Original Article

Histopathological correlations of appendectomies: a clinical audit of a single center

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Background: Acute appendicitis is a common presentation in surgical assessment units and appendectomy accounts for a large number of emergency operations in the UK. Histopathological examination of the appendectomy specimens are routinely carried out. The aim of this study is to correlate the histological findings of appendectomy specimens with the clinical diagnosis of acute appendicitis.

Methods: This is a retrospective analysis of 238 appendectomies carried out in a single UK center between January and December 2013. The Histopathology reports of appendectomy specimens were retrieved.

Results: A total of 238 appendectomies were performed during the study period. The mean age of the patients was 32 years (range, 7-81 years). Adult patients (>16 years) represented 79.4% of the study population. The female sex accounted for 46.6% of all the patients. Of the 238 resected appendix, 211 (88.7%) had histopathology findings consistent with appendicitis. Approximately 1.7% of the 238 specimens were abnormal pathologies other than inflammation of the appendix. The negative appendectomy (normal appendix on histology) rate was 11.3%. The female sex accounted for 59.1% of the negative appendectomies. Adults (>16 years) represented 77.8% of the negative appendectomies.

Conclusions: The observed high rates of negative appendectomy in the female sex can be reduced by utilizing combined clinical assessment and diagnostic imaging modalities. The findings of abnormal pathologies on histopathological examination of the appendix which could potentially impact on the management of the patients justify the current practice of routine histopathological examination of resected appendix.

Keywords: Appendectomy specimens; histopathological review; negative appendectomy rates (NARs)

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Introduction

Appendicitis is a common acute surgical emergency with over 40,000 cases in the UK every year (1) and the estimated life time risk of appendicitis in the USA is 8.6% and 6.7% for males and females respectively (2). The diagnosis of appendicitis is largely clinical and appendectomy is the treatment of choice. Delayed diagnosis of appendicitis could lead to complications like perforated appendix, peritonitis, sepsis, increased morbidity and mortality (3,4). Right iliac fossa pain can be a presenting complaint of different pathologies that may mimic appendicitis especially in the female population causing diagnostic difficulties and often leads to negative appendectomies.

There is variation between institutions in the practice of routine histopathological examination of appendectomy specimens. Arguments against the practice include the rarity of incidental pathologies that may impact on treatment and also the financial implications of routine histopathological assessments (5,6). Histological examination of appendix specimens is routinely done in our institution hence the need to correlate the histopathological findings with the clinical diagnosis of appendicitis.

Table 1 Study population characteristics of patients with appendectomy

Characteristics	N (%)
Age, mean [range] (years)	32 [7-81]
Adult (>16 years)	189 (79.4)
Female sex	111 (46.6)
NAR	27 (11.3)
Female sex with normal appendix	16 (59.3)
Adult >16 years with normal appendix	21 (77.8)
Number of patients who had USS	18 (7.6)
Number of patients who had CT scans	15 (6.3)

NAR, negative appendectomy rate; USS, ultrasound scan.

Methods

Data of patients who had appendectomies during the study period between January and December 2013 was retrieved from the surgical database. Study population characteristics and the histopathology reports of the appendectomy specimens were retrieved from the computer records. The primary outcome measure was appendicitis confirmed by histopathology.

Negative appendectomy was defined as a post-operative appendix specimen for suspected appendicitis that was however microscopically normal on histopathological examination without evidence of inflammation, tumors and parasitic infestation (7-10). Fibrous obliteration of the lumen of the appendix and reactive lymphoid hyperplasia without evidence of inflammation was not included as abnormal findings (8,11). The variables in the data were summarized using appropriate summary statistics. Analysis of the data was carried out by IBM SPSS version 20.

Results

Study population

Overall 238 appendectomies were performed during the study period. The mean age of the patients was 32 years (range, 7-81 years). Adult patients (>16 years) represented 79.4% of the study population. The female sex accounted for 46.6% of all the patients (*Table 1*).

Histopathology findings

Of the 238 resected appendix, 211 (88.7%) had histopathology findings consistent with appendicitis which was variously reported as acute suppurative appendicitis, transmural inflammation of the appendix with or without fecalith and gangrenous perforated appendix. Four cases of fibrous obliteration of the lumen of the specimen without evidence of inflammation were reported.

Table 2 Histopathological findings in appendectomy specimens

Specimens	N (%)
Appendicitis	211 (88.7)
Normal appendix	27 (11.3)
Unusual pathologies	4 (1.7)
Carcinoid tumour	1 (0.4)
Mucinous lesions	2 (0.8)
Granulomas suspicious for crohn's disease	1 (0.4)

Approximately 1.7% of the 238 specimens were unusual pathologies other than inflammation of the appendix (*Table 2*) and two mucinous lesions were reported. One of the findings suggestive of mucinous cystadenoma was reported as "specimen is covered with fibrous exudate. A nodule of 10 mm in maximum dimension is seen. Focally dilated appendiceal lumen is lined with mildly atypical epithelium which is thrown into convoluted folds. Mucin extravasation with a single gland within tissue is seen all suggestive of cystadenoma with low grade dysplasia associated with acute appendicitis". One case of carcinoid tumor at the tip of the appendix which was synaptophysin and chromogranin positive was reported. The negative appendectomy rate (NAR) was 11.3%. The female sex accounted for 59.3% of the negative appendectomies. Adults (>16 years) represented 77.8% of the negative appendectomies (*Table 1*).

Imaging

Of the total number of the patients with suspected appendicitis, 7.6% [18] had abdominal ultrasound scan (USS) and the female sex accounted for 94% of patients who had abdominal USS. Three and seven patients were reportedly positive and negative for appendicitis on USS respectively. Eight patients were reported as inconclusive on USS. Correlating the USS findings with the histopathological findings, the three patients reported as positive on USS were truly positive on histopathology. Five patients of seven USS negative cases had positive histopathological report and five patients of eight USS inconclusive patients also had positive histopathological report.

The proportion of patients who had CT scans was 6.3% [15]

and all the 15 patients had CT scan findings consistent with acute appendicitis. The CT scan findings correlated with the histopathological findings of appendicitis.

Discussion

This study reviews the histopathological findings of resected appendix specimens. Appendectomy is a common surgical procedure for the management of acute appendicitis. NAR, a recognized consequence of appendectomy varies from 6% to 40% in the literature (8,12,13). The suggested acceptable rate of negative appendectomy is 20% (4,11) and the NAR for this study was 11.3%. The high rates of negative appendectomy was considered acceptable to avoid missing cases of appendicitis and the possible sequelae of appendicitis such as perforation, peritonitis, abscess formation, peritonitis and sepsis (11). Arguments against acceptable high rates of negative appendectomies have been made with the observation of attendant significant clinical and financial consequences (14).

Flum and Koepsell reported the findings of a retrospective analysis of 261,134 patients who underwent non-incidental appendectomies with a NAR of 15.3% [39,901]. When compared with patients with appendicitis, negative appendectomy was associated with a significantly longer length of stay (5.8 *vs.* 3.6 days, P<0.001), infectious complications rate (2.6% *vs.* 1.8%, P<0.001) case fatality rate (1.5% *vs.* 0.2%, P<0.001) and total charge-admission ($18,780 *vs.* 10,584, P<0.001). An estimated $741.5 million in total hospital charges resulted from admissions in which a negative appendectomy was performed (15). Hence NAR has been recognized as a quality metric in the management of acute appendicitis.

The incidence of negative appendectomies has reportedly been on the decline with large database studies as low as 6-8.4% (9,16) and single institution studies as low as 1.7-7% (10,17). The documented decline in NAR notably coincided with increased use of imaging especially computed tomography and laparoscopy as diagnostic tools for appendicitis (18). Low NAR have been attributed to the use of computed tomography by some studies (10,11,17), however, a definitive causal relationship has not been established.

CT has a sensitivity of 90-100%, specificity of 91-99% and positive predictive value of 95-97%. CT has also proven to be superior to USS in the diagnosis of suspected appendicitis (4) and this observation is consistent with the findings of this study which suggests that USS negative and USS inconclusive reports are not reliable. The contributory role of imaging in the low incidence of NAR has been further supported by the findings of Raja *et al*. in an 18-year review. They observed significant reduction in NAR from 23% in 1990 to 1.7% in 2007 and this reduction occurred with the significant increase of preoperative CT from 1% to 97.5% in the same period (10). Our study reinforces the importance of history taking, clinical examination, basic laboratory investigations and the selective use of imaging in the diagnosis of acute appendicitis.

Higher NAR in the female sex compared to the male sex have been reported by multiple studies (7-9,19,20). Seetahal *et al*. in a 10-year review of a nationally representative sample of 475,651 cases of appendectomy reported that women accounted for 71.6% of the negative appendectomies (16). This is consistent with the findings of this study in which females accounted for approximately 60% of the negative appendectomies. Reasons adduced for this observation includes the gynecological conditions that could mimic the presentation of acute appendicitis. Ovarian cysts, leiomyoma, endometriosis, benign ovarian neoplasms, malignant ovarian disease, pelvic adhesions have been reportedly misdiagnosed as acute appendicitis in women (16).

Histopathological examination of resected appendix specimens helps to confirm the diagnosis of appendicitis and also unravels other incidental pathologies that may impact on the management of patients. The consequences of unusual pathological findings in the literature include gastroenterology follow up, periodic surveillance, anti-tuberculosis medications, helminthic treatment, right colectomy and palliative care (21).

The incidence of unusual pathologies in our study is low (1.7%) and this is consistent with the findings in the literature (21-28) (*Table 3*). Unusual pathologies in our study include mucinous lesions, carcinoid tumor and granulomatous lesions suspicious for crohn's disease which is consistent with findings reported in the literature. Documented unusual pathologies found on histological examination of resected appendix in the literature includes endometriosis, primary or secondary adenocarcinoma, neurofibroma, lymphomas, granulomatous conditions suspicious for tuberculosis and crohn's disease, eosinophilic appendicitis, E.vermicularis and actinomycosis of the appendix (7,21,29,30). The observation of 1,825 unusual pathologies in the retrospective review of 24,697 appendectomy specimens is in support of the continued use of routine histopathological examination of resected appendix (7). A systematic review of 19 studies on the

Table 3 Selected articles of histopathological findings of appendectomies in the literature

Author	Year	Study population	NAR (%)	Unusual findings (%)
Duzgun *et al*. (27)	2004	2,458	210 (8.5)	19 (0.7)
Marudanayagam *et al*. (8)	2006	2,660	738 (27.7)	185 (7.0)
Jones *et al*. (6)	2007	1,225	284 (23.2)	46 (3.8)
Khan *et al*. (28)	2007	236	61 (25.8)	10 (4.2)
Chamisa (22)	2009	324	55 (17.0)	28 (8.6)
Raja *et al*. (10)	2010	971 *vs*. 637	23% *vs*. 1.7%	nr
Akbulut *et al*. (23)	2011	5,262	nr	54 (1.0)
Seetahal *et al*. (16)	2011	475,651	56,252 (11.8)	nr
Chandrasegaram *et al*. (26)	2012	4,670	1,192 (25.5)	116 (2.5)
Emre *et al*. (24)	2013	1,255	76 (6.1)	88 (7.0)
Charfi *et al*. (7)	2014	24,697	3,723 (15.1)	1,825 (7.4)
Karagulle *et al*. (25)	2014	1,466	328 (22.4)	57 (3.9)

NAR, negative appendectomy rate; nr, not reported.

usefulness of routine histopathological examination of appendectomy specimens also observed that the incidence of unexpected findings in appendectomy specimens is low and intra-operative diagnosis alone appears insufficient for identifying unexpected disease and it is subject to great variation (21).

Conclusions

In conclusion, appendectomy in the female sex contributes to high NARs which may be lowered by utilizing combined clinical assessment and selective diagnostic imaging modalities. Unusual pathologies on histopathological examination of the appendix which could potentially impact on management of the patients justify the continued routine histopathological examination of resected appendix.

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