1.011 (0.535–1.912)	0.973
	100–149.9	1.099 (0.508–2.378)	0.811
	150–199.9	2.159 (1.004–4.639)	**0.049**
	200–249.9	5.646 (2.526–12.619)	**<0.001**
	250–299.9	3.400 (1.131–10.227)	**0.029**
	300–349.9	3.784 (1.295–11.062)	**0.015**
	350+	8.234 (1.398–48.517)	**0.020**
Perforation	No	1.000	
	Yes	1.327 (0.668–2.635)	0.419

What this study adds is that a significantly elevated CRP of >150mg/l is an independent variable for complications. Only two studies identify CRP as a marker for complications with appendicectomy.[24,25] CRP is one of the body's acute phase inflammatory markers.[26] A higher level of CRP is therefore suggestive of a more intense local inflammatory reaction and more severe appendicitis. We theorise that this is due to inflammatory and/or infective components (but not necessarily a perforated appendix or an abscess).

A study from 2013 corroborates our outcomes, showing that with a higher CRP, there is an increased conversion rate from LA to LCOA.[25] The paper stated that a preoperative CRP of >100mg/l is a statistically significant predictor of LCOA. In order to build on this concept, our study shows that not only does a high CRP make the procedure more challenging technically (resulting in a higher conversion rate) but it also increases the chance of complications arising in the LA group.

Conclusions

Laparoscopic appendicectomy is a safe procedure with a clear benefit. On the other hand, when CRP is over 150mg/l, there is established inflammation, making the operation more challenging technically and predisposing to a higher rate of complications. This raises the question of whether we should be offering primary open appendicectomies as well as whether we should lower our threshold of converting to an open procedure in patients with a high level of CRP. At present, there is not enough information to draw statistically significant conclusions. However, we would currently recommend a lower threshold for converting to an open procedure as we had no major complications in the LCOA group. We also feel that a follow-up study must be conducted to assess the benefit of primary open appendicectomy.

We performed a literature search for open appendicectomy versus laparoscopic converted to open appendicectomy but there does not appear to be a direct comparison between the two. We aim to compare our data with a trust that performs primary open appendicectomies. This may give more focused information on predicting patients who would be likely to be converted to an open procedure and enable assessment of the risk–benefit profile of offering them a primary open appendicectomy.

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