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Research Article

On the Road Again: Paediatric Appendicectomy Outcomes at a Regional Referral Hospital

Christopher Shean*, Jared Chang

Orange Health Service, Orange, NSW, Australia

***Corresponding author:** Christopher Shean, Orange Health Service, Orange, NSW

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Abstract

Objective: To analyse paediatric appendicectomy at a regional referral hospital to ascertain whether more remote residence is associated with increased negative appendicectomy rate (NAR) or complicated appendicitis.

Methods: Retrospective analysis of electronic medical records.

Design: Retrospective case series.

Setting: Orange Health Service, Orange, NSW.

Participants: 248 paediatric patients who underwent appendicectomy during a five-year period between 2014 and 2019.

Main outcome measures: NAR and rate of complicated appendicitis according to distance of residence from the regional referral hospital.

Results: The overall NAR was 22.2%, with a significant reduction in NAR found in patients with an ultrasound diagnosis of appendicitis ($p=0.018$), or with a raised white cell count ($p<0.001$). Both rate of complicated appendicitis and the NAR was not increased in patients from increasingly remote residence. Appendicectomy was completed laparoscopically in 96.8% of patients, with rates of post-operative ileus, wound infection, and total re-admission lower than in data from the most recent overall NSW literature.

Conclusions: More remote residence from the regional referral hospital was not associated with increased rate of complicated appendicitis or higher NAR in patients treated at OHS. A higher proportion of cases were undertaken laparoscopically at OHS compared to the rate identified in the most recent literature, with superior post-operative outcomes for post-operative ileus, wound infection, and re-admission rate.

Keywords: Complicated appendicitis; Laparoscopic rate; Negative appendicectomy; Rural surgery; Surgical complications

Introduction

Paediatric acute appendicitis often presents differently to the classical migratory umbilical to right iliac fossa pain [1]; this along with difficult history and examination can make diagnosis challenging. An Australian Negative Appendix Rate (NAR) has been identified at 24% [2], with positive appendicectomy including histopathology proven appendicitis, presence of faecolith, vermicularis infection, appendiceal tumours, and endometriosis. NAR in other countries ranges from 15 to 35% [3]. Rural healthcare is complicated by patients residing long distances from hospitals, requiring many hours of travel to access care. Rates of perforation and complicated appendicitis in paediatric patients increase as time from onset of symptoms to hospital presentation increases [4]. The differential diagnosis of abdominal pain in the paediatric population is broad as benign causes are the most prevalent [5], but with sinister pathology that cannot be missed. Significant clinical acumen is required to decide on operative

intervention as no single diagnostic test can completely confirm or rule out appendicitis [6]. Despite advances in the investigations for appendicitis, an accepted negative appendix rate still exists, where the patients' abdominal pain may have been caused by an alternative pathology. Issues that have been implicated in the causation of appendicitis include western diet [7], appendiceal lumen obstruction by faecolith impaction, lymphoid hyperplasia, and parasite infestation [8]. Complicated appendicitis is defined as perforation, abscess formation or peritonitis [9], and is associated with higher morbidity.

Two hypotheses are presented - firstly, that patients from more remote residence may have decreased conservative management as they cannot easily re-present, therefore possibly leading to a lower threshold for operative management and subsequently a higher NAR; and secondly, patients from more remote residence may have higher rates of complicated appendicitis due the increased time from symptom onset to presentation caused by remote residence.

Methods

Ethics approval was granted under reference 2019/ETH13059 by the Greater Western Human Research Ethics Committee within Western New South Wales Local Health District. Retrospective analysis of electronic medical records was undertaken for all paediatric appendicectomy procedures completed in a five-year period from 2014 to 2019 at Orange Health Service (OHS) in Orange, NSW, Australia. All patients under the age of 16 were included in analysis. Only procedures where the primary diagnostic concern was acute appendicitis were included in this study, with procedures completed for other causes excluded from analysis.

Each individual medical record was reviewed for pre-operative investigations including imaging and pathology, distance of patient residence from OHS, the operation report, as well as records of complications of the procedure and re-admission following discharge. No differentiation between procedures booked as an appendicectomy, and those booked as a diagnostic procedure where the appendix was removed was made in this analysis.

Results

A total of 248 paediatric appendicectomy procedures occurred in the five-year period. Median age was 11 (range 2 to 15 years of age). Most patients were male (152 patients, 61.3% of cohort). Under half resided in Orange, the town where the regional hospital is located (111 patients, 44.8% of cohort). The median distance of residence from OHS was 45 kilometres. For patients that did not live in a postcode in the town of the referral hospital the median distance of residence was 97 kilometres. 55 patients (22.1% of cohort) were located more than 100 kilometres from OHS, with a similar proportion (53 patients, 21.4% of cohort) from between 50 and 99 kilometres away. 114 patients (46%) had an ultrasound, with a radiological diagnosis of appendicitis in 73.7% (84 of 114 patients). Patients from increasingly remote residence did not have an increased prevalence of ultrasound scans. 72.6% of patients (180 patients) had a raised white cell count. Most patients had a laparoscopic appendicectomy (96.8% of patients), with eight patients (3.2%) having an open procedure. The NAR for the overall cohort was 30.5% based on histopathology alone, and 22.2% when vermicularis and faecolith were included as positive appendicectomies (see table 1). Patients were significantly less likely to have a negative appendicectomy with an ultrasound result indicating a radiological diagnosis of appendicitis ($p=0.018$), or with a raised white cell count ($p<0.001$). NAR was not increased in patients residing at over 50 or 100 kilometres from the health service. NAR was increased in female sex at 45.7% ($p<0.001$) (see table 2).

Median length of stay was 24 hours (interquartile range of 6 to 144 hours). Thirty patients (12.1% of cohort) were found to have complicated appendicitis. Increased rate of complicated appendicitis was not found for patients from more remote residence. Two patients (0.8% of cohort) with complicated appendicitis had a return to the operating theatre within their index admission. Four patients had post-operative ileus (1.6% of cohort) during their initial admission. Ten patients (4.0% of cohort) had records of re-admission to hospital. Four of these patients had a return to the operating theatre (1.6% of cohort) during their subsequent admission, three for intra-abdominal washout, and one for a superficial port site infection washout. Post-operative ileus, wound infection and re-admission rates were all lower than the most recent published NSW data [10] (see table 3).

Distance of residence from hospital	NAR % (includes faecolith, vermicularis)	NAR % (histopathology alone)	Complicated appendicitis (percentage of cohort)
<50 kilometres	25.6%	31.2%	13.2%
50-99 kilometres	24.6%	24.5%	12.3%
>100 kilometres	17.7%	34.5%	8.1%
Overall	22.2%	30.5%	12.1%

Table 1: Rate of NAR and complicated appendicitis according to distance of residence from regional hospital.

	NAR % (by histopathology alone)
Investigation	
Abdominal ultrasound – radiological diagnosis of appendicitis	26.3% (p=0.018)
Raised white cell count	15.6% (p<0.001)
Sex	
Male	21.1%
Female	45.7% (p<0.001)

Table 2: NAR for sub-groups by pre-operative investigation and sex.

Complication	Percentage of cohort (number of patients)
Index admission	
Post-operative ileus	1.6% (4)
Intra-abdominal abscess	1.2% (3)
Return to operating theatre	0.8% (2)
Wound infection	0% (0)
Re-admission	
Intra-abdominal abscess	1.2% (3)
Re-admission	4.0% (10)
Return to operating theatre	1.6% (4)
Wound infection	0.4% (1)
Overall	
Total return to operating theatre	2.4% (6)

Table 3: Table showing rates of post-operative complications.

Discussion

Although long distances from definitive care can complicate healthcare in rural and remote Australia, increased NAR and complicated appendicitis were not found in patients from more remote residence from OHS. The classical understanding of the natural history of appendicitis suggests that longer time between onset of symptoms and presentation leads to higher rates of perforation. Studies now suggest that many patients have a more benign process with slow or no progression to perforation [11]. The long duration of travel from more remote residence leading to a longer period between symptom onset and presentation to hospital may have less of an impact than initially thought. The dogmatic teaching that progression to perforation occurs with delay in treatment[4] may need to be reconsidered, as we have shown no increase in complicated appendicitis for the group of patients from more remote residence. This finding has implications for rural surgical care in Australia. Patients that are from long distances from surgical services, who do not have higher rates of NAR or complicated appendicitis in this analysis, may therefore be initially managed within peripheral hospitals with intravenous antibiotics, with transfer to definitive care at the referral hospital not having to occur in an emergent manner. This new evidence will allow for more rational utilisation of rural healthcare resources, including the most optimal and cost-efficient timing and method of transfer. The conservative treatment of appendicitis is an ongoing area of research [12], and surgical practice is likely to require ongoing evolution with this changing evidence. Although low rates of post-operative complications occurred within this cohort at OHS, if many of these patients would not progress to complicated appendicitis, even low rates of complications may not be tolerable in the future if there is evidence to suggest conservative management is just as appropriate.

An Australian NAR has been identified as 24% [2], with positive appendicectomy defined as including faecolith, vermicularis, as well as histopathology proven appendicitis. To draw an accurate comparison an NAR that included these pathologies was calculated as 22.2% in this cohort, which is in-line with prior Australian evidence, giving further support for the equivalent management of paediatric appendicitis in rural healthcare settings. Patients with an ultrasound indicating a radiological diagnosis of appendicitis and raised inflammatory markers had a statistically significant decreased NAR. This provides further support for these investigations to continue to be included in the routine investigation of abdominal pain in children. In addition to this, patients from increasingly remote locations did not have an increased NAR, indicating that patient access to these pre-operative investigations that have become key in diagnosis of acute appendicitis is imperative in rural healthcare. The rate of post-operative ileus, wound infection, and total re-admission were lower for patients who had an appendicectomy at OHS compared to other regional hospitals in the most recent NSW literature[11].

Appendicectomy remains the standard of care in paediatric acute appendicitis. 96.8% of appendicectomies were completed laparoscopically at OHS. The most recently published NSW data showed 90% of cases in metropolitan and 61% of cases in regional hospitals were completed laparoscopically[11]. The high rate of laparoscopic cases, along with lower levels of post-operative complications and re-admission in comparison to the most recently published NSW data, provides strong support for the significant uptake, safety and efficacy of new technologies such as the rollout of laparoscopic surgery within regional and rural healthcare.

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