International Journal of Surgery 33 (2016) S45–S50

Contents lists available at ScienceDirect

International Journal of Surgery

journal homepage: www.journal-surgery.net

Original research

Surgeon's clinical valuation and accuracy of ultrasound in the diagnosis of acute appendicitis: A comparison with intraoperative evaluation. Five years experience

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ARTICLE INFO

Article history:
Available online 30 May 2016

Keywords:
Ultrasound
Appendicitis
Acute appendicitis

ABSTRACT

Introduction: Acute appendicitis is the most common cause of acute abdomen in adolescents, with an overall incidence of 7%. Two such tools are used to diagnose acute appendicitis: ultrasound and Computer Tomography imaging. End point of this study was to verify the accuracy of ultrasound imaging in the diagnosis of acute appendicitis with respect to intraoperative observations and the respective clinical and laboratory findings in young and in the elderly.

Methods: We considered all the appendectomies for acute appendicitis performed between 1 January 2010 and 1 January 2015. We evaluated clinical symptoms, laboratory findings, ultrasound findings, intraoperative signs, and anatomical and pathological findings. In the study we compared the ultrasound and intraoperative findings and then compared these with the respective clinical and laboratory data.

Results: In a comparison of diagnostic accuracy, the difference between clinical and ultrasound examinations was not significant. The differences between the diagnostic accuracy of clinical and laboratory findings and between ultrasound and laboratory investigations were statistically significant.

Conclusion: We defined white blood cells and C protein levels as non-diagnostic of the type of acute inflammation but rather as indicators of the severity of the inflammatory process.

We also agree with the authors who proposed the incorporation of ultrasonography into routine practice in the diagnosis of acute appendicitis, but only and exclusively to support other diagnostic procedures and preferably within emergency departments. A thorough clinical examination of patients with suspected acute appendicitis is still the best diagnostic procedure available to us.

1. Introduction

Acute appendicitis is the most common cause of acute abdomen in adolescents [1–4], frequent both in young and elderly, with an overall incidence of 7% as reported in the literature [5].

An important predictor in the clinical diagnosis of acute appendicitis is the classic migration of pain described by Murphy in 1905 [6]; according to the medical literature, this alone has a diagnostic accuracy of up to 95% [7,8]. The positivity of McBurney's sign increases suspicion of acute appendicitis [9]. If presentation is typical, the diagnosis of acute appendicitis is based on clinical and laboratory findings with no need for any further investigations; however, in 35–40% of cases the clinical features are non specific and unclear [10]. According to some studies, the discriminatory power of clinical and laboratory findings alone is not strong enough to diagnose acute inflammation of the appendix [11–16], and the use of a first-level diagnostic tool is essential for early diagnosis

Abbreviations: CT, Computed tomography; US, ultrasound.

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http://dx.doi.org/10.1016/j.ijsu.2016.05.052
1743-9191/

[17].

Two such tools are used to diagnose acute appendicitis: ultrasound and CT imaging [18–21].

The use of ultrasonography to visualize the appendix was first described by Deutsch and Leopold in 1981 [22], and in 1986 Puylaert described the use of graded compression during ultrasound examination in the diagnosis of patients with suspected acute appendicitis [23].

Ultrasound imaging is currently the diagnostic examination of choice for patients admitted to the emergency department with acute inflammation [24,25]. CT imaging has been found to have better diagnostic accuracy than ultrasonography, but is also more expensive [18–21,26]. It also delivers a dose of radiation & should not be used in children or in childbearing aged women.

End point of this study was to verify the accuracy of ultrasound imaging in the diagnosis of acute appendicitis with respect to intraoperative observations and the respective clinical and laboratory findings.

2. Methods

This retrospective study was performed at the San Luigi Gonzaga University Hospital General Surgery Unit, in collaboration with the University Radiology Unit, in Orbassano, Turin, Italy, and took into consideration all the appendectomies for acute appendicitis performed between 1 January 2010 and 1 January 2015. The cohort comprised a total of 157 patients.

Of these, the following were excluded from the study: 44 patients in whom a certain diagnosis was made on the basis of clinical and laboratory findings and surgery was performed without preoperative imaging, and nine patients with particularly serious clinical and biohumoral symptoms, all of whom underwent a preoperative CT scan in the first instance. In the latter group of patients, ultrasound scans were not performed prior to surgery. Our study sample thus comprised 104 patients.

The following parameters were evaluated: clinical symptoms (pain, nausea, vomiting, body temperature, McBurney's sign, guarding in the right iliac fossa), laboratory findings (WBC, CRP), ultrasound findings (visualization of the appendix, appendiceal peristalsis, appendiceal wall thickening, compression of the viscus by application of the probe, periappendiceal effusion and lymphadenopathy), intraoperative signs (appendiceal erythema-edema, appendiceal phlegmon, gangrene of the appendix, perforation, gangrene and effusion), and anatomical and pathological findings (perivisceritis, edema, serositis, necrosis). For each group, a final overall rating of the “typicality of findings” for acute appendicitis was assigned.

Typical clinical symptoms included fever and localized right iliac fossa pain, with or without nausea and vomiting. As regards laboratory variables, typical symptoms included a WBC of >13,000 and CRP of >5. Ultrasound variables included visibility of the appendix with thickening of the walls, or the simultaneous presence of two or more of the following secondary characteristics: adipose inflammation, periappendiceal lymphadenopathy, periappendiceal effusion. Typical anatomical and pathological findings confirmed the presence of lymphocytic infiltration associated with one or more of the following characteristics: perivisceritis, exudative peritonitis, edema, serositis, necrosis or polymorphonuclear inclusions.

For the ultrasound diagnosis only, the “doubtful finding” parameter was included when just one of the secondary signs was present.

Intraoperatively, a positive diagnosis of acute appendicitis was made if the surgeon identified one of the following signs: appendiceal erythema, erythema-edema, phlegmon, necrosis. The simultaneous presence of free fluid or visceral perforation with diffuse peritonitis was recognized as characteristic of acute appendicitis but not as an actual diagnostic variable.

All ultrasound scans were performed by a team of radiologists from the same school.

All the appendectomies were performed by laparoscopy, with access Veress assisted through an umbilical incision and the use of two operative ports: one in the left iliac fossa and one in the suprapubic area.

All the operations were performed by three surgeons with similar experience in laparoscopy (more than 100 emergency laparoscopic procedures and more than 200 laparoscopic cholecystectomies).

Results of the anatomical and pathological evaluations were found to be fully in agreement with intraoperative observations. The latter were therefore taken as valid findings.

In the study we compared the ultrasound and intraoperative findings and then compared these with the respective clinical and laboratory data.

3. Results

Demographic characteristics of our study sample are described in Table 1: the patients were statistically comparable. Table 2 shows the results in terms of the “typical findings” of the evaluations performed. 24 uncertain diagnoses were made with ultrasonography; of these, 20 were found to be acute appendicitis during surgery and four were normal.

Uncertain diagnoses were based on the identification of a single positive finding and were therefore classified as positive, albeit only faintly.

Table 3 shows the definitions and the stratification of the true positive, true negative, false positive and false negative results for each parameter evaluated. As regards true positives, clinical examinations identified 70 cases, laboratory investigations 35 and ultrasound imaging 75. Clinical examinations produced false negative results in 31 cases, laboratory investigations in 62 and ultrasonography in 22. Clinical examinations produced no false positives and four true negatives. Laboratory investigations also produced four true negatives and four false positives. Ultrasound imaging produced five false positives and three true negatives.

Specificity, sensitivity, positive predictive value, negative predictive value and diagnostic accuracy are shown in Table 4.

Significance was: 100% for clinical examinations, 50% for laboratory investigations, 37.5% for ultrasound imaging.

Sensitivity was: 67.9% for clinical examinations, 77.3% for

Table 1
Patient baseline characteristics.

Patient baseline characteristics	
Male [n° (%)]	59 (56.19%)
Female [n° (%)]	46 (43.81%)
Mean age (yr), mean (±SD)	35 (±12.3)

SD: Standard deviation.

Table 2
Results of evaluation.

	Opinion		
	Typical	Not typical	Dubt
Clinic (n°)	70	35	∅
Laboratory (n°)	39	66	0
Ultrasound (n°)	56	25	24