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Streptococcus anginosus is associated with postoperative intraabdominal collections in appendicitis☆

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ABSTRACT

Aim of study: Streptococcus anginosus group (SA) (formerly *Streptococcus milleri*) are pathogens recognised to have a high risk of postoperative collection in appendicitis, although little data exist specifically in children. We performed a retrospective review of all microbiological data from appendicectomies to assess whether there was an association in children.

Methods: A retrospective case note review of patients admitted to a paediatric tertiary centre coded for appendicitis from January 2015 to October 2016 was completed. Initial length of stay (LOS), cumulative hospital days, histology, microbiology, and radiology reports were recorded. The postoperative antibiotic regimen was based on surgeon's choice and not standardised.

Main results: 231 children were identified, and 18 were excluded. In the remainder, 169 (78.9%) had positive microbiology cultures, and of these 45 were positive for SA (26.6%). There was no significant variation in monthly incidence ($P = 0.58$). Patients with SA + ve cultures were associated with complicated appendicitis on histology ($P = 0.01$), longer LOS and cumulative hospital days ($P = 0.001$), and increased likelihood of developing postoperative collections ($P = 0.001$). The relative risk of developing a postoperative collection with SA + ve cultures was 2.40. There was no difference in time to presentation, histology, or intervention between SA and non-SA patients who developed collections. All SA cultures were sensitive to penicillin and erythromycin.

Conclusion: SA cultured from intraoperative serial swabs is associated with an increased risk of developing postoperative collection (2.40). Using this information with standardisation of antimicrobial management may reduce the rate of postoperative complications in paediatric appendicitis.

Level of evidence: Level II prognosis study.

Acute appendicitis is very common in children with around 12,000 emergency appendicectomies performed in children less than the age of 18 in England each year [1]. The value of intraoperative microbiology specimens has been controversial, not least owing to the low sensitivity with peritoneal swabs [2,3], though the ability to predict postoperative intraabdominal collections would be clinically useful.

We have previously [5] compared the value of appendix serosal swabs, peritoneal swabs and rectal swabs in isolating culprit microorganisms in appendicitis, finding that the highest rate of positive cultures occurred from appendix serosal swabs. It has since become departmental practice to collect intraoperative microbiological swabs from the appendix serosa of every patient undergoing an appendicectomy, immediately following surgical excision.

Isolation of *Streptococcus anginosus* (SA) has a recognised association with an increased risk of intraabdominal collection postappendicitis, though there has been a paucity of real data to support this in children. The purpose of this study was to establish using a now standardised microbiological protocol whether this observation could be established in a paediatric population.

1. Methods

Retrospective case-note review was conducted for all children coded for "appendicitis", or its synonyms, admitted to our institution between January 2015 and October 2016. Data were collected from review of each patient's discharge summary, microbiology, histology and radiology reports. Data were identified on the length of stay (LOS), cumulative number of hospital days, 30 day readmission rate, intraoperative findings (including histopathology and microbiology swabs of the appendix) and postoperative collections. Children who did not have an appendicectomy at our centre or underwent an interval appendicectomy were excluded from our series.

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Table 1
Microbiology cultures isolated from initial appendix serosal swabs and postoperative collection pus swabs.

Total number of Appendicectomies	Culture result (n, %)						
	Streptococcus anginosus (SA)	*Escherichia coli*	Mixed anaerobes	Pseudomonas aeruginosum	Other	No growth	Not available (NA)
213	n = 45 (21.1%)	n = 60 (28.2%)	n = 18 (8.5%)	n = 6 (2.8%)	n = 6[a] (2.8%)	n = 34 (16.0%)	n = 44 (21.0%)

[a] *Klebsiella pneumoniae* (n = 2), *Coagulase negative Staphylococcus* (n = 2), *Bacteroides fragiles* (n = 2).

Appendix histopathology was classified as follows: acute appendicitis, complicated appendicitis (gangrenous or perforated) or noninflamed/normal appendix. Standard practice in our department has been to take a serosal microbiology swab of the appendix on removal. The isolated pathogens, extent of their growth and antibiotic sensitivities were collected. Postoperative antibiotic regime was not formally recorded and was based on surgeon's choice.

Initial length of stay (LOS) was defined as the number of days a patient was admitted for their original presentation of appendicitis. Number of cumulative hospital days was calculated for those patients who required readmission for management of postoperative complications.

Postoperative imaging reports were reviewed to confirm and date the presence of collections. Management of these radiologically confirmed collections was classified according to the furthest extent of their treatment: either oral antibiotics alone, intravenous (IV) antibiotics, ultrasound guided drainage or surgical intervention. In those patients requiring drainage or surgery, further pus swabs were collected with cultures and sensitivities also being reported. These pus swabs cultures were collated with appendix serosal swab cultures to provide better understanding of the microorganism(s) responsible.

Statistical analysis for the data was carried out using Microsoft Excel 2013 and software Statplus (2015 Analystsoft Inc.). The Student *t*-test was used to compare the differences between age, LOS and cumulative hospital days of patients in the SA and non-SA groups. Fisher's exact test was used to compare histopathology, collection incidence and extent of intervention between the SA and non-SA groups. Mann–Whitney U test was used to compare the difference in number of postoperative days collections were confirmed between the SA and non-SA groups. Chi-square goodness-of-fit test was used to compare the incidence of SA over the study period. $P < 0.05$ was deemed significant.

2. Results

Between 1st January 2015 and 31st October 2016, 231 children were discharged with the diagnosis of 'appendicitis'. Eighteen patients were excluded: twelve were treated conservatively with IV antibiotics, three presented with non-specific abdominal pain, two had an interval appendicectomy and one patient had their primary operation at a peripheral centre, leaving 213 to be included in this study.

Mean age at presentation was 9.2 (1.5–16.6) years. An appendix serosal swab was not documented in 47/213 leaving 166 children for analysis. Of these, 41 (24.7%) cultured SA, 90 (54.2%) swabs cultured other microorganisms and 35 (21.1%) swabs revealed no growth. Overall 78.9% of serosal swabs had positive culture results.

A further set of cultures was obtained in those children who developed postoperative collections and were managed with radiological drainage or surgical intervention. So, four more children were identified with SA cultures whose initial appendix serosal swab had either not been done (n = 1) or initially isolated a different microorganism: *E. coli* (n = 2) or *Mixed coliforms* (n = 1). *E. coli* was also isolated from pus swab cultures of two who did not have an initial serosal swab and one with 'no growth' documented from their swab. Results from both serosal and collection pus swabs were collated together.

Hence, 169 of the 213 patients had microbiology cultures taken (serosal or collection pus swabs) and reported (Table 1). Overall, 45 of the 213 patients had a positive SA culture identified. 124 patients had cultures without SA isolated (non-SA), including 34 cultures which revealed no growth. All SA cultures isolated were sensitive to penicillin and erythromycin.

Mean age between the SA and non-SA groups was similar (8.4 years vs 9.5 years respectively, P = 0.1). Children with positive SA cultures were more likely to have complicated appendicitis (gangrenous or perforated appendix) on histology (60.5% vs. 39.1%; P = 0.01) (Table 2). They also had longer initial admissions (LOS) and cumulatively spent more days in hospital ($P < 0.01$). There was, however, no significant difference in 30-day readmission rate between the groups (P = 0.18) (Table 2).

20 children were readmitted with confirmed diagnosis of a postoperative collection on ultrasound, of which 8 had positive SA cultures. Seven had had prior positive serosal swabs.

The incidence of appendicectomies associated with SA varied across the study period and followed a Poisson distribution (Fig. 1). Two time periods (September to October '15 and August to November '16) appeared to have a higher frequency than the back ground rate, however, this was not statistically significant (P = 0.58).

Incidence of postoperative collections appeared to increase over the course of the study with most presenting within the 10 months of 2016 compared to the rest of 2015 (Fig. 1). The incidence of SA positive patients developing collections also increased towards the end of study. Half of the 20 SA positive patients with collections occurred in the last 3 months of the study, compared to the other 10 presenting over the previous 12 months between July 2015–2016 (Fig. 2).

Overall, 43/213 (20.1%) patients developed a radiologically-confirmed postoperative collection. A greater proportion of patients with SA positive cultures developed postoperative collections compared to non-SA patients (n = 45, n = 124) (44.4% vs. 18.5%; P = 0.001, Relative risk = 2.4) (Table 2). There was no significant difference in appendix histopathology between the SA and non-SA patients with collections (Table 3). The number of cumulative hospital days was similar between SA and non-SA groups who developed collections (15.9 and 15.7 days respectively; P = 0.95). There was a two-fold increase in those positive SA cultures developing postoperative collections that were more likely

Table 2
Appendix histology, hospital admissions and postoperative complications.

Culture result	n	Mean age (years)	Mean length of initial admission (days)	Appendix histopathology (n, %)			30 day re- admission rate (n, %)	Cumulative hospital days	Collections (n, %)
				Normal	Inflamed	Complicated			
All	213	9.2	6.4	14 (6.9)	101 (49.5)	89 (43.6)	20 (9.4)	6.9	43 (20.2)
SA	45	8.4	9.1*	0 (0)	17 (39.5)	26 (60.5)**	8 (17.8)	10.3***	20 (44.4)****
Non-SA	168	9.5	5.7	14 (8.7)	84 (52.2)	63 (39.1)	12 (7.1)	6.0	23 (18.5)

*P = 0.007, ** P = 0.01, *** P = 0.001, **** P = 0.001.