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Comparative Study between Ultrasonography & the Alvarado Score in Diagnosis of Acute Appendicitis - A Study of 110 Cases

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Abstract
Acute appendicitis is one of the most common surgical emergencies encountered by surgeon. The diagnostic accuracy in these cases should be high because negative appendectomy carries significant morbidity as there is a great risk for abdominal adhesions after appendectomy. Ultrasound is operator dependant for diagnosing acute appendicitis. Alvarado scoring is a simple additive scoring system for quick diagnosis of acute appendicitis. A comparative study of cases with ultrasound & Alvarado scoring system was carried out in the department of general & laparoscopic surgery, VSSIMSAR, Burla, Odisha march 2016 to march 2017 to ascertain both procedures.

Introduction

Acute appendicitis is the most common acute abdominal condition in young adults. Although Reginald Heber Fitz was able to consolidate a fragmented surgical philosophy regarding appendicitis, more than a century ago diagnosis of appendicitis remained a challenges. Appendicitis has an ability to simulate other conditions and also it can be mimicked by other pathological conditions. Although considered as one of the most elemental of general surgical disease processes. It is difficult to obtain an accurate preoperative diagnosis in many cases. Therefore delay in diagnosis and surgery result in deadly complication like and the rate of which rises by 5% per 12 hour period, 36 hours after the onset of symptoms to prevent this high morbidity and mortality from perforation, traditionally surgical intervention has been advocated accepting a negative appendectomy rate ranging from 2% to 30%. But this causes considerable clinical and financial costs. As this disease is amenable for treatment by surgery, early diagnosis plays an important role. Commonly used modalities for diagnosing acute appendicitis are various diagnostic scores, USG, CECT abdomen, Laparoscopy etc. One such diagnostic scoring is the Alvarado scoring.

In a tertiary care centre like VSSIMSAR, Burla. There still exist no comparative data on the efficacy of clinical scoring system like the Alvarado scoring versus imaging modality

ultrasonography in the diagnosis of acute appendicitis. This study aims to compare both these modalities.

Aims and Objectives

1. To study & compare the accuracy of USG & Alvarado scoring system in acute appendicitis
2. Cost effectiveness of USG & Alvarado scoring system in acute appendicitis.

Inclusion Criteria

Those satisfying following conditions were included.

a) All patients above the age of 15 years undergoing surgery for the suspected acute appendicitis in VIMSAR, Burla during the study period.
b) Patients who have not received any antibiotics before presenting to the hospitals as it can mask the clinical signs.

Exclusion Criteria

a) Patients less than 12 years of age
b) Patient with other pre-existing ileocaecal pathology like Tuberculosis or malignancy which is the underlying causes for appendicitis.
c) Patients who have received antibiotics before presenting to the hospital.

Material & Methods

Patients admitted in VSSIMSAR with features suggestive of acute appendicitis and undergoing for the same were included in this study, for each patient Alvarado score was calculated and the result of ultrasonography was noted. Diagnosis of appendicitis was confirmed on the basis of the histopathological examination of the respected appendix specimen. Efficacy of Alvarado scoring system and ultrasonography in making the accurate diagnosis of appendicitis were compared.

Study Design: The present study was a prospective study.

Study Period: This study was performed during the period from March 2016 to march 2017

Source of Data: Data was collected from inpatient and outpatient records of the subjects included in the study.

Method of Collection of Data

a) History and physical examination
b) Blood investigations including leucocyte counts and differential count
c) Ultrasonography
d) Operative notes and anaesthesia notes
e) Day to Day progress records
f) Histopathological examination of the respected appendix were entered into the proforma made for the study.

Observation

Age Distribution

Age in yrs	No. of patients	%
≤ 20	18	16.36
21-30	55	50
31-40	18	16.36
41-50	7	6.36
51-60	6	5.45
>60	6	5.45
TOTAL	**110**	**100**

Range was 15 years to 75 years. Majority of the patients were in the age group 20-30 years (50 %)

Gender Distribution

Gender	No.	%
Male	64	58
Female	45	42
Total	**110**	**100**

There was a male preponderance noted in this study out of 110 patients, 64 were males and 46 were females.

Type of Operation

Type of operation	No.	%
Laparoscopy	23	24
Open	73	76
Total	**96**	**100**

Out of 96 patients 73 underwent open appendicectomy and 23 underwent Laparoscopic Appendicectomy.

Alvarado Scoring

Out of 110 patients has a score of 7 or more, 40 had a score less than 7.

Prevalence of Various Clinical and Laboratory Parameters in acute Appendicitis Patients

Clinical Parameters	% in acute appendicitis
RIF tenderness	100
RIF Pain	96.36
Shift to left	64.45
Leucocytosis	62.73
Anorexia	62.73
Nausea/vomiting	58.18
Rebound Tenderness	51.8
Fever	35.45

Association between Alvarado Score and Acute Appendicitis

Score	Acute appendicitis		Total
	Positive	Negative	
≥ 7	64	6	70
< 7	14	26	40

Sensitivity and Specificity of Alvarado Score Considering a score of 7 or more as Positive

Diagnostic test results	Appendicitis	Not appendicitis	total
Score ≥ 7 (positive)	(true positive) 64	(false positive) 6	70
Score < 7 (negative)	(False negative) 14	(true negative) 26	40
Total	78	32	110

Sensitivity ---------- 82.05 %
Specificity ---------- 81.25 %
PPV---------- 91.42 %
NPV---------- 65 %
DA---------- 81.52 %
Negative Appendicectomy Rate----- 8.5 %

Discussion

The Alvarado score is a simple additive scoring system for diagnosis of acute appendicitis. It has been reported to be a cheap & quick diagnostic tool in patient with acute appendicitis. However different in diagnostic accuracy have been observed if the score are applied to various populations and clinical settings.

In the present study positive ultrasound showed an overall sensitivity of 84.61 % a specificity of 50 %, a positive predictive and negative predictive value of 80.48% and 57.14% respectively. The predictive value of positive ultrasound is very good at 80.48 % as shown in the study; where out of the 82 cases which ultrasound reported as positive for appendicitis 78 cases were proven to have appendicitis on histopathology.

Appendicitis is defined as the inflammation of the vermiform appendix. In 1886, Reginald Fitz of Boston correctly identified the appendix as the primary cause of right lower quadrant inflammation. He coined the term appendicitis and recommended early surgical treatment of the disease. Richard hall reported the first survival of a patient after removal of a perforated appendix, which focused attention on the surgical treatment of the acute appendicitis. In 1889, Chester McBurney described characteristics migratory pain as well as localization of the pain along an oblique line from the anterior superior iliac spine to the umbilicus. McBurney described a right lower quadrant muscle-splitting incision for removal of the appendix in 1894.

Alfred Alvarado conducted a retrospective study of 305 patients admitted at Nazereth Hospital, Philadelphia from Jan 1975 to Dec 1976 with presentation suggestive of acute appendicitis with an aim to formulate a practical scoring for early diagnosis of acute appendicitis. Signs symptoms and laboratory findings were analyzed for sensitivity, specificity, predictive value and joint probability. It was found that none of the signs or symptoms or laboratory investigations was sensitive or specific enough to make the accurate diagnosis of appendicitis alone. Thus a scoring system consisting of 3 symptoms, 3 signs and 2 laboratory investigations was formulated.

Alvarado scoring for acute appendicitis

Symptoms	**Score**
Migratory RIF pain	1
Anorexia	1
Nausea and vomiting	1
Signs	
Tenderness (RIF)	2
Rebound tenderness	1
Elevated temperature	1
Laboratory	
Leucocytosis	2
Shift to left	1
Total	**10**

Patients with scores of 9 to 10 are almost certain to have appendicitis; there is little advantage in further workup and they should go to the

operating room. Patients with scores of 7 to 8 have a high likely hood of appendicitis, while scores of 5 to 6 are compatible with but not diagnostic of appendicitis. Imagine a certainly appropriate for patients with Alvarado scores of 5 and 6 and a case can be built for imaging those with scores of 7 and 8 on the other hand it is difficult to justify the expense, radiation exposure time and possible complications of imaging modalities like CT scanning in those patients whose scores of 0 to 4 make it extremely unlikely (but not impossible) that they have appendicitis.

Ultrasonography in appendicitis: graded compress USG is a well-documented technique for examination of the appendix. The USG probe is applied with gradually increased pressure over the right iliac fossa in order to displace bowel loops and examine the appendix. USG signs of acute appendicitis include visualization of a blind-ending tubular structure, which is no compressible with a diameter of 7 cm or greater. An appendicolith may be seen as a hyper echoic focus casting an acoustic shadow and the surrounding inflammatory mass, which consists mainly of fat is hyper. An abscess or fluid around the appendix may be seen. USG of acute appendicitis has been reported to have a sensitivity of 78-98 percent and specificity of 85-98 percent. The most sensitive sign is that of a non-compressible appendix with a diameter of 7 mm or greater. Similar results are reported in adults and children. There are interpretative pitfalls: fall-negative results can arise in focal appendicitis of the appendiceal tip, retrocaceal appendicitis, gangrenous or perforated appendicitis, a gas-filled appendix and a massively enlarged appendix which is very unusual in the inflamed appendix. Pitfalls leading to a false-positive examination include resolving appendicitis, dilated fallopian tube, inflammatory bowel disease and inspissated stool mimicking an appendicolith. When the appendix has perforated it may be compressible at USG. This phenomenon has been reported in 38 % of paediatric perforations and 55 % of adult perforations. The main drawback of USG is that in most instances, in most hands, a normal appendix is not visualized and subsequently a negative USG result, where the appendix is not seen is of little value. Nevertheless USG can diagnose a number of conditions that mimic appendicitis clinically. When an experienced radiologist is available, USG can be recommended in children where there is diagnostic doubt in young women (due to higher incidence of tubal disease) and in those patients who are pregnant.

C D Douglas et al in a randomized control trail comparing clinical diagnosis (control) with a diagnostic protocol incorporating ultrasonography and the Alvarado score (intervention group) measured sensitivity and specificity of ultrasonography in diagnosing acute appendicitis at 94.7 % and 88.9 % respectively.

Ultrasound diagnosis of acute appendicitis was based on criteria of Jeffery et al which include the following.

1. In early acute appendicitis five layers can be identified.
2. In suppurative stage, the lumen is distended with pus/fluid and there is increased thickening of the wall.
3. In perforation an asymmetric thickening of the wall with a focal / circumferential lack of visualization.
4. In inflamed appendix is seen as a probe tenderness, blind-ended tubular structure with a laminated wall arise from the base of the calcium, aperistaltic, non compressible, duiameter>6 mm.
5. Pericaecal fluid collection.
6. Single/multiple inter-loop abscess.
7. Appendicolith
8. Hyperaemia of mesoappendix.

Pathology

Age: appendicitis is most frequently seen in patients between the second and the fourth decades.

Sex: Males are affected more commonly than females.

Race: It is particularly common in the highly civilized European, American and Australian countries while it is rare in Asians and Africans.

Diet: The high incidence in developed nations has been attributed to the high protein and low residue diet. Which is being adopted by most of the urban classes, which cause hard, dry faces relative to that high fibre.

The Two Important Factors for Causing Appendicits

1. **Luminal Obstruction**

   Obstruction to the lumen is believed to be

   The major cause of acute appendicitis as when as acutely inflamed appendix has been removed some form of obstruction to its lumen can be demonstrated. Obstruction of the lumen can be:

   - In the lumen – faecolith, foreign body, parasites.
   - In the wall – inflammatory, direct occlusion by carcinoma of caecum.
   - Outside the wall – adhesions and kinking.

Faecoliths: They are composed of inspissated faecal material, calcium and magnesium phosphates and carbonates, bacteria and epithelial debris.

2. **Bacterial Factors:** Lumen of the appendix harbours a variable and mixed flora such as E.Coli, bacteriodes, streptococci. Epithelial erosions may admit organism to the sub mucosal layer and progressive inflammation will occur with a pathogenic organism. Alternatively organism in the blood stream may enter the wall of the appendix and the lymphoid follicles may be the initial sites of active inflammation. Appendicitis is a polymicrobial infection with series reporting up to 14 different organism cultured in patients with perforation.

Clinical Features

Symptoms

1. **Abdominal pain:** At the onset, pain is of central colicky type around the umbilicus (per umbilical). After a few hours, the pain shifts to the right lower abdomen and is continuous and severe.
2. **Nausea and vomiting:** A bout of vomiting may occur, rather than repeated episodes.
3. **Disturbances of bowel habits:** The bowels are usually constipated but occasionally diarrhea occurs especially when the appendix lies in the postileal or pelvic position.
4. **Urinary Symptoms:** Disturbances of micturation in the form of frequency, dysuria or haematuria are usually an indication that the appendix is situated near the ureter or the bladder.
5. **Anorexia:** Most of the patients complain of anorexia.
6. **Temperature:** Usually patients might have a low grade fever. Higher grade fever should the suspicion of a perforated appendix.
7. **Pulse rate:** There might be tachycardia, especially in perforated appendicitis.

Signs

Rovsing's Sign: If the left iliac fossa is pressed, pain in appreciated in the right iliac fossa. The sign appears to be due to the shift of coils of ileum to the right impinging on the appendix.

Rebound tenderness (Blumber'g Sign): with each expiration the hand on the abdomen is gradually pressed down as the circumstances may allow. This is now withdrawn suddenly and completely. As a result of this abrupt removal the abdominal musculature springs back into its original place. The patient will immediately cry out or at least wince with pain. This is due to the fact that parietal peritoneum which has already been inflamed due to the presence of underlying inflamed organ also springs back along with the abdominal muscle. This sudden movement of the inflamed peritoneum is very painful.

Psoas Test: A retro caecal appendix lies on the psoas major muscle. Inflammation of this appendix will cause irritation of the muscle. When the right hip joint of the patient is hyper extended,

this muscle is stretched and with initial pain in case of retrocaecal appendicitis.

Cope's obturrator test: A pelvic appendix may lie on the obturator internus muscle. When this appendix becomes inflamed, internal rotation of the hip joint will stretch the obturator internus and the patient will complain of pain.

Hyperaesthesia: Presence of hyperaesthesia in sherren's triangle which is formed by lines joining the umbilicus, right guide in the diagnosis of gangrenous appendicitis.

Per rectal examination: The right rectal wall may be tender in pelvic type of appendicitis which may not show tenderness or rigidity on the anterior abdominal wall.

Ultrasonography

Graded compression ultrasonography has been suggested as an accurate way to establish the diagnosis of acute appendicitis. The technique is inexpensive can be performed quickly does not require contrast and can be used even in pregnant patients.

Advantages of Graded Compression are:

1. The distance between the transducer and the pathologic process is greatly reduced, which allows the use of high-frequency transducer with a short focus.
2. The region of maximal tenderness as indicated by a patient with his fingers is approached more precisely.

Sonographic Findings of acute Appendicitis

Sonographically the appendix in appendicitis is visualized as blind ending, non peristaltic bowel loop with compression, the diameter of the appendix is measured in an antero – posterior dimension. A scan is considered positive if a non compressible, blind ending, aperistaltic, tubular, hypo echoic structure of 6 mm or greater in the antero – posterior direction is demonstrated. The presence of an appendicoilth suggests the diagnosis. The presence of thickening of the appendiceal wall and periappendical fluid and hyperechoic pericaecal fat is suggestive.

Differential Diagnosis

The clinical manifestations are not specific for disease which cause acute abdomen, but rather are specific for disturbance of a physiologic function. Thus an identical clinical picture can result from a wide variety of acute processes or near the peritoneal cavity that produce the same alterations of function as acute appendicitis. Depends on the locations of the inflamed appendix patient's age and sex.

	CAUSES
OTHER GIT CAUSES	Acute Gastroenteritis Meckel's Diverticulitis Intussusception Crohn's Enteritis Perforated Peptic Ulcer Perforating Carcinoma of Caecum Right sided Diverticulitis Epiploic Appendicitis Acute Mesenteric Adenitis
GYNECOLOGICAL	Pelvis Inflammatory Disease Ruptured Ovarian Follicle Ruptured Ectopic Pregnancy Twisted Ovarian Cyst Acute Epididymitis
UROLOGIC	Acute Pyelonephritis Ureteral Stone Testicular Torsion Acute Epididymitis
THORACIC	Basal Pleurisy

Treatment

The correct treatment of appendicitis in all its aspects is one of the most important subjects in abdominal surgery because it is the most common major abdominal condition calling for emergency operation. Erikkson and Grandstrom compared antibiotic therapy alone versus surgery in patients with appendicitis. But the recurrence rate is very high in cases treated with antibiotic therapy alone. Hence patients with acute appendicitis are managed by prompt surgical intervention. The acute attack of appendicitis has been linked to a knock at the door saying "let me out'' (William Boyd). The exception to this rule is when a palpable mass by interval appendectomy after 6-10 weeks should be done.

Per-operative preparation

Once a decision to operate has been a brief period of resuscitation is done. A preoperative dose of

antibiotic is needed to reduce the incidence of postoperative wound infections.

Incisions for open appendicectomy

A McBurney (oblique), Rockey-Davis (transverse) or modified McBurney (curvilinear over Langer's line sometimes called Lanz) muscle splitting incision is typically performed classically over the point of maximal tenderness. The Rockey-Davis incision allows for medial extension over the rectus muscle (Flower-Weir extension) or lateral extension through the muscle bellies of the internal oblique and transverses abdominal muscles (Rutherford Morrison Incision) for better exposure.

Conclusion

Alvarado score is a simple aid in diagnosing acute appendicitis and found to be a better diagnostic tool than ultrasound alone in diagnosis of acute appendicitis. But as no statistical difference could be proven between them neither one can be entirely relied upon as single best diagnostic test because in such situation significant number of cases are missed. Neither Alvarado score nor ultrasonography is absolute tool in reducing negative laparotomy in suspected appendicitis cases. However the false positive rate is reduced when both studies are positive. Ultrasound improves the diagnostic accuracy when one's degree of clinical suspicion is high. However the additional information provided by ultrasound dose improves diagnostic accuracy in cases where Alvarado score is negative or equivocal.

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