Delay To Surgery In Acute Appendicitis: Contributing Factors And Associated Morbidity

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Citation

J Wilson, R Skourat, L Lai, E Babu, C Kelley. *Delay To Surgery In Acute Appendicitis: Contributing Factors And Associated Morbidity*. The Internet Journal of Surgery. 2006 Volume 13 Number 1.

Abstract

Introduction:
We undertook a retrospective study to investigate factors associated with increased time delay to surgery in acute appendicitis and the impact of delays on post-operative morbidity and length of hospital stay in a district general hospital.

Patients and Methods:
Patients admitted with the diagnosis of acute appendicitis during a 12 month period were identified from hospital records. Clinico-pathological data collated included patient age at the time of admission (years), gender, time delay to surgery following surgeons' decision to operate (hours), the use of pre-operative imaging (ultrasound and CT), the duration of antibiotic use and total length of hospital stay (days), and post-operative complications.

Results:
One hundred and ninty-three patients were included for data analysis comprised 58 children (mean age 12.6±0.3 [SEM] yrs), 78 adult males (mean 35.0±1.8yrs), and 57 adult females (mean 34.5±1.9yrs). The overall rate of negative appendicectomy was 26.4%. Twenty-nine patients (15%) developed post-operative complications. Increasing patient age (p=0.001), time delay to surgery (figure 2; p=0.001), and use of pre-operative imaging (figure 3; p=0.033) were each significantly associated with an increase in complication rate. Patients with complications subsequently required significantly longer use of post-operative antibiotics and total hospital stay (p<0.001). There was a significant correlation between patient gender and time delay to surgery (p=0.009), with females waiting significantly longer than males (p=0.011). The use of pre-operative imaging (64% females) was associated with an increase time delay to surgery (p<0.001). Pre-operative imaging had no impact on reducing the rate of negative appendicectomy. Patients who received pre-operative imaging were significantly more likely to develop post-operative complications.
Patients seen by a surgeon during normal daylight working hours (0800-1600hrs) benefited from the designated afternoon CEPOD emergency operating list with reduced time delays to surgery, whilst those patients seen during the hours approaching the CEPOD watershed of 2200hrs waited the longest for their surgery (mean 24.7±4.2hrs).

Discussion and Conclusion:
Patients who waited longer for surgery had a significantly higher post-operative complication rate, greater use of antibiotics, and longer stay in hospital. The use of pre-operative imaging (more common in females) and local CEPOD policies were significant contributing factors to these delays.

INTRODUCTION

Appendicitis is the most common abdominal emergency accounting for over 40,000 hospital admissions in England every year (1) and is most common between the ages of 10-20 years, although no age group is exempt (2). Whilst the diagnosis of this condition is primarily a clinical one, ultrasound and computed tomography can be helpful in clinically equivocal patients (3,4,5,6). Appendicectomy is a relatively safe procedure with a mortality rate for non-perforated appendicitis of 0.8 per 1000 (7). However, morbidity and mortality increase significantly with perforation, with a 6-fold increase in mortality rates thereafter (7). The mean perforation rate 36 hours after the onset of symptoms is between 16-36%, and increases by 5% for every subsequent 12 hour delay to surgery (4,5,6).

Historically, the majority of appendicectomies are performed by junior surgeons. The 'Report of the Confidential Enquiry into Perioperative Deaths' (CEPOD) highlighted the potential dangers of night-time operations being performed by tired and inexperienced junior staff ($_8$), and recommended that only 'life or limb' threatening conditions be operated on at night, with all other procedures scheduled for dedicated daytime 'CEPOD' emergency operating lists the following day under increased levels of consultant supervision. As a result, patients with appendicitis who display only mild to moderate signs at presentation are often not considered suitable for surgery between the hours of 2200 and 0800 hrs, and routinely wait until the following day. In our district general hospital, the designated CEPOD list for general surgical emergencies is in the afternoon, therefore, patients often experience unacceptable delays to surgery.

The aim of this retrospective study was firstly to investigate the effect of CEPOD guidelines on delay to appendicectomy, and secondly, to investigate the impact of increased time delay to surgery on post-operative morbidity and length of hospital stay in a district general hospital.

PATIENTS AND METHODS

Patients admitted with the diagnosis of acute appendicitis during a 12 month period (1/2/04-1/2/05) were identified from hospital electronic records. Clinico-pathological data were recorded for each patient following case notes and theatre log book review. Information collated included patient age at the time of admission (years), gender, time delay to surgery following surgeons' decision to operate (hours), the use of pre-operative radiological imaging (ultrasound and CT), the duration of antibiotic use and total length of hospital stay (days), and post-operative complications. Statistical analysis was performed using SPSS for Windows (version 11.0). For data following a normal distribution, the Independent-samples T-test was used to compare means between 2 groups, while ANOVA One-way analysis of variance was used for comparison between more than 2 groups. For non-parametric data, Mann-Whitney U test was used to compare means between 2 groups, and Kruskal-Wallis One-way analysis of variance was used for more than 2 groups. Correlations between variables were explored and quoted as Pearson's correlation coefficient (parametric data) and Spearman's rho (non-parametric). The level of significance $p \leq 0.05$ was assumed.

RESULTS

A total of 236 patients were identified as having undergone open appendicectomy over the 12 month period from hospital electronic records. Case notes were available in only 198 of these cases, and a further 5 'interval appendicectomies' were excluded, leaving a total of 193 cases for data collection and analysis. This cohort comprised 58 children (≤ 16 yrs; age range 7-16 yrs; mean age 12.6 0.3 [SEM] yrs), 78 adult males (age range 17-84 yrs; mean 35.0 1.8yrs), and 57 adult females (age range 17-81yrs; mean 34.5 1.9yrs). The overall rate of negative appendicectomy was 26.4% (n=51) which is consistent with other studies in the literature ($_7$). Data for these 3 patient groups are tabulated in table 1.

Clinicopathological data collated for all patients (n=193) included patient age at the time of admission (years; mean SEM), gender, the use of pre-operative radiological imaging (ultrasound : CT ratios), time delay to surgery following surgical consultation (hours; mean SEM), post-operative complications and the duration of post-operative antibiotic use and total length of hospital stay (days; mean SEM), and post-operative complications. Two adults required prolonged hospital stays (25 days) following laparotomy for advanced appendicitis. Statistically significant differences between patient groups appear in bold print (pre-operative imaging and time delay to surgery; p=0.001).

Figure 1

Table 1: Patient clinicopathological data

Clinicopathological parameter	Children (≤16yrs) (n=58; 34M:24F)	Adult males (n=78)	Adult females (n=57)
Age (mean±SEM)	12.6±0.3 yrs (range 7-16)	35.0±1.8 yrs (range 17-84)	34.5±1.9 yrs (range 17-81)
Pre-operative imaging	**n=7 (12.1%; all u/s; 6F:1M)**	**n=15 (19.2%; 9 u/s:6 CT)**	**n=23 (40.4%; 22 u/s:1 CT)**
Time delay to surgery (mean±SEM)	**13.5±1.8 hrs (range 0.7-71.8)**	**20.9±2.3 hrs (range 1.8-130.5)**	**36.6±7.5 hrs (range 1.0-125)**
Grade of appendicitis (Normal;acutely inflamed;advanced)	27.6%; 53.4%; 19%	16.7%; 59%; 24.4%	40.4%; 43.9%; 14%
Complications	n=4 (6.9%)	n=16 (20.5%)	n=9 (15.8%)
Post-operative antibiotic use (mean±SEM)	1.4±0.2 days (range 0-6)	2.9±0.2 days (range 0-10)	1.7±0.2 days (range 0-7)
Length of hospital stay (mean±SEM)	3.1±0.2 days (range 1-12)	4.7±0.6 days (range 1-25)	4.5±0.5 days (range 1-25)

The most striking differences between groups were in the time delay to surgery (p=0.001), and the use of pre-operative imaging (p=0.001), with adult females obtaining significantly higher values in each of these variables than either adult males or children. The length of hospital stay (mean number of days) for each patient group is also tabulated (table 1). Of note, 2 patients stayed in hospital for 25 days, which was significantly longer than average. The first patient (a 31-year-old male) developed post-operative small bowel obstruction following the removal of a gangrenous appendix, which settled with conservative management. The second patient (a 58-year-old female) experienced prolonged ileus following laparotomy for perforated appendicitis. This was also managed successfully conservatively.

Figure 2

Table 2: Post-operative complications

Complication	Frequency
Chest infection	8
Wound infection	3
Prolonged ileus	3
Excessive abdominal pain	3
Peritonitis	2
Pelvic abscess	2
Ventilatory support HDU/ITU	2
Small bowel obstruction	1
Wound dehiscence	1
Urinary tract infection	1
Gastroenteritis	1
Stitch granuloma	1
Deranged liver function	1

The individual post-operative complications are described above (n=29; 15% complication rate).

Figure 3

Table 3: Comparison of clinicopathological parameters in patients with and without post-operative complication

Clinico-pathological parameter	No complications (n=164)	Complications (n=29)	P value
Age (mean±SEM)	25.9±1.1 yrs	40.5±4.1 yrs	<0.001
Gender	Male (n=94; 57.3%) Female (n=70; 42.7%)	Male (n=18; 62.1%) Female (n=11; 37.9%)	0.634
Pre-operative imaging	No (n=130; 79.3%) Yes (n=34; 20.7%)	No (n=17; 58.6%) Yes (n=11; 37.9%)	0.033
Time delay to surgery (mean±SEM)	19.8±1.6 hrs	43.2±13.9 hrs	0.001
Grade of appendicitis (Normal;acutely inflammed;advanced)	Normal (n=46; 28%) Acutely inflamed (n=85; 51.8%) Advanced (n=32; 19.5%)	Normal (n=6; 20.7%) Acutely inflamed (n=17; 58.6%) Advanced (n=6; 20.7%)	0.698
Post-operative antibiotic use (mean±SEM)	1.7±0.1 days	4.3±0.4 days	<0.001
Length of hospital stay (mean±SEM)	3.3±0.1 days	9.2±0.4 days	<0.001

Univariate analysis demonstrated that increasing patient age (p=0.001), time delay to surgery (p=0.001), and use of pre-operative imaging (p=0.033) were each significantly associated with an increase in complication rate (bold print).

Overall, a total of 29 patients (15%) developed post-operative complications, which are described in table 2. Univariate analysis (table 3) demonstrated that increasing patient age (figure 1; p=0.001), time delay to surgery (figure 2; p=0.001), and use of pre-operative imaging (figure 3; p=0.033) were each significantly associated with an increase in complication rate. Patients with complications subsequently required significantly longer use of post-operative antibiotics and total hospital stay (p<0.001). There were no statistically significant differences in gender or grade of appendicitis between those with or without post-operative complications (table 3).

Figure 4

Figure 1: Increasing patient age is associated with increased time delays to surgery

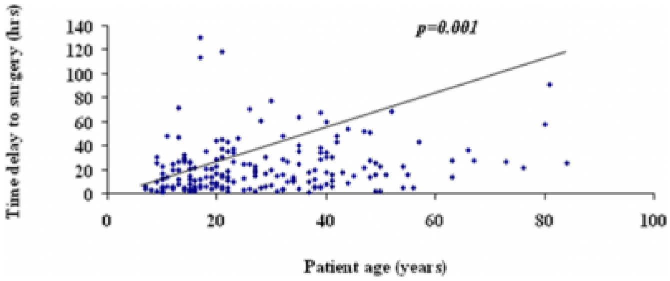


Figure 5

Figure 2: Delay to appendicectomy is associated with a significant increase in post-operative complication rate

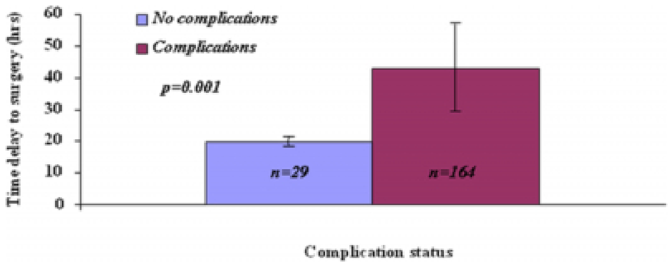
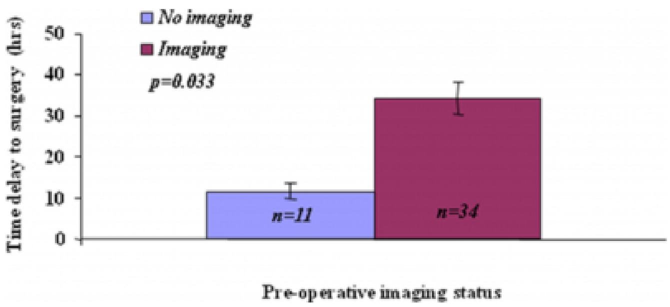


Figure 6

Figure 3: Patients who underwent pre-operative imaging waited significantly longer for surgery



There was a significant correlation between patient gender and time delay to surgery (Spearman's rho = 0.186; p=0.009), with females waiting significantly longer (30.9 5.5[SEM]hrs) than males (18.2 1.7hrs; p=0.011). In addition, there was a significant correlation between increasing patient age and time delay to surgery (figure 2; Spearman's rho = 0.301; p<0.001). The use of pre-operative imaging (n=45: 29 females [64%]; 16 males [36%]) was associated with an increase time delay to surgery (Spearman's rho =0.385; p<0.001) with a mean delay of 37.0 4.3hrs in the 'imaging' group compared with 19.1 3.0hrs in the 'no imaging' group (Figure 3; p=0.003). Although females were more likely to receive pre-operative imaging than men (64% of all imaging;

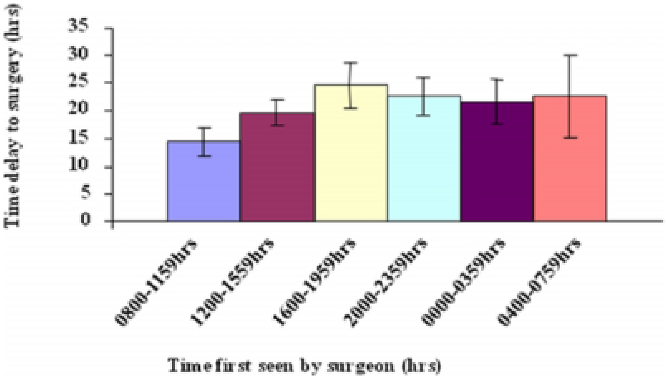
p=0.001), this patient group actually had a higher rate of negative appendicectomy (40.4%; table 1) compared with adult males (16.7%) and children (27.6%). Overall, pre-operative imaging had no impact on reducing the rate of negative appendicectomy (23.8% in the ‘no imaging' group; 35.6% in the ‘imaging' group).

Patients who received pre-operative imaging were also significantly more likely to develop post-operative complications (table 3). Out of the 38 cases of histologically advanced (gangrenous perforation) appendicitis, 44.7% of cases had undergone surgery within 8 hours of surgical review with only 1 patient undergoing pre-operative imaging. However, the majority of this cohort (55.2%) waited 8 hours for appendicectomy with 23.8% receiving pre-operative imaging (n=5; 2M:3F).

Patients seen by a surgeon during normal daylight working hours (0800-1600hrs) benefited from the designated afternoon CEPOD emergency operating list with reduced time delays to surgery, whilst those patients seen during the hours approaching the CEPOD watershed of 2200hrs waited the longest for their surgery (mean 24.7 4.2hrs), although this difference did not reach statistical significance (figure 4).

Figure 7

Figure 4: Time delay to surgery varied according to time first seen by surgeon



DISCUSSION AND CONCLUSION

In summary, patients who waited longer for surgery had a significantly higher post-operative complication rate, greater use of antibiotics, and longer stay in hospital. The use of pre-operative imaging (more common in females) and local CEPOD policies were significant contributing factors to these delays.

Pre-operative imaging resulted in significant delays to surgery and had no impact on reducing the rate of negative appendicectomy, especially in women. Although adult females were more likely to receive pre-operative imaging, they actually had a higher rate of negative appendicectomy (40.4%) than adult males (16.7%) or children (27.6%), although this did not reach statistical significance. This finding is consistent with a recent longitudinal study which suggested that implementation of ultrasound and CT did not improve diagnostic accuracy, with no change in the rate of negative appendicectomy ([9]). Ultrasound was the most commonly used modality in our study (84.4%) and was demonstrated to have a sensitivity of only 31.8%, much lower than figures quoted in the literature ([9,10, 11,12]). Ultrasonographers in our study included Consultant Radiologists, Associate Specialists, Specialist Registrars of variable experience, and Radiographers. Undoubtedly, ultrasound should continue to play an important role as a non-invasive, non-radioactive, investigation in clinically equivocal patients, and in the exclusion of gynaecological causes of right iliac fossa pain in females of reproductive years ([13]). However, its successful implementation demands rapid access (including out-of-hours imaging) to avoid delays, and a more consistent standard from experienced technicians. A dedicated daily 0900 hr pelvic u/s slot (including weekends) for acute surgical patients would considerably reduce imaging-associated delays to surgery. CT, with its much higher sensitivity, remains a useful adjunct in patients, especially males, in whom the clinical diagnosis remains in doubt. In addition, there is scope for expansion in the use of diagnostic laparoscopy in this group of patients which carries with it the obvious advantage of definitive diagnosis and intervention, as well as reduced post-operative morbidity and hospital stay compared with open surgery ([14, 15]).

The experiences described in the literature suggest a mixed success in the implementation of CEPOD recommendations. Some authors report little change in the level of seniority of the principal surgeon with junior surgeons still performing the majority of the workload ([16]), while others describe innovative consultant-led emergency services which maximise daytime consultant operating without conflict with other programmed activities or loss of elective activity ([17, 18]). What seems clear is that for recommendations to be successful, significant restructuring is required at a local level with the appropriate increase in resources made available ([17]). In our hospital, designated CEPOD theatre time for general surgical emergencies runs between 1400-1700 hours. As demonstrated, this contributed to unacceptable delays for patients admitted the previous evening for reasons discussed below. Patients admitted during daylight hours up to approximately 1600 hrs benefited from that day's afternoon CEPOD list. However, the majority of patients do not undergo senior review until after this time point. Thereafter, sequential factors contributing to unacceptable delays to surgery for these patients include (i) absence of emergency theatre staff, whilst covering elective list over-runs (often >1800 hrs), (ii) evening shift change-over for both anaesthetic and surgical teams (2000-2100 hrs), (iii) the 2200 hr CEPOD ‘watershed', (iv) absence of a morning CEPOD list for general surgical emergencies, which is an obvious potential solution in need of debate locally. Furthermore, there may be an argument for re-evaluation of CEPOD recommendations for night time operating in conditions such as appendicitis, in light of European Working Time Directive (EWTD) and Royal College re-structuring of both surgical and anaesthetic training, which have led to the widespread implementation of shift work, thereby negating several of the original NCEPOD concerns ([19]).

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