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Negative Paediatric Appendicectomy Rates

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Abstract

Aim
To assess the local paediatric negative appendectomy rates at University Hospital Limerick (UHL) with regard to age, gender, histological diagnosis, biochemistry and radiology.

Methods
A retrospective audit was undertaken to examine the histological, radiological and bicohemical records of paediatric appendectomies at UHL from 2010 to 2016. Negative appendectomy was defined as the removal of an appendix without any signs of histological inflammation (transmural acute inflammation).

Results
The local negative appendectomy rate at UHL was 31.9% (n=423/1325). The true negative appendectomy (TNA) rate was 6.6% (n=87/1325). We found that the non-inflamed appendix with other pathology subgroup (AWOP) was 25.4% (n=336). Other pathologies were found within the inflamed appendices; fecolith in 25.1% (n=226); lymphoid hyperplasia (LH) in 4.4% (n=40); enterobius in 2.3% (n=21) and carcinoid in 0.2% (n=2). Regarding the AWOP group specifically, the other pathologies identified were; fecolith in 55.7% (n=187), LH in 55.7% (n=187), enterobius in 24.1% (n=81) and carcinoid in 0.3% (n=1). The ultrasound scan (US) rate was 22.7% (n=301), which was inconclusive in 80.7% (n=243) and diagnostic in 18.3% (n=55).

Conclusion
Despite a high rate of NA, other pathologies were encountered which might explain RIF pain. We propose more specific definitions for negative appendectomy and highlight the need for a standardised approach to pathology and ultrasonography reporting.

Introduction

Appendectomies are the most common emergency surgical procedure carried out in the paediatric population.[1] The ability to accurately diagnose acute appendicitis has been the subject of discussions for decades due to it's widely variable presentation, non-specific symptoms and wide differential diagnoses, particularly in the paediatric population.[2] Acute appendicitis occurs in nearly all age-groups and is notably difficult to diagnose among infants and toddlers.

The lifetime risk of developing appendicitis is approximately 9% in males and 7% in females. The initial misdiagnosis rate for appendicitis range from 28% to 57% for older children and may reach up to 100% for those 2 years or younger.[3] Current strategies to help diagnose acute appendicitis include clinical scoring systems[4-7], inflammatory markers [8-10] and diagnostic imaging studies like ultrasound or CT.[11-14]

A negative appendectomy (NA) is defined as the removal of an appendix which shows no evidence of inflammation or pathology.[15] Velanovich et al. suggested that the complication rate in appendicitis patients was markedly reduced when the perforated appendix rate was low.[16] The inverse relationship between negative appendectomies and perforated appendicitis means early diagnosis is key to ensure low rates of perforation and complications of appendicitis. This often means a higher, but justified, negative appendectomy rate (NAR). The appendix is no longer viewed as a vestigal organ as studies have shown that the removal of a normal appendix was suggested to increase the risk of acute myocardial infarction[17] and is an independent risk factor for inflammatory bowel disease (IBD) development.[18] Detmer et al. historically quoted acceptable NAR as between 15-25%.[19] Over the past decade, due to improved various diagnostic imaging and scoring systems a drop in the paediatric NAR to <10% was reported.[20-22] A paper published in the United States showed that the rates of negative appendectomy (NA) in children range anywhere from 1% to 40% in the literature and that many reports do not provide clear pathological definitions for either appendicitis or NA on which they base their calculation of NAR. The authors concluded that the institutional variation of paediatric NAR may explain discrepancies in the literature as by example, including only those that show "the absence of inflammation or other appendiceal pathology" would decrease their NAR by 50%. This study calls into question the interpretation of interhospital NAR and the use of NAR as a quality metric in the management of appendicitis.[23] Our aim was to assess the local paediatric NA rates at University Hospital Limerick (UHL) with secondary objectives look at NA in relation to age, gender, histological diagnosis, biochemistry and radiology.

Methods

A retrospective study was undertaken to compare clinical and histological records of all children (defined as 16 years of age or less) from 29/12/10 to 7/9/16, who underwent appendectomy at UHL. A dataset was created and analysed using IBM SPSS Statistics for Windows, version 23 (IBM Corp., Armonk, N.Y., USA). Data regarding admission dates, age, gender and type of surgery were obtained from the Hospital In-Patient Enquiry (HIPE) database. Descriptive data analysis was described using frequencies, medians and interquartial range (IQR), means and standard deviation (SD). Acute appendicitis was defined histologically as inflammation of the appendix identified by the presence of infiltrating neutrophil polymorphs. This also included necrotic, gangrenous, suppurative and perforated appendices. A negative appendectomy (NA) was defined as the removal of an appendix without any signs of inflammation. A true normal appendix (TNA) was the removal of an appendix that shows no signs of acute inflammation or any other pathologies. An appendix with other pathology (AWOP) was the removal of an appnedix that has no signs of inflammation and other pathology is present (figure 1). Biochemistry values used for analysis were taken from the admission bloods. A positively diagnostic US meant the sonographer described a visualised and inflammed appendix in the written report. A negatively diagnostic US meant the sonographer described a visualised, non-inflammed appendix and indicated that it was normal. An US was termed inconclusive if the appendix was not visualised.

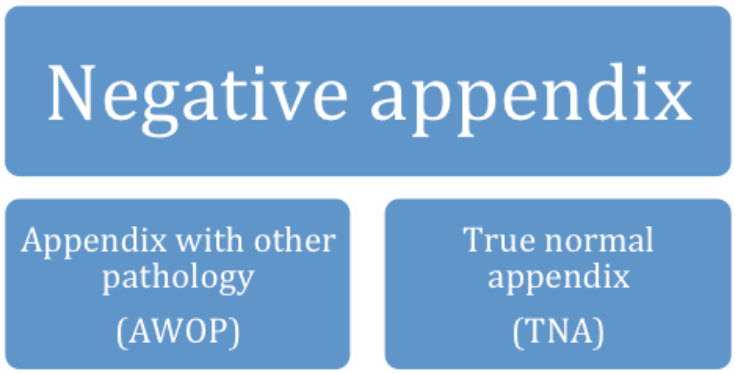

Figure 1. Histological definition clarification for negative appendectomies.

Results

Demographics

There were 1325 paediatric appendectomies over the study period (5 years and 8 months). The cohort was 57% male (n= 672) and the mean age (±SD) was 11.6±3.2 years. The median length of stay in hospital was 3 days (IQR 2-4).

Pathology

The local negative appendectomy rate at UHL was 31.9% (n=423/1325). The TNA rate was 6.6% (n=87/1325). We found that the non-inflamed appendix with other pathology subgroup (AWOP) was 25.4% (n=336). Appendictis was present in 68.1% (n= 902) of the appendectomies. Other pathologies were found within the inflammed appendicies; fecolith in 25.1% (n=226); lymphoid hyperplasia (LH) in 4.4% (n=40); enterobius in 2.3% (n=21) and carcinoid in 0.2% (n=2). The AWOP subgroup comprised 25.4% (n=336) of the total appendicectomies. Regarding the AWOP group specifically, the other pathologies identified were; fecolith in 55.7% (n=187), LH in 55.7% (n=187), enterobius in 24.1% (n=81) and carcinoid in 0.3% (n=1).

Radiology

The ultrasound rate was 22.7% (n=301). Of the ultrasounds performed, 80.7% (n=243) were inconclusive, 18.3% (n=55) were positively diagnostic and 1% (n=3) were negatively diagnostic. When radiology wasn't performed, 72% (n=737) of the appendices showed inflammation on histology. When radiology was positively diagnostic, 94.5% (n=52) showed inflammation and when it was inconclusive, 45.3% (n=110) were inflammed.

Biochemistry

Biochemical markers showed significant baseline differences between the appendecomies that histologically showed inflammation (Table 1).

Table 1. Biochemistry values for negative appendectomy and appendicitis groups.

		Negative appendectomy	Appendicitis	
Variable	Total (n=)	Median (IQR)	Median (IQR)	P-value
White blood count	1306	8.5 (4.3)	14.2 (7.2)	<0.001
Lymphocyte count	1306	2.1 (1.3)	1.5 (1.1)	<0.001
Neutrophil count	1306	5.0 (4.4)	11.7 (7.6)	<0.001
Eosinophil)	1305	0.1 (0.2)	0.2 (0.3)	<0.001
C-Reactive Protein	657	3.0 (1.0)	26.0 (66.0)	<0.001
ESR	158	8.0 (6.2)	11.0 (15.2)	0.036
Amylase	575	51.0 (28.0)	44.0 (23.0)	<0.001
Bilirubin	658	10.0 (6.8)	13.0 (8.5)	<0.001
Aspartate aminotransferase	11	23.5 (0.5)	24.0 (6.0)	1
Alanine aminotransferase	650	17.0 (7.0)	16.0 (6.0)	0.043

Discussion

It is common in the literature for people to interchange the terms 'normal appendix' and 'negative appendectomy'. Many reports do not provide clear pathological definitions for either appendicitis or NA on which they base their calculation of NAR.[23] Acute appendicitis is defined histologically as inflammation of the appendix, identified by the presence of infiltrating transmural neutrophil polymorphs. A negative appendectomy is defined as the removal of an appendix without any signs of inflammation. Negative appendectomy was relatively common at UHL (31.9% (n=423)) in comparison to international figures of 10-20%, and which are significantly less when using CT.[14] The pathologies for negative appendectomy rarely warranted surgeries and thus this is an area that requires reformation. In this study, we have shown that despite lack of inflammatory features on histology, 25% of NA would have other pathological non-inflammatory features that might cause pain in the RIF. As such, for better pathological characterisation as well as clearer patient counseling and communication, we propose more specific negative appendectomy subgroup definitions. Thus, we coin the term for a 'true normal appendix' (TNA), which shows no signs of acute inflammation or any other pathology present. In contrast, the removal of an appendix with no signs of inflammation but with other pathologies present is an appendix with other pathology (AWOP). Further to this point there is a lack of consensus as to whether the presence of fecolith material and LH in the appendix should be deemed pathological. In our study they were both considered a pathology. We noted variability in pathology reporting, in particular the presence of fecolith and/or LH. We did not differentiate between transmural inflammation, necrotic, gangrenous, suppurative or perforated appendices. Radiology was under-utilised at UHL and calculating the sensitivity and specificity of ultrasound at our institute was beyond the scope of this study. Higher rates of US and adequate time allocation for ultrasonogrophers may be beneficial. However, for futher reasearch in this area to progress it is essential that we address the lack of standardised pathology and ultrasound reporting which has downstream effects on any research outputs. In our sample population, there was a high rate of enterobius thus consideration of pruritus ani could be included into clinical exams. Future studies could look at the potential role for high fibre diet in reducing fecoliths. There is a need for studies and guidelines to address non-inflammatory aberrations and pathologies of the appendix. Previously the Paedatric Appendicitis Score (PAS) or Alvarado score were proposed as clincal tools but more recently the Shera score was the best performing model, when compared to 15 risk prediction models.[24] Studies have shown that early paediatric consultant involvement can reduce NAR further.[25]

Keywords: Negative appendectomy, Normal appendix, Paediatric appendicitis

Declaration of Conflicts of Interest:
We declare no competing interests.

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References:

1. Lund DP, F.J. Appendicitis. In: Allan Walker PRDW, Richard Hamilton J, Walker-Smith JA,Watkins John B, editors. Pediatric gastrointestinal disease: pathophysiology, diagnosis, management. 2nd ed. St Louis, Mo: Mosby; 1996. p. 907–15
2. Cappendijk VC, Hazebroek FW. The impact of diagnostic delay on the course of acute appendicitis. Arch Dis Child 2000;83:64-6.
3. Nance ML, Adamson WT, Hedrick HL. Appendicitis in the young child: A continuing diagnostic challenge. Pediatr Emerg Care 2000;16:160-2.
4. Samuel M. Pediatric appendicitis score. J Pediatr Surg 2002;37:877–81.
5. Alvarado A. A practical score for the early diagnosis of acute appendicitis. Ann Emerg Med 1986;15:557–64.
6. Kulik DM, Uleryk EM, Maguire JL. Does this child have appendicitis? A systematic review of clinical prediction rules for children with acute abdominal pain. J Clin Epidemiol 2013;66:95–104.
7. Schneider C, Kharbanda A, Bachur R. Evaluating appendicitis scoring systems using a prospective Pediatric cohort. Ann Emerg Med 2007;49:778–84.
8. Beltrán MA, Almonacid J, Vicencio A, Gutiérrez J, Cruces KS, Cumsille MA. Predictive value of white blood cell count and C-reactive protein in children with appendicitis. J Pediatr Surg 2007;42:1208–14.
9. Gavela T, Cabeza B, Serrano A, Casado-Flores J. C-reactive protein and procalcitonin are predictors of the severity of acute appendicitis in children. Pediatr Emerg Care 2012;28:416 9.
10. Kharbanda AB, Rai AJ, Cosme Y, Liu K, Dayan PS. Novel serum and urine markers for pediatric appendicitis. Acad Emerg Med 2012;19:56–62.
11. Puig S, Staudenherz A, Felder-Puig R, Paya K. Imaging of appendicitis in children and adolescents: useful or useless? A comparison of imaging techniques and a critical review of the current literature. Semin Roentgenol 2008;43:22–8.
12. Frush DP, Frush KS, Oldham KT. Imaging of acute appendicitis in children: EU versus U.S. … or US versus CT? A North American perspective. Pediatr Radiol 2009;39:500–5.
13. Holscher HC, Heij HA. Imaging of acute appendicitis in children: EU versus U.S.. or US versus CT? A European perspective. Pediatr Radiol 2009;39:497–9.
14. Doria AS, Moineddin R, Kellenberger CJ, et al. US or CT for diagnosis of appendicitis in children and adults? A Meta-Analysis 1. Radiology 2006;241:83–94.
15. Mariadason JG, Wang WN, Wallack MK, Belmonte A, Matari H. Negative appendicectomy rate as a quality metric in the management of appendicitis: impact of computed tomography, Alvarado score and the definition of negative appendectomy. Ann R Coll Surg Engl. 2012;94:395–401. doi: 10.1308/003588412X13171221592131

16. Velanovich V, Satava R. Balancing the normal appendectomy rate with the perforated appendicitis rate: implications for quality assurance. Am Surg 1992;58:264–9.
17. Janszky I, Mukamal KJ, Dalman C, Hammar N, Ahnve S. Childhood appendectomy, tonsillectomy, and risk for premature acute myocardial infarction – a nationwide population-based cohort study. Eur Heart J.2011;32:2290–2296. doi: 10.1093/eurheartj/ehr137. [PubMed] [Cross Ref]
18. Ye Y, Pang Z, Chen W, Ju S, Zhou C. The epidemiology and risk factors of inflammatory bowel disease. International Journal of Clinical and Experimental Medicine. 2015;8(12):22529-22542.
19. Detmer DE, Nevers LE, Sikes ED. Regional results of acute appendicitis care. JAMA 1981;246(12):1318–1320.
20. Bachur RG, Hennelly K, Callahan MJ, Chen C, Monuteaux MC: Diagnostic imaging and negative appendectomy rates in children: effects of age and gender. Pediatrics 2012;129:877-884
21. Oyetunji TA, Ong'uti SK, Bolorunduro OB, Cornwell EE 3rd, Nwomeh BC: Pediatric negative appendectomy rate: trend, predictors, and differentials. J Surg Res 2012;173:16-20
22. Schok T, Simons PC, Janssen-Heijnen ML, Peters NA, Konsten JL: Prospective evaluation of the added value of imaging within the Dutch national diagnostic appendicitis guideline - do we forget our clinical eye? Dig Surg 2014;31:436-443.
23. Maloney C, Edelman MC, Bolognese AC, Lipskar AM, Rich BS. The Impact of Pathological Criteria on Pediatric Negative Appendectomy Rate. J Pediatr Surg. 2019 Sep;54(9):1794-1799. doi: 10.1016/j.jpedsurg.2018.10.106. Epub 2018 Dec 28.
24. Nepogodiev, Dmitri et al. Appendicitis risk prediction models in children presenting with right iliac fossa pain (RIFT study): a prospective, multicentre validation study. The Lancet Child & Adolescent Health, Volume 4, Issue 4, 271 – 280.
25. Tiboni S, Bhangu A, Hall NJ. Outcome of appendicectomy in children performed in paediatric surgery units compared with general surgery units. Br J Surg. 2014 May;101(6):707-14. doi: 10.1002/bjs.9455. Epub 2014 Apr 2.