Negative Appendectomy: an Audit of Resident-Performed Surgery. How Can Its Incidence Be Minimized?

Mohit Kumar Joshi · Richa Joshi · Shaan E. Alam ·
Sarla Agarwal · Sunil Kumar

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Abstract Negative appendectomy remains a concern in current surgical practice. Data from the developing world is scarce. Data of appendectomies during the last 5 years were analyzed. Interval and incidental appendectomies were excluded. The demographic details, presenting complaints, clinical signs, and investigations performed were recorded in a predesigned proforma. The data were critically analyzed. Six hundred eighty-five appendectomies were performed during the period. One hundred eighty-five patients with a normal appendix were identified on histopathology. Sixty-seven patients with incidental or interval appendectomies were excluded. Thus, 118 patients had appendectomies performed erroneously. All these patients with presumed diagnosis of acute appendicitis were operated on by resident surgeons. Records of 17 patients could not be retrieved. The most common symptom was abdominal pain (100 %), and the commonest sign was right iliac fossa tenderness (93 %). Most of the patients underwent USG to supplement the diagnosis. CT scan and diagnostic laparoscopy were not performed. The negative appendectomy rate was 17.2 % (12.4 % in males; 33.3 % in females). The highest incidence of negative appendectomy was in females aged 11–20 years (66.7 %). The rate of negative appendectomy at our institute is comparable with the world statistics. More diligence is required in making the clinical diagnosis of acute appendicitis, especially in young

females. The use of C-reactive protein and CT scan may decrease the negative appendectomy rate.

Keywords Appendicitis · Acute appendicitis · Negative appendectomy · Diagnostic error

Introduction

Acute appendicitis (AA) is the most common surgical emergency making appendectomy the commonest emergency operation performed worldwide [1–3]. It also probably is the first abdominal surgery a resident performs during his surgical training. Although clinical suspicion of appendicitis appears straightforward with well-known symptoms and signs being recognized for years, a number of medical and surgical illnesses closely mimic appendicitis resulting in the establishing of a false diagnosis in a considerable number of patients. This leads to the removal of the normal appendix in patients presumed to be having AA. The reported negative appendectomy rate (NAR) varies from 4 to 45 %, with the highest incidence in women of the reproductive age group [4–6].

Performing appendectomy with an erroneous diagnosis may lead to complications inherent to the surgery and problems from systemic adverse events, wound infection, hospital stay, and even death [7, 8]. Various scoring systems, biochemical markers, and imaging modalities have been introduced to substantiate the diagnosis of AA and thereby decrease NAR. However, there is continuing controversy regarding their availability, cost, validity, and routine use [1, 9, 10]. A number of studies have been conducted in the West to audit and decrease NAR, but there is paucity of similar studies from the developing world. We undertook this as an opportunity to look at our NAR and compare the results with the published English literature. We also appraised the views, results, and

M. K. Joshi · S. E. Alam · S. Kumar
Department of Surgery, University College of Medical Sciences and
GTB Hospital, Delhi 110095, India

R. Joshi · S. Agarwal
Department of Pathology, University College of Medical Sciences
and GTB Hospital, Delhi 110095, India

M. K. Joshi (✉)
C-1/1201, Olive County, Sector-5, Vasundhara, Ghaziabad, UP, India
e-mail: drmohitjoshi@gmail.com

recommendations of authors who worked on this problem and derived conclusions which may further help to decrease NAR.

Material and Methods

The study was approved by the Institutional Review Board. Data of all patients who underwent appendectomy at our institute, which is a high-volume tertiary care teaching hospital, over 5 years (January 2008 to December 2012) were collected from the clinical database of the hospital. The patients with a histopathological finding of normal appendix were identified. Out of this, the patients with nonemergency appendectomies like interval appendectomy following resolution of an appendicular lump or incidental appendectomy performed during some other surgery were excluded. The medical case records of the patients with true negative appendectomy were sought. The names of the patients from the case records were covered by a paper flag, and the files were then coded with numbers to maintain patient confidentiality. Records of 17 patients could not be found. Remaining case records were reviewed in detail, and the following parameters were recorded: demographic data (age and sex), presenting complaints (duration of illness, nature, character, shifting and radiation of pain), associated symptoms (anorexia, nausea, vomiting, fever, bowel or urinary complaints), vital parameters (tachycardia and body temperature), examination findings (tenderness, peritonism), hematological investigations performed [notably total leukocyte count (TLC)], special investigations (ECG in patients above 35 years and urine pregnancy test in females of the reproductive age group), radiological investigations [ultrasonography (USG) of the abdomen, X-ray of the chest and abdomen], and specialist referral like gynecological opinion in select patients. The operative findings and outcome following surgery were also recorded. The data so obtained were analyzed, and the results were compared with those of similar studies done elsewhere.

Results

General Data and Demography

Six hundred eighty-five patients underwent appendectomy during the 5-year period (526 males and 159 females; sex ratio 3.3:1). Most patients were 20–30 years of age. The average number of appendectomies performed each year was 137 with variation from a minimum of 111 in 2010 to a maximum of 152 in 2007. Appendiceal pathology was confirmed in 500 patients (Table 1) while 185 patients had a normal appendix on histopathologic examination. Of all the normal appendices, 67 belonged to patients with either interval or incidental appendectomies; thus, in 118 patients, the

Table 1 Histopathological findings of appendectomy specimens

Appendiceal pathology	Number of patients (<i>n</i> =500)
Acute appendicitis	494
Granulomatous appendicitis	3
Mucinous cystadenoma	2
Adenocarcinoma	1

appendix was removed wrongly. This comprised 65 males and 53 females (sex ratio 1.2:1), with males mostly in the age group 21–30 years (*n*=25) and females in the age group 11–20 years (*n*=24). Overall NAR was 17.2 % (12.4 % in males and 33.3 % in females). However, the NAR in females aged 11–20 years was 66.7 % (Table 2).

Presenting Complaints

The most common symptom was abdominal pain (100 %), followed by anorexia (70 %), vomiting (59.1 %), and fever (45.7 %). Only 45.3 % of patients reported shifting of pain. Other symptoms reported were diarrhea (11 cases), constipation (14 cases), and dysuria (13 cases). The mean duration of symptoms was 92 h (range 2 h to 8 days).

Vital Parameters and Examination Findings

Tachycardia was documented in 35 % while 13.6 % had fever at presentation. Right iliac fossa (RIF) tenderness was present in 93 % and rebound tenderness in 79 % of patients. In 5.9 %,

Table 2 Age, sex distribution, and NAR in patients with negative appendectomy

Gender	Age (years)	Appendectomy (<i>n</i>)		NAR (%)
		Total	Negative	
Males	0–10	26	6	23
	11–20	163	11	6.7
	21–30	192	25	13
	31–40	88	13	14.8
	41–50	34	3	8.8
	51–60	12	3	25
	>60	11	4	36.4
Females	0–10	9	2	22.2
	11–20	36	24	66.7
	21–30	51	13	25.5
	31–40	40	6	15
	41–50	12	5	41.7
	51–60	6	2	33.3
	>60	5	1	20

NAR negative appendectomy rate

the pain was generalized to the whole of the lower abdomen. Three patients presented with shock.

Investigations

Among the patients, 59.3 % exhibited leukocytosis (counts $>12,000/\text{mm}^3$). X-ray of the chest and/or abdomen was performed in 23 %; however, the findings were unremarkable pertaining to acute abdomen. Urine pregnancy test done in 17 % was negative in all except in one lady who presented in her late first trimester. USG abdomen was done in 75.2 % of patients. The commonest findings were probe tenderness in RIF (34.7 %) and periappendiceal fluid (25.3 %); however, the appendix was not visualized in 25.7 % of patients. In 10 % of patients, the appendix was reported normal. Out of 118 patients with negative appendix, USG abdomen was performed in 63. Probe tenderness was reported in 40, periappendiceal fluid was detected in 6, and the appendix was not visualized in 17 patients. CT scan, MRI scan, and diagnostic laparoscopy (DL) was not performed in any patient.

Specialist Referral

Gynecological referral was sought in 57.1 % of female patients, and in most of them, a gynecological cause for acute abdomen was ruled out.

Treatment

All patients underwent emergency appendectomy under general or spinal anesthesia by surgical residents. In most of the patients, gridiron incision was used except in three who presented with generalized pain in the lower abdomen, where a lower midline laparotomy incision was used for exploration. In seven patients, either the incision was extended to a muscle cutting one or a lower midline laparotomy was performed owing to operative difficulty.

Operative Findings

In nearly 90 % of patients, one or more of gross inflammation of the appendix, periappendiceal fluid, surrounding bowel/omental adhesions, or pus/fibrinous flecks were recorded in operative notes. In 10 % of patients, the appendix was not grossly inflamed and there were no other findings suggesting an intra-abdominal acute inflammatory process.

Outcome

The postoperative period of 98 patients (97 %) was uneventful, and most of them were discharged on the third postoperative day (range 3–6 days). Three patients died of septic complications.

Discussion

The problem of negative appendectomies has long been recognized. The patients undergoing surgical removal of a normal appendix are exposed to all adverse events of anesthesia and surgery; in addition, the pathology which was the actual cause of acute abdomen is not recognized in the garb of AA. Concerns have been raised to decrease NAR in order to overcome these problems. It goes without saying that every effort should be made for making a correct diagnosis of AA. This may sound simple, but as so many medical and surgical diseases resemble closely the clinical symptoms and signs of AA, it is not infrequent to misdiagnose AA [11–13]. Urgent surgical intervention in AA is prudent to avert the complications of an acutely inflamed appendix. One has to use all of his judgment to strike the fine balance between misdiagnosing AA and not denying surgery to a patient of AA.

Our NAR is comparable to other studies [14–17]. Various authors have reported that the highest incidence of NAR occurs in females of the reproductive age group (15–49 years) [5, 6, 13, 18]. Although we also recorded a higher incidence in this population, the highest incidence was found in young girls aged 11–20 years.

It cannot be overemphasized that a detailed history and good clinical examination remain the cornerstone in making a correct diagnosis of AA. Few biochemical investigations like raised TLC and C-reactive protein (CRP) have been found to be associated with AA; however, raised TLC was found in only 59.3 % of our patients. It is known that TLC may be normal in AA and when used alone is not a consistent predictor of appendicitis [9, 19]. Some studies have found a strong correlation between raised CRP and AA. These authors suggest that CRP is inexpensive, reduces NAR, and thereby decreases financial burden on the governmental health-care setup [9, 20]. The combination of TLC and CRP, however, correlates better than any one of these investigations alone [9, 12, 13, 20]. CRP was not performed in our patients as this facility is not present in our emergency department. However, we feel that CRP estimation, being cheap and informative, can be made available in all hospitals.

Various decision tools including clinical algorithms, checklists, and scoring systems exist to help substantiate the diagnosis of AA [10, 21]. These tools utilize various clinical and biochemical parameters to validate diagnosis. We could not use them as either few investigations employed by these tools were not available in emergency hours in our hospital or at times the patient was poor enough to afford them from elsewhere. Similar situations might be existing in the health-care institutes across developing nations.

While USG, CT, MRI scan, and DL have been advocated to improve accuracy in the diagnosis of appendicitis, the benefits of these modalities in clinical trials have not been realized in general practice [8, 22, 23]. USG is cheap and

easily available, but the results are operator dependent and at times the appendix may not be visualized due to overlying bowel gas limiting the use of this modality. USG was performed in 75.2 % of our patients, and some features suggestive of AA were documented in nearly 90 % of them; still, the NAR in our study was 17.2 % suggesting that USG findings alone cannot be relied on. In addition, in nearly one fourth of our patients, the appendix could not be visualized and USG remained noncontributory.

Various studies recommend preoperative CT scan to decrease NAR [16, 23, 24]. We agree with them in principle, but we feel that availability, cost, radiation exposure, and time required are factors precluding its use in all patients of suspected AA. Similar concerns have been raised by other authors [9, 22, 23, 25]. Although CT is not infallible [26, 27], it has considerably higher sensitivity and specificity. Following a review of available studies on the usefulness of CT scan in suspected AA, we conclude that judicious use of CT scan can reduce NAR significantly especially in women of the reproductive age group with equivocal clinical findings and laboratory investigations. MRI has still not achieved the status of standard investigation primarily because of its cost and availability. We could not employ DL as the facility for minimally invasive surgery is not available in our emergency operation theatre.

All patients were operated on by residents having at least 2 years of surgical experience. We believe that patient management by them would not have led to much difference in making the diagnosis, operative complications, and mortality. The safety of surgery performed by residents has been supported by other studies [28, 29]. In the operative records of 90 % of patients, one or the other finding suggesting AA was mentioned, but still, NAR in the present study was more than 10 %. We assume that either these findings could have been part of a more generalized inflammatory process which was missed by the operating surgeon, or he may have been biased in reporting these findings once these findings were subtle or absent. In nearly 10 % of patients, appendectomy was performed even in the absence of the operative findings suggesting AA; however, this can be justified as it is known that the appendix may appear grossly normal even in AA [30].

Three of our patients died in the postoperative period. One of them was elderly with chronic obstructive airway disease who died 5 days after surgery due to acute lower respiratory tract infection. Two other patients who died had presented with generalized lower abdominal pain and shock. In these patients, the periappendiceal fluid was also reported on USG examination. Analyzing retrospectively, we assume that these patients may have had a localized or sealed bowel perforation which might have resulted in localized tenderness leading to the misinterpretation of AA.

To our disappointment, we failed to recover case records of 17 patients reflecting poor record keeping in our setup.

Clinical information from these records would have further strengthened our study. Nevertheless, encountering this shortcoming gave us the opportunity to discuss this problem with the hospital administration and record keeping authorities of our institute. This has resulted in more stringency in collecting, recording, and keeping the data subsequently, and we hope that this will improve the hospital data management.

Conclusion

Our NAR is comparable with that of existing literature. More diligence is required in making clinical diagnosis of AA. Use of CRP in every patient and judicious use of CT scan in select ones may further decrease NAR although it may be impossible to abolish it completely.

References

1. Rosen MP, Ding A, Blake ME, Cash BD, Fidler JL, Grant TH et al (2011) ACR Appropriateness Criteria® right lower quadrant pain—suspected appendicitis. *J Am Coll Radiol* 8:749–755
2. Ma KW, Chia NH, Yeung HW, Cheung MT (2010) If not appendicitis, then what else can it be? A retrospective review of 1492 appendectomies. *Hong Kong Med J* 16:12–17
3. Grönroos JM (2011) Clinical suspicion of acute appendicitis—is the time ripe for more conservative treatment? *Minim Invasive Ther Allied Technol* 20:42–45
4. Cavaşoğlu YH, Erdoğan D, Karaman A, Aslan MK, Karaman I, Tütün OC (2009) Do not rush into operating and just observe actively if you are not sure about the diagnosis of appendicitis. *Pediatr Surg Int* 25:277–282
5. Coursey CA, Nelson RC, Patel MB, Cochran C, Dodd LG, Delong DM et al (2010) Making the diagnosis of acute appendicitis: do more preoperative CT scans mean fewer negative appendectomies? A 10-year study. *Radiology* 254:460–468
6. Morse BC, Roettger RH, Kalbaugh CA, Blackhurst DW, Hines WB Jr (2007) Abdominal CT scanning in reproductive-age women with right lower quadrant pain: does its use reduce negative appendectomy rates and healthcare costs? *Am Surg* 73:580–584
7. Flum DR, Koepsell T (2002) The clinical and economic correlates of misdiagnosed appendicitis: nationwide analysis. *Arch Surg* 137: 799–804
8. Bijnen CL, van den Broek WT, Bijnen AB, de Ruiter P, Gouma DJ (2003) Implications of removing a normal appendix. *Dig Surg* 20(215–9):220–221
9. Howell JM, Eddy OL, Lukens TW, Thiessen ME, Weingart SD, Decker WW (2010) Clinical policy: critical issues in the evaluation and management of emergency department patients with suspected appendicitis. *Ann Emerg Med* 55:71–116
10. Ebell MH (2008) Diagnosis of appendicitis: part 1. History and physical examination. *Am Fam Physician* 77:828–830
11. Williams NS, Bulstrode CJK, O’Connell PR editors (2008) Bailey & Love’s short practice of surgery. 25th Edition. International Students Edition. Hodder Arnold, pp 1209–11
12. Cole MA, Maldonado N (2011) Evidence-based management of suspected appendicitis in the emergency department. *Emerg Med Pract* 13:1–29

13. Laméris W, van Randen A, Go PM, Bouma WH, Donkervoort SC, Bossuyt PM, Stoker J, Boermeester MA (2009) Single and combined diagnostic value of clinical features and laboratory tests in acute appendicitis. *Acad Emerg Med* 16:835–842
14. Mirza MR, Habib L, Jaleel F (2009) Factors identified for negative appendicectomies. *Mymensingh Med J* 18:198–202
15. Mohebbi HA, Panahi F, Kabir A (2006) Comparing presentation and diagnostic accuracy for conscripts and nonconscripts who have already been selected for appendectomy. *Mil Med* 171:1110–1112
16. Chooi WK, Brown JA, Zetler P, Wiseman S, Cooperberg P (2007) Imaging of acute appendicitis and its impact on negative appendectomy and perforation rates: the St. Paul's experience. *Can Assoc Radiol J* 58:220–224
17. Chamisa I (2009) A clinicopathological review of 324 appendices removed for acute appendicitis in Durban, South Africa: a retrospective analysis. *Ann R Coll Surg Engl* 91:688–692
18. Das MK, Gautam D, Roy H, Mukherjee A, Gaurav R, Sen S (2009) Unnecessary appendicectomy in suspected cases of acute appendicitis. *J Indian Med Assoc* 107:354–357
19. Merlin MA, Shah CN, Shiroff AM (2010) Evidence-based appendicitis: the initial work-up. *Postgrad Med* 122:189–195
20. John SK, Joseph J, Shetty SR (2011) Avoiding negative appendectomies in rural surgical practice: is C-reactive protein estimation useful as a diagnostic tool? *Natl Med J India* 24:144–147
21. Zimmermann PG (2008) Is it appendicitis? *Am J Nurs* 108:27–31
22. Khairy G (2009) Acute appendicitis: is removal of a normal appendix still existing and can we reduce its rate? *Saudi J Gastroenterol* 15: 167–170
23. Piper HG, Rusnak C, Orrom W, Hayashi A, Cunningham J (2008) Current management of appendicitis at a community center—how can we improve? *Am J Surg* 195:585–588
24. Cuschieri J, Florence M, Flum DR, Jurkovich GJ, Lin P, Steele SR et al (2008) Negative appendectomy and imaging accuracy in the Washington State Surgical Care and Outcomes Assessment Program. The SCOAP Collaborative. *Ann Surg* 248:557–563
25. Chiang DT, Tan EI, Bricks D (2008) 'To have or not to have'. Should computed tomography and ultrasonography be implemented as a routine work-up for patients with suspected acute appendicitis in a regional hospital? *Ann R Coll Surg Engl* 90:17–21
26. Pooler BD, Lawrence EM, Pickhardt PJ (2012) MDCT for suspected appendicitis in the elderly: diagnostic performance and patient outcome. *Emerg Radiol* 19:27–33
27. Binnebösel M, Otto J, Stumpf M, Mahnken AH, Gassler N, Schumpelick V et al (2009) Acute appendicitis. Modern diagnostics—surgical ultrasound. *Chirurg* 80:579–587
28. Graat LJ, Bosma E, Roukema JA, Heisterkamp J (2012) Appendectomy by residents is safe and not associated with a higher incidence of complications: a retrospective cohort study. *Ann Surg* 255:715–719
29. Kazaure HS, Roman SA, Sosa JA (2012) The resident as surgeon: an analysis of ACS-NSQIP. *J Surg Res* 178:126–132
30. Phillips AW, Jones AE, Sargen K (2009) Should the macroscopically normal appendix be removed during laparoscopy for acute right iliac fossa pain when no other explanatory pathology is found? *Surg Laparosc Endosc Percutan Tech* 19:392–394