A COMPARATIVE STUDY OF APPENDICITIS INFLAMMATORY RESPONSE SCORE AND ALVARADO SCORE FOR PATIENTS WITH ACUTE APPENDICITIS AT TERTIARY CARE HOSPITAL, BELGAUM – A PROSPECTIVE ANALYTICAL STUDY

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This is to certify that the thesis entitled **"A COMPARATIVE STUDY OF APPENDICITIS INFLAMMATORY RESPONSE SCORE AND ALVARADO SCORE FOR PATIENTS WITH ACUTE APPENDICITIS AT TERTIARY CARE HOSPITAL, BELGAUM - A PROSPECTIVE ANALYTICAL STUDY"** is a bonafide research work done by Candidate **REG NO:BH0113002.**

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ABSTRACT

***Background*:** Acute appendicitis still remains one of the most common abdominal emergency, demanding surgery. No perfect diagnostic evaluation tool exists to detect appendicitis if symptoms are ambiguous. With the advent of modern diagnostic tools, misdiagnosis of appendicitis has remained constant. Many scoring systems have been designed for diagnosis of acute appendicitis, among those, Alvarado system being simple to apply and efficacious.

***Aim*:** To compare Appendicitis Inflammatory Response Score (AIR) and Alvarado scoring systems in evaluating suspected cases of acute appendicitis.

***Materials & Methods*:** In a tertiary care hospital, 100 patients presenting with pain in the right lower quadrant of abdomen, who after clinical examination and relevant investigations were provisionally diagnosed to have acute appendicitis and warranting surgery for the same were evaluated using the scoring system – Alvarado Score and Appendicitis Inflammatory Response Score. The scores were tallied and compared with final histopathology report. The study was conducted for a period of one year.

***Results*:** AIR (at score >4) demonstrated a higher sensitivity and specificity compared to Alvarado score (89.9 vs 78.6%) and (63.6 vs 54.5) respectively. Alvarado showed a slightly better sensitivity at score>8 (21.3 vs 12.3%) respectively.

***Conclusion*:** Appendicitis Inflammatory Response Score outperformed Alvarado score . Such a scoring system is required for better diagnosis and avoid negative appendectomies.

LIST OF ABBREVIATIONS

AIR – Appendicitis Inflammatory Response

AA – Acute Appendicitis

CA – Chronic Appendicitis

HPR – Histopathology Report

CRP – C – Reactive Protein

ASA – Acute Suppurative Appendicitis

CT – Computerised Tomography

USG – Ultrasound

RLQ – Right Lower Quadrant

PML – Polymorphonuclear Leucocytes

WBC – White Blood Cell

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INTRODUCTION

Reginald Fitz from Boston first identified appendix as cause of right lower quadrant pain. He coined the term appendicitis and recommended early surgery intervention. Robert Lawson performed first appendectomy in England [1].

Now 130 years later, acute appendicitis still remains one of the most common abdominal emergency, demanding surgery. Mortality rate has improved since advent of antibiotics in 1940.

No perfect diagnostic evaluation tool exists to detect appendicitis if symptoms are ambiguous. If symptoms are vague diagnostic process takes longer , thus delaying surgery increasing the possibility of complications .

On the other hand, hasty operation without accurate diagnosis will lead to negative appendectomy, increasing the morbidity and cost of treatment [2,3] .

With the advent of modern diagnostic tools, misdiagnosis of appendicitis has remained constant. The percentage of misdiagnosis is higher among women than men.

Diagnostic approaches include symptoms, physical examinations, labarotory findings and imaging modality like ultrasonography and computerized tomography (CT) of abdomen.

Although the advent of ultrasound has improved the diagnosis of appendicitis, it is highly operator dependant. The abdominal CT carries risk of radiation exposure and also increases the cost [4].

Many surgeons tend to rely on abdominal ultrasound or CT examination for objective diagnosis.

Many scoring systems have been designed for diagnosis of acute appendicitis. Among those systems, Alvarado system being simple to apply and efficacious [5,6] .

The Alvarado score – a scoring system for diagnosing appendicitis uses eight variables with total of 10 points.

Alvarado scoring system has the following drawbacks: Its construction was based on review of patients who had been operated with suspicion of appendicitis – retrospective analysis.

- Whether each variable is statistically and independently relevant to acute appendicitis and valid as an inflammatory reaction variable is not accounted for.
- The score does not incorporate C-reactive protein (CRP) as a variable, though many studies have showed its importance in assessment of patients with appendicitis [7].

The recently introduced Appendicitis Inflammatory Response Score incorporating CRP was designed with a view to overcome these drawbacks [8].

AIM OF THE STUDY

To compare Appendicitis Inflammatory Response Score and Alvarado scoring systems in evaluating suspected cases of acute appendicitis.

REVIEW OF LITERATURE

Historical Review

In 1886, Reginald Fitz identified appendix as cause of right lower quadrant inflammation. He coined the term 'appendicitis' and early surgical intervention [9].

Berengario-da-Carpi (1524), Fleming and Andreas Vesalius first described the anatomy of appendix.

First appendicectomy was performed by Claudius Amyand, a surgeon at St.George's Hospital in London and Sergeant Surgeon to Queen Ann, King George I and King George II. He operated on an 11 year old boy with a scrotal hernia and a fecal fistula. He removed the appendix and repaired the hernia [10].

In 1824, Louyer-Villermay presented a paper before the Royal Academy of Medicine in Paris. He reported two autopsy cases of appendicitis and stressed the importance of the condition.

Dupuytren said that inflammation of the cecum was the primary cause of pathology of the right lower quadrant. The term *typhlitis* or *perityphlitis* was used to describe right lower quadrant inflammation.

In 1848, Hancock performed the first surgery for appendicitis or perityphlitis without abscess . He incised the peritoneum and drained the right lower quadrant without removing the appendix.

The first published account of appendectomy for appendicitis was by Krönlein in 1886.

However the greatest contributor to the advancement in the treatment of appendicitis was Charles McBurney. In 1889, he described the McBurney point of maximum tenderness, when one examines with the fingertips, in adults, half to two inches inside the right anterior superior iliac spine on a line drawn to the umbilicus[11].

Kurt Semm is credited with performing the first successful laparoscopic appendicectomy in 1982 [12].

The Alvarado score was described in 1986 [5]. Later it was modified by Kalan[13].

The AIR score was first introduced in sweden in 2008.

Embryology of the Appendix

The derivatives of the midgut are:

- The small intestine
- The cecum, appendix, ascending colon and right half to 2/3rd of the transverse colon.

The primordium of the cecum and appendix – the cecal diverticulum – appears in the 6th week as a swelling on the antimesentric border of the caudal limb of the midgut loop (figure-1A). The growth of the apex lags as compared to the rest of it, making, the appendix a small diverticulum of the cecum initially (figure-1A). The length of the appendix increases rapidly so that at birth it is a relatively long tube arising from the distal end of the cecum (figure-1B). After birth the wall of the cecum grows unequally, with the result that the appendix comes to enter its medial side (figure-1B). The position of the appendix is variable. As the ascending colon elongates, the appendix may pass posterior to the cecum (retrocecal appendix) or

colon (retrocolic appendix). It may also descend over the brim of the pelvis (pelvic appendix). In 64% of people, the appendix is located retrocecally [14].

Appendiceal absence, duplication, and diverticula have all been described.

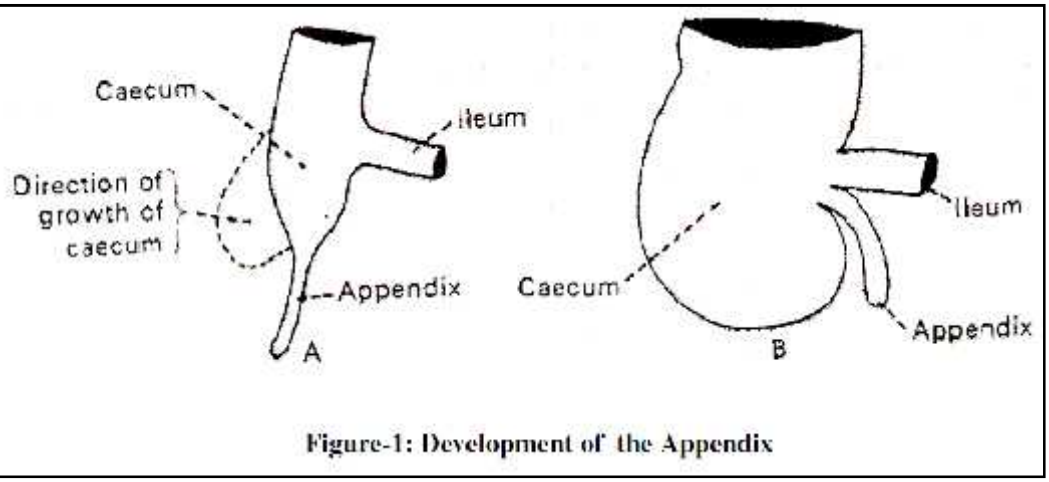


Figure-1: Development of the Appendix

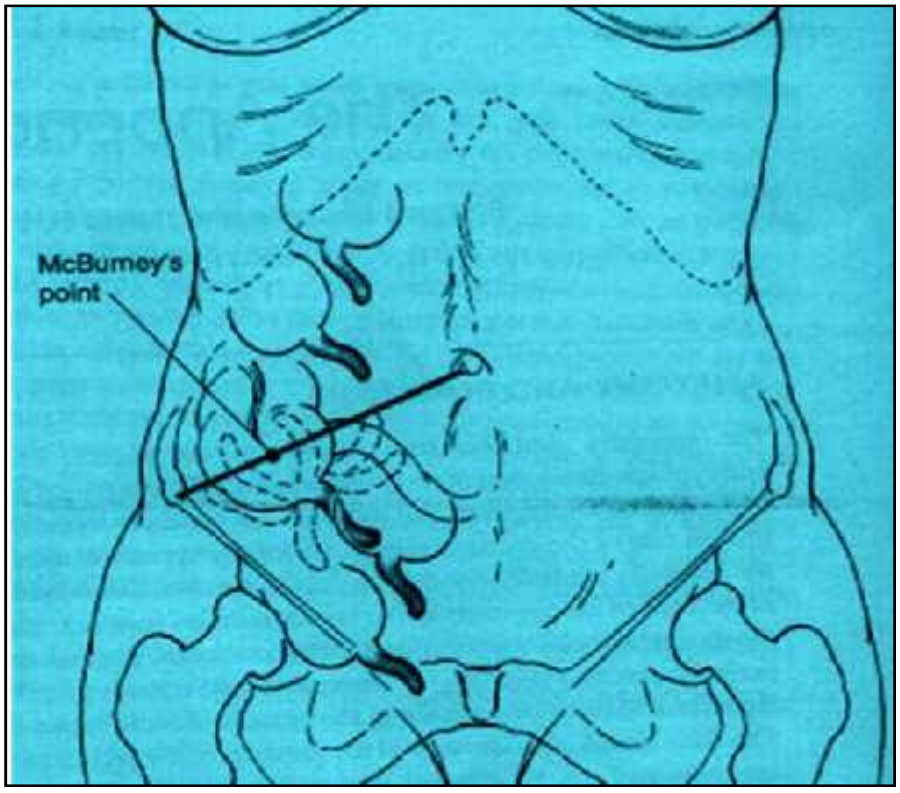


Figure-2: Various Anatomic Locations of the Vermiform Appendix

Position of the Appendix:

The location of the base of the appendix depends on the position of the caecum. The base is attached to the postero-medial surface of the caecum 2.5cm below the ileocaecal junction at a site where the 3 taenia coli meet. The remaining part is free.

In relation to anterior abdominal wall base lies 1/3rd or away from the line joining right anterior superior iliac spine to the umbilicus (McBurney's point).

In incomplete rotation of the bowel, caecum may lie at a higher level beneath the liver in relation to duodenum and gall bladder. In this position signs and symptoms of acute appendicitis mimic acute cholecystitis. When the caecum is long and mobile the appendix may lie in the pelvis, in which case the tenderness in acute appendicitis is felt on pelvic examination. Very rarely, in situs inversus, caecum and appendix lie in the left iliac fossa, in such cases acute appendicitis mimics acute diverticulitis of sigmoid colon.

The following positions of the appendix are described:

- Para-colic or Para-caecal or 11 O' clock position (2%)
- Retro-caecal or Retro-colic or12 O' clock position (74%)
- Splenic or 2 O' clock position
- Promonteric or 3 O' clock position
- Pelvic or 4 O' clock position
- Midinguinal or 6 O' clock position

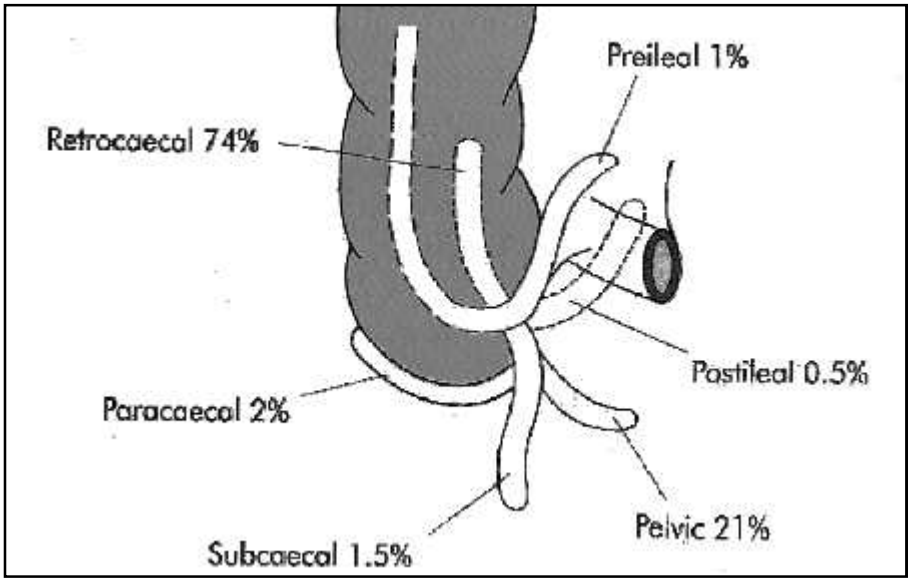


Fig 3: Positions of appendix

Anatomy of the appendix :

The posteromedial side of the caecum gives origin to the vermiform appendix about 1.7 cm from the end of the ileum. Posteriorly it is related to the iliopsoas muscle. Anteriorly it is related to the abdominal wall, the greater omentum, coils of ileum. The appendiceal wall is similar to the wall of the colon.

It is formed by:

The serosa, a muscular layer composed of the longitudinal and circular layers, submucosa, which contains many lymphoid islands and the mucosa.

The mesentery of the appendix is derived from the posterior side of the mesentery of the terminal ileum. The mesentery attaches to the cecum and proximal appendix. It contains the appendicular artery. The base of the appendix often lies deep to a point that is 1/3rd of the way along the oblique line joining the right anterior superior iliac spine to the umbilicus (McBurney point). The appendix can vary in length from <1 cm to >30 cm; most appendices are 6 to 9 cm long .

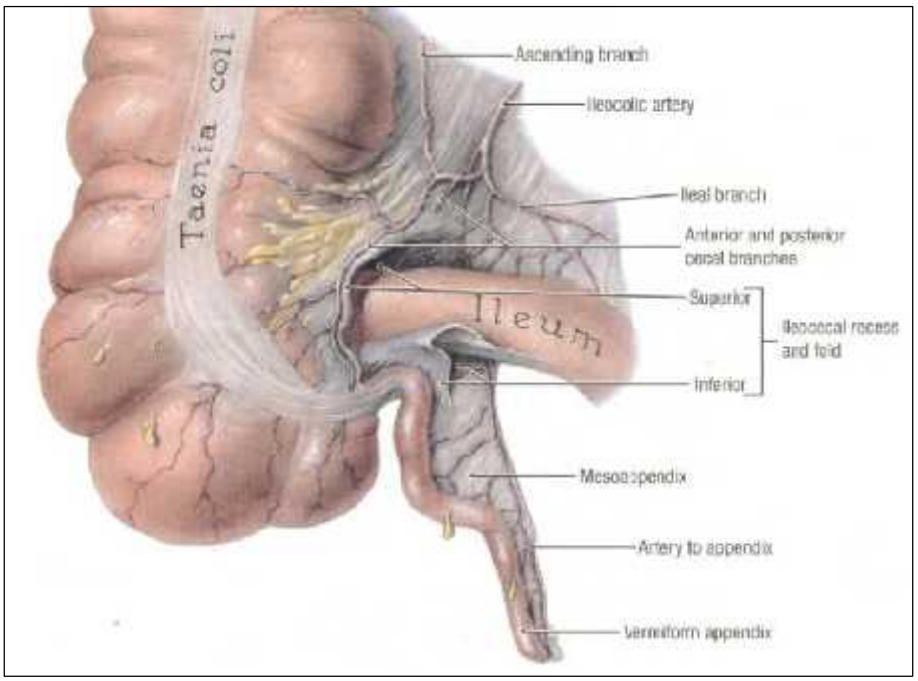


Fig 4 : Anatomy of the appendix

Blood supply: The appendicular artery arises from the ileocolic artery, an ileal branch, or from a caecal artery. The appendicular vein and artery are enveloped by the mesentery of the appendix. The appendicular vein joins caecal veins to become the ileocolic vein, which is a tributary of the right colic vein.

The **accessory appendicular artery** (or **artery of Seshachalam**) is a branch of the posterior caecal artery, which in turn arises from the ileocolic artery, and runs in the mesoappendix.

It is named after **Dr T Sheshachalam** who described it.

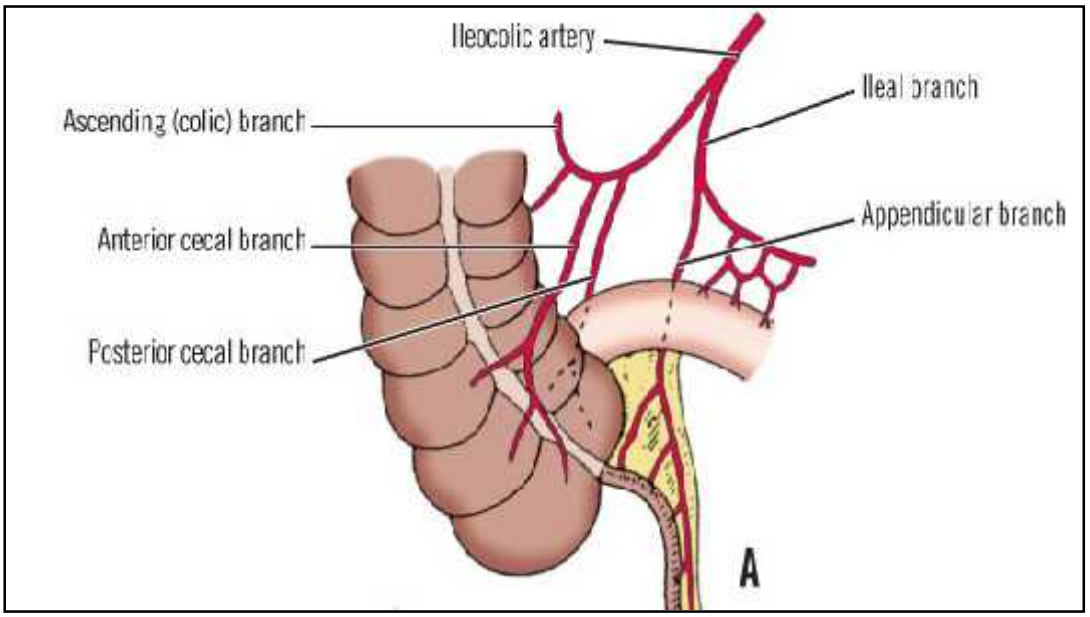


Fig 5 : Blood supply of appendix

Lymphatics: The lymphatics drain into the anterior ileocolic lymph nodes . Efferent lymphatic vessels pass to the superior mesenteric lymph nodes.

Nerve supply: Both sympathetic and parasympathetic from the superior mesenteric plexus . Sympathetic nerve fibres originate in lower thoracic part of spinal cord (T10-T12) and parasympathetic fibres arise from the vagus .

Acute appendicitis

It is inflammation of appendix. It is the commonest cause of acute abdominal pain. Obstruction of the lumen being the root cause.

The lifetime rate of appendectomy is 12 % for men and 25 % for women, with approximately 7 % of all people undergoing appendectomy during their lifetime.

It is most frequent in second to fourth decades of life, mean age 31.3 years and median age of 22 years. There is slight male: female preponderance (1.2 to 1.3:1).

Etiology

No definite hypothesis exists with regard to the etiology. Decreased dietary fiber and increased consumption of refined carbohydrates may be of importance.

Intestinal parasites, Pinworm in particular can proliferate in the appendix and occlude the lumen [15] .

Pathogenesis

Luminal obstruction is the dominant cause in acute appendicitis. Fecoliths being most common cause.

Others being, hypertrophy of lymphoid tissue, tumours, vegetable seeds , intestinal parasites .

There is a predictable sequelae of events leading to appendiceal rupture. The proximal obstruction of the appendiceal lumen produces a closed-loop obstruction with continuing secretion by the appendiceal mucosa producing distention. With the luminal capacity of the normal appendix being only 0.1 ml , secretion of as little as 0.5 ml of fluid distal to an obstruction raises the intraluminal pressure to 60 cm of water .

Distention of the appendix stimulates nerve endings of visceral afferent stretch fibers, producing vague, dull, diffuse pain in the midabdomen or lower epigastrium. Peristalsis is also stimulated by the distention, so that cramping may be superimposed on the visceral pain early in the course of appendicitis. Distention continues . Distention of increasing magnitude usually causes reflex nausea and vomiting and the visceral pain becomes more severe and diffuse . As pressure in the organ increases, venous pressure is exceeded. Capillaries and venules are occluded, but

arteriolar inflow continues, with resultant engorgement and vascular congestion. The inflammatory process then involves the serosa of the appendix and in turn parietal peritoneum in the region, producing the characteristic shift in pain to the right lower quadrant .

As mucosa in GIT , including appendix is compromised of vascular supply , bacterial invasion occurs. The area with the poorest blood supply suffer the most. Ellipsoidal infarcts develop in the antimesenteric borders .

Perforation generally occurs just beyond the point of obstruction rather than at the tip because of the effect of diameter on intraluminal tension.

This sequence is not inevitable, though some episodes of acute appendicitis subside spontaneously. Many patients who are found at operation to have acute appendicitis give a history of past , but less severe, attacks of right lower quadrant pain. Pathologic examination of the appendices removed from these patients often reveals thickening and scarring, suggesting old, healed, acute inflammation [16,17] .

Microscopy in acute appendicitis

The mucosa is edematous, hyperemic, infiltrated with polymorphonuclear leucocytes and in places with necrosis. There is also polymorphs infiltration seen in submucosa and muscularis. Vascular thrombosis is frequent in the appendix that eventually perforates. The lymphoid follicles are hyperplastic, necrotic.

The blood vessels of the serosa are often dilated and on the serous surface there may be a fine fibrinous exudate. Usually, a localized part in the wall is completely necrotic. The fibro-adipose tissue of the mesoappendix is usually edematous and hyperemic.

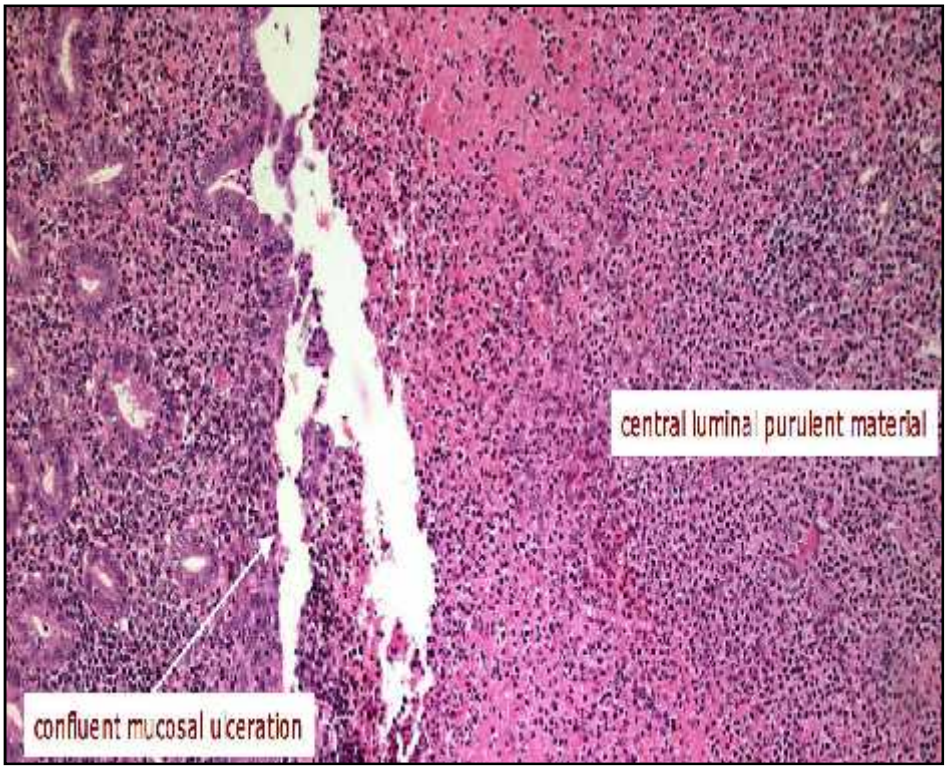


Fig 6 . Microscopy of the appendix

Bacteriology

The flora in normal appendix is similar to colon , with various facultative aerobes and anaerobic bacteria . Among patients with perforated appendicitis , peritoneal fluid cultures are more likely to be positive . The polymicrobial nature of perforated appendicitis is well established .

Aerobic : E.coli – 77 % , Streptococcus viridians 43% .

Anaerobic : Bacteroides fragilis 80 % .

Clinical features

Pain is the primary symptom. Pain is initially centered around lower epigastrium or umbilical area, moderately severe and steady, sometimes superimposed by crampy abdominal pain. After period of 4-6 hours, pain is localized to right lower quadrant. In some patients pain begins in right lower quadrant and remains there. Variations in the anatomic location of the appendix account for varying principal loci of pain.

For example, a long appendix with the inflamed tip in the left lower quadrant causes pain in that area. A retrocecal appendix may cause flank or back pain; a pelvic appendix, may present as suprapubic pain.

Anorexia nearly always accompanies appendicitis. Vomiting occurs in nearly 75% of patients, but is neither prominent nor prolonged. It is caused by both neural stimulation and ileus.

In >95% of patients with acute appendicitis, anorexia is the first symptom, followed by abdominal pain, which is in turn followed by vomiting (if vomiting occurs). If vomiting precedes the onset of pain, the diagnosis of appendicitis should be questioned.

Signs

Physical findings are determined principally by anatomic position of the inflamed appendix is, whether the organ has already ruptured when the patient is first examined.

In uncomplicated appendicitis temperature elevation is rarely >1°C and the pulse rate is normal or slightly elevated. Greater changes indicate that a complication has occurred and/or another diagnosis should be considered.

Classical physical signs are present when the inflamed appendix lies in the anterior position. Tenderness is maximal at or near the McBurney point. Direct rebound tenderness is present. In addition, referred or indirect rebound tenderness is present. This referred tenderness is felt maximally in the right lower quadrant, indicating localized peritoneal irritation [18].

Cutaneous hyperesthesia in the area supplied by the spinal nerves on the right at T10, T11, and T12 frequently accompanies acute appendicitis.

Muscular resistance to palpation of the abdominal wall parallels the severity of the inflammatory process. Early in the disease, resistance, if present, consists mainly of voluntary guarding. As peritoneal irritation progresses, muscle spasm increases and becomes largely involuntary, that is, true reflex rigidity due to contraction of muscles directly beneath the inflamed parietal peritoneum.

Other signs :

- Rovsing sign: pain in the right lower quadrant when palpatory pressure is exerted in the left lower quadrant - indicates the site of peritoneal irritation.
- Obturator sign: Flexion and internal rotation of right hip causes pain – indicates pelvic appendicitis.
- Iliopsoas sign: Elevation and extension of leg against resistance causes pain – retrocecal appendicitis .

Varying features as per age/condition :

Infants: Appendicitis is rare in infants under 36 months of age. Nonfocal findings such as lethargy, irritability and anorexia may be present in early stages of acute appendicitis .

Children: Those with appendicitis usually have aversion to food. In addition, they do not sleep during the attack and very often bowel sounds are absent in the early stages[19]. Mesenteric lymphadenitis commonly mimics this condition.

The Elderly: Fever is uncommon. Many do not experience lower quadrant pain. Perforation rate is high. Malignancy is to be considered in the differential diagnosis.

The Obese: Obesity can obscure and diminish all the local signs of acute appendicitis.

Pregnancy: Appendicitis is most common nonobstetric surgical disease of the abdomen during pregnancy. As nausea, vomiting and anorexia are common during pregnancy diagnosis is difficult. With gestation, location of tenderness is shifted. Fetal loss occurs in 3-5% of cases, increases upto 20% if perforation is found at operation [19].

AIDS or HIV infection: Incidence is reported to be 0.5 %. This is higher than 0.1 to 0.2 % incidence reported in the general population. Majority have fever, periumbilical pain radiating to right lower quadrant, right lower quadrant tenderness and rebound tenderness. Risk of appendiceal rupture appears to be increased in HIV-infected patients. Opportunistic infections should be considered as possible cause of right lower quadrant pain. Such opportunistic infections include cytomegalovirus (CMV) infection, Kaposi's sarcoma, tuberculosis, lymphoma, and other causes of infectious colitis.

Laboratory Findings :

White blood cell count is raised, with more than 75% neutrophils in most patients. A normal leukocyte count and differential is found in 10% of patients. A high white blood cell count (>20000/ml) suggests complicated appendicitis (gangrene or peforation).

A urinalysis is helpful in excluding acute pyelonephritis or nephrolithiasis. Minimal pyuria is seen in older age group but, does not exclude appendicitis, because ureter may be irritated adjacent to inflamed appendix. Though microscopic hematuria is common in appendicitis, gross hematuria is uncommon and may indicate presence of kidney stone.

C-Reactive protein

C-Reactive Protein level significantly differ between the surgical treatment necessary group and non-surgical treatment group. CRP level is consistent with the severity of appendicitis and considered to be a surgical indication marker for acute appendicitis.

Scoring Systems

Various scoring systems for appendicitis include :

Teicher Scoring System [20]

Predictors of Positive Appendicitis	**Predictors of Negative Appendicitis**
+2 Male	-1 Female
+3 Age 50+ years	-1 Age 20-39 years
+2 Duration 1-1/2 days	-3 Duration 3 days
+1 Duration 2 days	-3 GU symptoms
+3 Involuntary right lower quadrant muscle spasm	-3 No right lower quadrant muscle spasm
+2 WBC >13,000	-3 WBC <10,000
	-3 Rectal mass- r. side

Scores range from -11 to + 11. Cutoff point being "-3".

The purpose of the scoring system is to discriminate between the two groups when there is uncertainty as to indications for surgery for the *acute abdomen* or observation rather than diagnosing it.

Eskelinen Score [21]

Symptom/sign	**Criterion, points**	**Factor**
Tenderness	2 = RLQ, 1 = any other location	11.41
Rigidity	2 = Yes, 1 = no	6.62
Leucocyte count	2 = >10,000 G/l, 1 = <10,000 G/l	5.88
Rebound tenderness	2 = Yes, 1 = no	4.25
Pain at presentation	2 = RLQ, 1 = any other location	3.51
Duration of pain	2 = <48 h, 1 = > 48 h	2.13

Listed symptoms/signs - one or two points are given each.

Then multiplied by the respective factor and added to give a final sum.

C*ut-off point* for the diagnosis of acute appendicitis is **55**.

Disadvantage: Score was more *sensitive* leading to *false positive* clinical decisions, which would have resulted in a large number of unnecessary operations yielding to a more number of negative appendicectomies.

Alvarado Score [5]

Nausea or vomiting	1
Anorexia	1
Pain in right lower quadrant	2
Migration of pain to right lower quadrant	1
Rebound tenderness	1
Body temperature>37.5 C	1
Leukocytosis shift	1
WBC count >10000/cumm	2

Sum 0-4 – not likely appendicitis, sum 5-6 – equivocal, sum 7-8 probably appendicitis, sum 9-10 – highly likely appendicitis.

Drawbacks: It was based on data collected retrospectively.

Appendicitis Inflammatory Response Score

Vomiting	1
Pain in right lower quadrant	1
Muscular defense Light Medium Strong	 1 2 3
Body temperature >38.5 C	1
Polymorphonuclear leucocytes 70-84% Equal or more than 85%	 1 2
WBC 10000-14999 cells/cumm Equal or more than 15000/cumm	 1 2
CRP estimation 10-49 mg/l Equal or more than 50 mg/l	 1 2

sum 0-4 = low probability , sum 5-8 = intermediate group , sum 9-12 = high probability .

RLQ – right lower quadrant , CRP – C-reactive protein , WBC – white blood cell

Imaging studies:

Noninvasive:

Radiographs:

A calcified appendicolith is visible on plain films in only 10-15 % of patients of acute appendicitis. Plain abdominal radiographs may be useful for detection of ureteric calculi, small bowel obstruction, perforated ulcer. Barium findings include – inability of the appendix to fill [22] has been associated with appendicitis, but lacks sensitivity and specificity.

Ultrasonography :

Sonography has been suggested as a fairly accurate way to establish the diagnosis of appendicitis. Sonographic findings consistent with acute appendicitis include an appendix of 7 mm or more in anteroposterior diameter, a thick-walled, noncompressible luminal structure seen in cross section, referred to as a *target lesion*, or the presence of an appendicolith.

In advanced cases, periappendiceal fluid or a mass may be found.

Advantages of sonography being a noninvasive modality requires no patient preparation, also avoids exposure to ionizing radiation. It is commonly used in children and in pregnant patients with equivocal clinical findings suggestive of acute appendicitis.

Sensitivity of sonography in diagnosing appendicitis – 55 to 96% and specificity of 85 to 98% [6, 23, 24].

Disadvantages of sonography includes operator-dependent accuracy and difficulty interpreting the images by those other than the operator.

Computerised Tomography:

Computed tomography is commonly used in the evaluation of adult patients with suspected acute appendicitis. The use of 5-mm sections, have resulted in increased accuracy of CT scanning [25], which has a sensitivity of approximately 90% and a specificity of 80% to 90% for the diagnosis of acute appendicitis in patients with abdominal pain .

CT findings of acute appendicitis increase with severity of the disease. Classic findings include a distended appendix more than 7 mm in diameter and circumferential wall thickening and enhancement, which may give the appearance of a halo or target.

As inflammation progresses, periappendiceal fat stranding, edema, peritoneal fluid, periappendiceal abscess may be seen.

CT can detect appendicoliths in approximately 50% of patients with appendicitis.

For older patients CT has proved most valuable in whom the differential diagnosis is lengthy, clinical findings may be confusing, and appendectomy carries increased

risk [26.27] .

CT scan may reduce the negative appendectomy rate in patients with atypical symptoms.

In a young male patient of typical right lower quadrant pain and tenderness with signs of inflammation, a CT scan is unnecessary, wastes valuable time, may be

misinterpreted, and exposes the patient to risks for allergic contrast reaction, nephropathy and ionizing radiation. The ionizing radiation carries increased risk in children with the rate of radiation-induced cancer estimated at 0.18% following an abdominal CT scan [28] .

In a small number of patients diagnosis of appendicitis remains elusive. Such patients benefit from diagnostic laparoscopy. It provides a direct examination of the appendix and a survey of the abdominal cavity for other possible causes of pain. Women of childbearing age in whom preoperative pelvic ultrasound or CT fails to provide a diagnosis are most benefited from diagnostic laparoscopy.

Differential Diagnosis

The following are the differential diagnosis of acute appendicitis :

- Acute mesenteric adenitis
- Acute gastroenteritis
- Meckel's diverticulitis
- Crohn's enteritis
- Perforated peptic ulcer
- Urinary tract infection
- Ureteral stone
- Primary peritonitis
- Gynecologic disorders like

- Pelvic inflammatory disease
- Ruptured Graafian follicle
- Ruptured ectopic pregnancy
- Twisted ovarian cyst

Treatment

Antibiotics

Most patients with acute appendicitis are managed by prompt surgical removal of the appendix. Preoperative antibiotics cover aerobic and anaerobic colonic flora. For patients with nonperforated appendicitis, a single preoperative dose of antibiotics reduces postoperative wound infections and intra-abdominal abscess formation .

For patients with perforated or gangrenous appendicitis, continued postoperative IV antibiotics is advised until the patient is afebrile.

Single-agent therapy, typically with a second-generation cephalosporin, or a quinolone/metronidazole regimen is adequate.

Surgery

Open Technique

Incision

Mc Burney incision is typically made at right angles to, and two-thirds along the line between the anterior superior iliac spine and umbilicus. A transverse or Rockey-Davis incision may also be used.

A lower midline incision may be necessary in morbidly obese patients, or in patients who have a strong possibility of having other pelvic abnormalities.

A muscle-splitting incision carries the least risk of dehiscence. The external oblique aponeurosis is incised parallel to the direction of its fibers. The internal oblique fascia and muscle are bluntly separated until the transversalis fascia is identified. The transversalis fascia and peritoneum are identified and sharply divided.

For simple cases, a small (2 to 4 cm) incision serves to keep viscera out of the operating field . Because the pathogens are fairly predictable and there is little chance that culture results will change management, the value of culturing any fluid seen on entry into the abdomen is questionable.

Exploration and Mobilization of the Appendix

A finger placed into the peritoneal cavity may be enough to identify the appendix and deliver it into the wound. If needed, the anterior taenia coli of the cecum can be followed by gently grasping the cecum and using it as a guide, the base of the appendix is identified.

If the appendix is retrocecal, medial mobilization of the cecum is needed to access the appendix, which can be done bluntly, with a finger combined with either sharp or electrocautery division of the tissue along the white line of Toldt.

Removal of the appendix

After adequately mobilizing the appendix , the vascular arcade is divided between clamps and tied. This may be done as a single step, at the base of the appendix or in stepwise fashion along the mesoappendix, allowing for further mobilization along the length of the appendix until the base is reached.

The appendix is then crushed with a straight artery clamp approximately 3 mm from the cecum. The straight artery clamp is then moved approximately 3 mm more distally onto the appendix and applied.

The appendix is then tied using a 2-0 ligature. A scalpel is used to transect the appendix at the proximal side of the straight clamp to avoid any spillage from the appendix. The mucosa of the appendiceal stump is cauterized, and then removed with the specimen of the surgical field, minimizing contamination. Inversion of the appendiceal stump is of questionable value [29] .

Fig 7: Ligation of mesoappendix

Laparoscopic techniques:

After injection of local anesthetic, a 10-mm port is placed into the umbilicus, followed by a 5-mm port in the suprapubic midline region and a 5-mm port midway between the first two ports to the left of the rectus abdominis muscle. The 5-mm, 30-degree laparoscope is moved to the central port, with the surgeon and assistant both on the patient's left. With the patient in the Trendelenburg position and rotated left side down, the terminal ileum is gently sweeped medially and the taeniae of the cecum followed caudally to locate the appendix, which is then elevated.

The mesoappendix is divided using a 5-mm harmonic scalpel or Liga-Sure, or between clips, depending on the thickness of this tissue.

The appendix is encircled with one or two absorbable Endoloops clinched down at the base of the appendix, then a third Endoloop is placed on the specimen side(1 cm distally), and the appendix divided.

Any spillage of fluid is promptly aspirated and any identified appendicoliths are removed to prevent postoperative abscess formation. The appendix is placed into a specimen bag and removed with the port through the umbilical wound . Fascia at the 10-mm trocar site is closed, and all wounds are closed primarily.

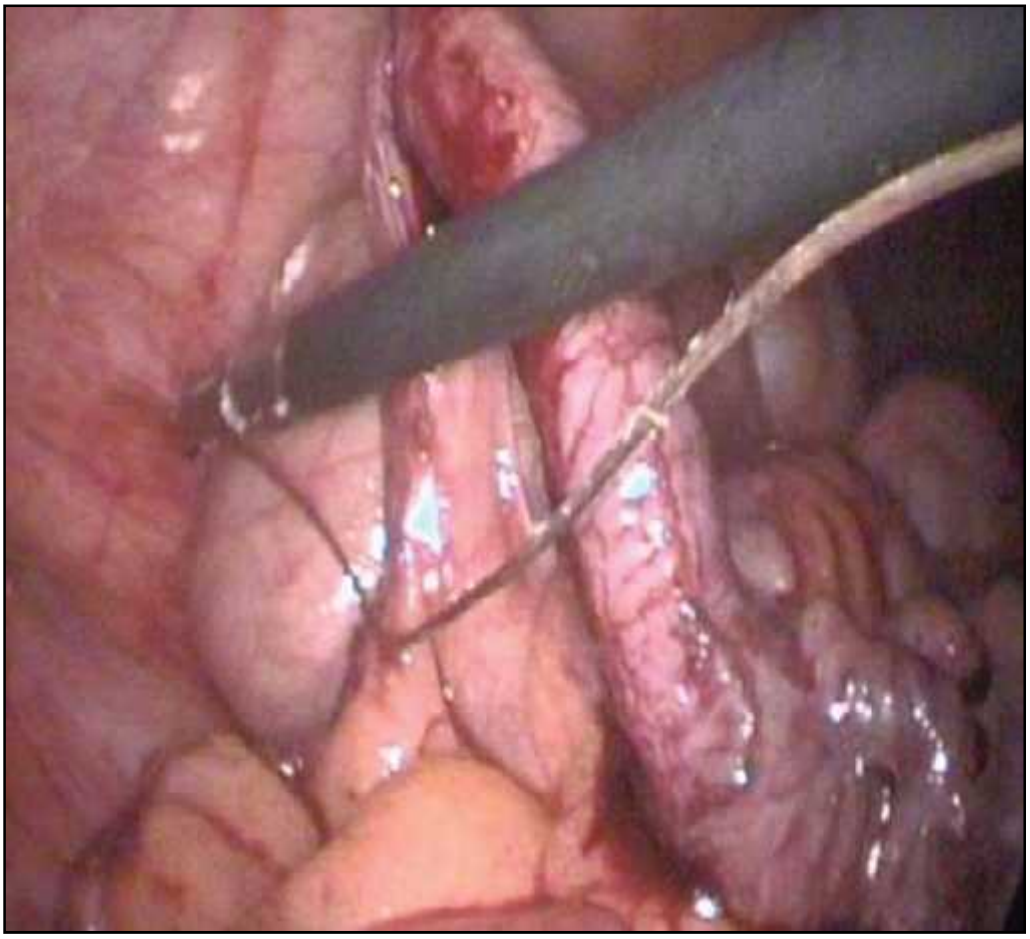


Fig 8: Laparoscopic view of appendix

Appendiceal Abscess

In this condition patients present late in the course of appendicitis, with a mass and fever.

They may benefit from nonoperative management. Imaging studies are useful for confirming the diagnosis.

Large abscesses, more than 4 to 6 cm, with high fever, benefit from abscess drainage.

Smaller abscesses or phlegmon and who are not sick may be successfully managed initially with antibiotics alone.

Patients who fail nonoperative treatment are likely to require appendectomy during the same hospitalization, whereas those who improve may be considered for interval appendectomy.

After nonoperative treatment of suspected late appendicitis, adults should undergo colonoscopy or barium enema because colon cancer is detected in an estimated 5% of cases.

The risk for recurrent appendicitis is approximately 15% to 25% after nonoperative treatment and warrants interval appendectomy.

Postoperative Complications

Wound infection: It is the most common postoperative complication, occurring in 5-10% of all patiens. Patient presents with pain and erythema of the wound on the 4th or 5th postoperative day. Treatment is by wound drainage and antibiotics.

Intraabdominal Abscess: With the advent of preop antibiotics this complication has become rare. Postoperative spikes of fever, malaise and anorexia developing 5-7 days post-op suggest an intraperitoneal collection.

Paracolic, pelvic and subphrenic, sites should be considered. Abdominal ultrasonography and CT scanning facilitate diagnosis and allow percutaneous drainage.

Laparatomy is to be considered in patients suspected to have intra-abdominal sepsis but in whom imaging fails to show a collection, particularly those with continuing ileus.

Ileus: A period of adynamic ileus is expected after appendicectomy, and may last a number of days following removal of a gangrenous appendix. Ileus persisting more than 4 or 5 days, with the presence of fever, is indicative of continuing intraabdominal sepsis and should prompt further investigation.

Venous thrombosis and embolism: These conditions are rare, except in the elderly and in women taking oral contraceptive pill. Appropriate prophylactic measures should be taken in such cases.

Portal Pyaemia (Pylephlebitis): This is a rare but serious complication of gangrenous appendicitis presenting with high fever, rigors and jaundice. It is caused by septicemia in the portal venous system and leads to the development of intrahepatic abscess. Treatment is with systemic antibiotics and percutaneous drainage of hepatic abscess.

Fecal Fistula: Leakage from the appendicular stump occurs rarely, but may occur if the encircling stitch has been taken too deeply or if the cecal wall was involved by edema or inflammation. Crohn's disease should be considered in the differential diagnosis.

Adhesive Intestinal Obstruction: It is a common late complication of appendicectomy. A single band adhesion is often found at laporotomy. Occasionally, chronic pain in the right iliac fossa is attributed to adhesion formation after appendicectomy. In such cases, laparoscopy is of value in confirming the diagnosis and allows division.

METHODOLOGY

In this study, over a period of one year (Jan 2014 to Dec 2014) ,100 patients presenting with pain in the right lower quadrant of abdomen, who after clinical examination were provisionally diagnosed to have acute appendicitis and warranting surgery for the same were evaluated using the scoring system – Alvarado Score and Appendicitis Inflammatory Response Score .

The study was conducted on the patients presenting with clinical features suggestive of acute appendicitis admitted in surgical wards of KLE Dr Prabhakar Kore Hospital, Belgaum.

Inclusion Criteria

- Patients with provisional clinical diagnosis of acute appendicitis .

Exclusion Criteria

- Patients presenting with non-right iliac fossa pain and those who had been admitted by other specialities for other complaints but subsequently developed right iliac fossa pain .

Collection of data

Sample Size

The sample size (n) was calculated using following formula:

n=4*sensitivity*(100-sensitivity) / L2*P

L- permissible error upto 5 %

P- prevalence of appendicitis in our hospital – 6.8 %

Sensitivity- 90% [sensitivity of AIR as found in study by Castro]

Applying in the above formula , n=30 . Therefore minimal sample size was 30 .

A total of 100 cases of suspected acute appendicitis who were admitted, investigated and treated were taken for the study. After detailed examination and investigations Alvarado score and Appendicitis inflammatory Response Score was applied to each case.

Every year an average of 300 patients of acute appendicitis get admitted and operated on. By stratified random sampling every 3rd patient was selected for the study.

Both the scoring systems were applied in all patients and scores tallied accordingly .

Alvarado Score

This system consisits of 4-symptoms, 1-sign , 3-labarotory findings .

Alvarado score

Nausea or vomiting	1
Anorexia	1
Pain in right lower quadrant	2
Migration of pain to right lower quadrant	1
Rebound tenderness	1
Body temperature>37.5 C	1
Leukocytosis shift	1
WBC count >10000/cumm	2

Appendicitis Inflammatory Response Score

This system consists of 2-symptom, 1-sign and 4-laboratory values .

AIR score

Vomiting	1
Pain in right lower quadrant	1
Muscular defense Light Medium Strong	 1 2 3
Body temperature >38.5 C	1
Polymorphonuclear leucocytes 70-84% Equal or more than 85%	 1 2
WBC 10000-14999 cells/cumm Equal or more than 15000/cumm	 1 2
CRP estimation 10-49 mg/l Equal or more than 50 mg/l	 1 2

Following decisions were taken :

Cases with score of 1-4 were observed for development of acute appendicitis.

Cases with score of 5-8 were observed for next 24 hours, reevaluated. If their clinical condition was highly suspicious of acute appendicitis as decided by treating surgeon they were subjected for appendicectomy.

If at any point, surgeon felt that on examination , clinical features were convincing enough to warrant surgery , then irrespective of the scores appendectomy were performed .

All patients who were considered for appendectomy underwent ultrasonography of abdomen to rule out other conditions mimicking acute appendicitis.

Both scoring systems were compared with final Histopathology analysis report. Sensitivity, specificity, positive predictive value and negative predictive value were determined.

RESULTS

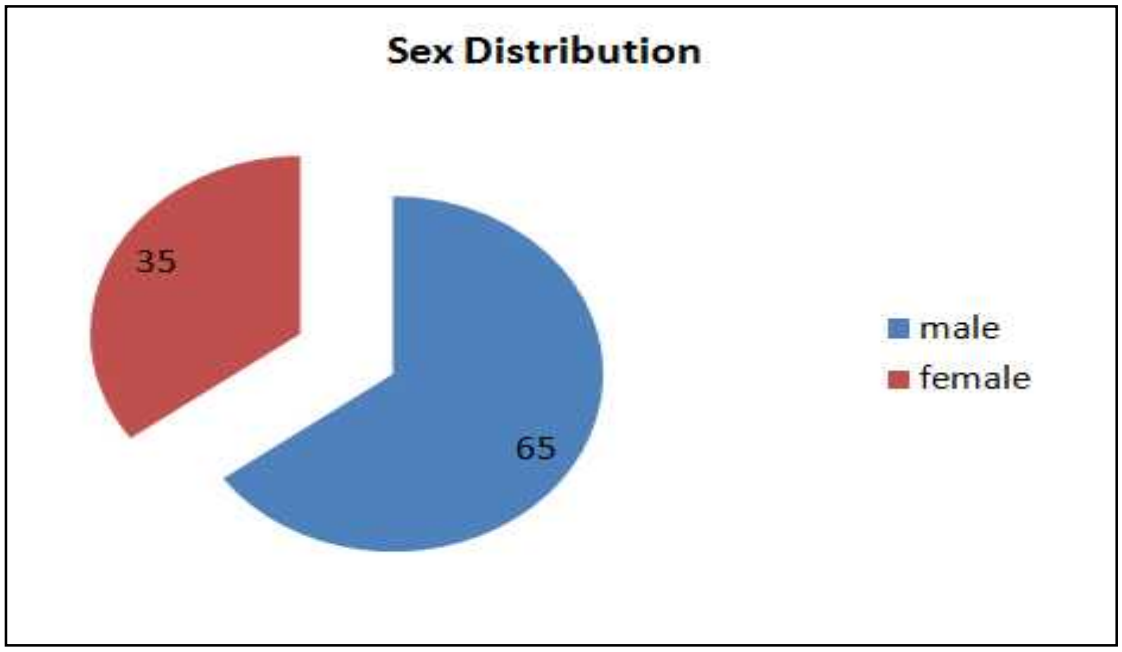
Statistical analysis of observations and results of the study was presented in tabular form.

Table -1

AGE & SEX CHARACTERISTICS			
AGE	FEMALE	MALE	TOTAL
<18 yrs	3	8	11
≥18 yrs	32	57	89
Total			100

In this study male patients (65) were more than female patients (35).

Graph -1- Pie-graph representation of sex distribution in the present study



Red-Female. Blue-Male

Table – 2

MEAN AGE		
SEX	MEAN AGE ± SD	RANGE
Female	27.2 ± 10.29	9 - 56 yrs
Male	29.8 ± 14.09	11 - 72 yrs
Both	28.9 ± 12.89	9 - 72 yrs

Mean age in females being 27.2 ± 10.29 and in males 29.8 ± 14.09 , with range in both sexes being 9 to 72 yrs .

Table – 3

USG FINDINGS	
AA	80
NORMAL OR PROBE TENDERNESS	20

Ultrasound could diagnose appendicitis in 80 patients.

Table - 4

FREQUENCY OF S/S		
SL NO	S/S	NO'S
1	ANOREXIA	99
2	VOMITING	74
3	PAIN RLQ	96
4	MIGRATING PAIN	17
5	R- TENDERNESS	75
6	GUARDING	40
7	LEUCOCYTOSIS	61

In this study, anorexia was the most common symptom, presenting in 99 individuals. Vomiting was present in 74 patients, pain in the right lower quadrant present in 96 patients. Guarding was present in 40 patients and leucocytosis present in 61 individuals.

Table – 5

DISTRIBUTION OF PTS AS PER SCORE			
SCORE	ALVARADO	AIR	HPR
≤4	25	16	AA - 89
5—8	56	73	CA - 11
>8	19	11	
TOTAL	100	100	100

Maximum number of patients were present in score range of 5-8, with 56 patients being grouped by Alvarado score and 73 patients grouped by AIR score .

Histopathology which was the gold standard used in this study reported 89 cases as acute appendicitis and 11 cases as chronic appendicitis.

Graph 2 - Graphical representation of score distribution y-axis: number of patients

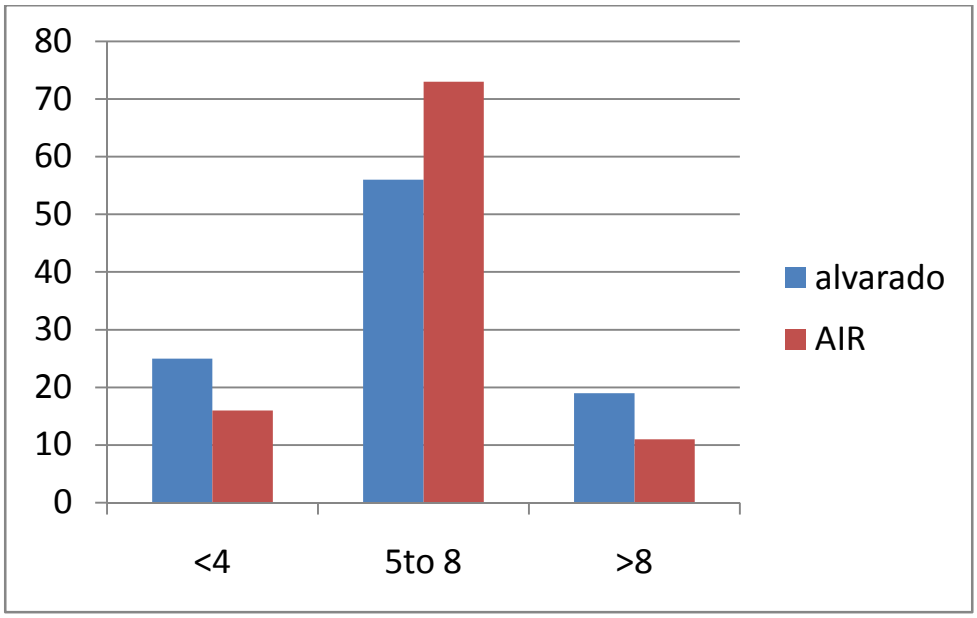


Table – 6

ALVARADO WITH HPR			
SCORE	AA	CA	TOTAL
>4	70	5	75
≤4	19	6	25
TOTAL	89	11	100

Alvarado diagnosed 75 patients as acute appendicitis (at score>4) of which 5 cases were false positive ones. Alvarado ruled out acute appendicitis (at score≤4) in 25 individuals of which 19 were false negative ones.

Table – 7

ALVARADO WITH HPR			
SCORE	AA	CA	TOTAL
>8	19	0	19
≤8	70	11	81
TOTAL	89	11	100

Alvarado score (at score >8) correctly diagnosed in 19 individuals with zero false positive cases.

Table – 8

AIR WITH HPR			
SCORE	AA	CA	TOTAL
>4	80	4	84
≤4	9	7	16
TOTAL	89	11	100

AIR diagnosed 84 patients as acute appendicitis (at score >4) of which 4 were false positive cases. It ruled out acute appendicitis (at score ≤4) in 16 individuals of which 9 were false negative ones.

Table - 9

AIR WITH HPR			
SCORE	AA	CA	TOTAL
>8	11	0	11
≤8	78	11	89
TOTAL	89	11	100

AIR could diagnose 11 cases of acute appendicitis (at score >8) with no false positive cases.

Table–10

CRP WITH HPR			
VALUE	AA	CA	TOTAL
≥10	82	6	88
<10	7	5	12
TOTAL	89	11	100

CRP was high (≥ 10 mg/L) in 88 individuals with falsely raised in 6 patients .

DISCUSSION

Acute appendicitis is one of the commonest surgical emergencies with an incidence of 1.17 per 1000 and lifetime risk of 8.6% in men and 6.7% in women. The incidence is highest in adolescents and young adults [30,31]. Surgeon's good clinical assessment is considered to be most important requisite in diagnosis of appendicitis. Several other condition can mimics this clinical condition.

Management strategy in patients of suspected appendicitis still remains a challenge even after introduction of USG, CT and diagnostic laparoscopy.

The use of USG or CT in suspected patients of appendicitis is common. CT should be used selectively to minimize exposure to ionizing radiation. False negative results may delay surgery and increase morbidity.

Decisions to operate based solely on physical examination, result in a higher rate of negative appendectomies. A negative appendectomy can lead to severe morbidity and even mortality [2,3]. Even without complications it is associated with unnecessary disability and costs.

Appendicitis Inflammatory Response score can be used to prevent negative appendectomy[32]. It was developed in 2008 in Sweden based on prospectively collected data of variables with independent prognostic value using a mathematically more appropriate method for the construction.

A scoring system should be of simple design in order to aid in decision making process for treatment. The goal of scoring system should be to discriminate when there is uncertainty rather than making a diagnosis.

In this prospective study, an attempt was made to evaluate the efficiency of Appendicitis Inflammatory Response Score and compare it with Alvarado score .

	Present study				Castro [32]			
	AIR		Alvarado		AIR		Alvarado	
Score	>4	>8	>4	>8	>4	>8	>4	>8
sensitivity	89.9	12.3	78.6	21.3	93	10	90	29
specificity	63.6	100	54.5	100	85	100	55	95

Sensitivity of AIR of 89.9% (at score >4) in the present study was comparable with studies of castro [32] (93%).

Both AIR and Alvarado (at score >8) demonstrated specificity of 12.3% and 21.3% respectively which were comparable with results obtained by Castro[32] – 10% and 29% respectively.

Specificity of Alvarado (at score >4) in the present study 54.5% was comparable with studies of Castro[32] - (55%).

The Alvarado was first reported in 1986. It was based on several variables found in 305 patients with acute appendicitis. Other variations exist but do not differ much[33,34].

Use of Alvarado like scoring system was evaluated in large German study. The scoring system consisted of eight variables. The scoring system also did not include C-reactive protein and it found no significant difference in negative appendectomy rates[35].

More recently a AIR – like scoring system was developed by Sammalkorpi [36]. The scoring system also included C-reactive protein was evaluated. It demonstrated a sensitivity of 95% and specificity of 54% respectively.

Anorexia was the most common symptom in the present study. It is said that the sequence of appendicitis that is anorexia , followed by pain , in turn followed by vomiting in present in more than 95% individuals . If vomiting preceeds the onset of pain the diagnosis of acute appendicitis should be questioned [37].

	Present study	Bin Soo Kim et al[38]
Leucocytosis	61%	72%
Rebound tenderness	75%	68%

Rebound tenderness was demonstrated in 75% individuals in the present study which was comparable with the studies of Bin Soo Kim et al [38] - (68%). It is a simple test that does not need lot of experience to perform or interpret. Lawrie[39] considers it a "popular and somewhat unkind way of emphasizing what is already obvious".

C-reactive Protein demonstrated a sensitivity of 92% and specificity of 45.5 % in the present study. A recent meta-analysis has shown that there is fivefold increase in the positive likelihood ratio for acute appendicitis when both WBC count and C-reactive protein are elevated [7].

Ultrasound is a safe, radiation-free method. In a review of graded compression US in the diagnosis of acute appendicitis the mean respective sensitivities and specificities of ultrasound were 78% and 83%.

In the present study, ultrasound demonstrated a sensitivity of 86.5% and specificity of 72.7% which was comparable with study conducted by Al-Ajerami [40], which demonstrated a sensitivity of 84.8% but a higher specificity of 83.3% .

CONCLUSION

Although acute appendicitis is commonest surgical emergency, its management is still challenging.

Appendicitis Inflammatory Response Score outperformed Alvarado score displaying higher sensitivity and specificity. Such a scoring system is important for better outcome.

Ultrasound is a useful tool in diagnosing patients of acute appendicitis.

The results of the present study were comparable with the studies of Castro [32.]

SUMMARY

- The study was done in tertiary care KLE Dr Prabhakar Kore hospital and medical research centre, Belgaum.
- In a study of 100 patients of suspected cases of acute appendicitis, males comprised 65% and females 35%.
- Mean age in females being 27.2 $\pm$ 10.29 and in males 29.8 $\pm$ 14.09 years.
- Anorexia was the most common symptom followed by pain abdomen and vomiting.
- Histopathology which was the gold standard used in this study reported 89 cases as acute appendicitis and 11 cases as chronic appendicitis.
- Majority of patients were in score range 5-8 , with 56 classified by Alvarado and 73 being classified by Appendicitis Inflammatory Response Score .
- At score >4 AIR demonstrated a sensitivity of 89.9% and specificity of 63.6%.
- At score >4 Alvarado demonstrated a sensitivity of 78.6% and specificity of 54.5%.
- At score >8 AIR demonstrated a sensitivity of 12.3% and specificity of 100%.
- At score >8 Alvarado demonstrated a sensitivity of 21.3% and specificity of 100%.
- USG is a safe, reliable modality for patients with acute appendicitis. In the present study it demonstrated a sensitivity of 86.5% and specificity of 72.7%.
- In the present study AIR outperformed Alvarado score.
- Scoring systems should aid in correct diagnosis in order to avoid negative appendectomies.

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ANNEXURE - I – CONSENT FORM

A COMPARATIVE STUDY OF APPENDICITIS INFLAMMATORY RESPONSE SCORE AND ALVARADO SCORE FOR PATIENTS WITH ACUTE APPENDICITIS AT TERTIARY CARE HOSPITAL, BELGAUM - A PROSPECTIVE ANALYTICAL STUDY

Objective and purpose of study:

The purpose of research is to compare the two scoring systems Alvarado and Appendicitis Inflammatory Response Score systems in patients with acute appendicitis. The principal investigator of the study is Dr _____ under the guidance of Dr _____.

Procedure:

If you agree to be part of the research study, you will be asked the relevant history and will be subjected to relevant clinical examination and investigations. Investigations include chest x-ray, blood investigations, and ultrasound abdomen.

Risk and benefits:

No risk as such. No direct benefits, but results of this study will help in the management of patients of acute appendicitis.

Alternatives:

Taking part in this study is voluntary. You may choose not to take part in this study, or if you decide to take part now, you can later change your mind and withdraw from the study. Your decision will not change the present or future health care or services that you receive. The study doctor or sponsor may terminate your participation in this study any time.

Privacy and Confidentiality:

All the information collected about you during the course of study will be kept confidential to the extent permitted by the law. The code numbers will identify you in the research record. Information from this study may be published but your identity will be confidential in any publication.

Institution / Sponsor's policy:

Does not apply to this research

Financial incentives for participation:

You will not be paid / offered any gift / incentives for participating in the study.

Authorization to publish the results:

The result of the study will be forwarded to the KLE University, Belgaum as part of requirement towards the completion of MS degree, review and publishing.

Consent Statement

I, Mr/Ms/Mrs. _____ voluntarily agree for the participation as a subject of study. By signing this consent form I am not giving up any of my legal rights, I may withdraw from the study anytime. I am signing the consent form after having read or been read for me in vernacular language, including the risks and the benefits and having all my questions answered. In queries, you may contact the following person –

Principal Investigator: DR _____

Guide: DR _____

Subject Name : _____

Signature or the Left Thumb Print of Subject : _____

Date:

Witness Name : _____ Signature: _____

Date:

Investigators Name: _____ Signature: _____

Date:

Place:

ANNEXURE - I – CONSENT FORM

A COMPARATIVE STUDY OF APPENDICITIS INFLAMMATORY RESPONSE SCORE AND ALVARADO SCORE FOR PATIENTS WITH ACUTE APPENDICITIS AT TERTIARY CARE HOSPITAL, BELGAUM - A PROSPECTIVE ANALYTICAL STUDY

Objective and purpose of study:

The purpose of research is to compare the two scoring systems Alvarado and Appendicitis Inflammatory Response Score systems in patients with acute appendicitis. The principal investigator of the study is Dr AMARENDRA DHARWAR under the guidance of Dr SHASHI UPPIN.

Procedure:

If you agree to be part of the research study, you will be asked the relevant history and will be subjected to relevant clinical examination and investigations. Investigations include chest x-ray, blood investigations, and ultrasound abdomen.

Risk and benefits:

No risk as such. No direct benefits, but results of this study will help in the management of patients of acute appendicitis .

Alternatives:

Taking part in this study is voluntary. You may choose not to take part in this study, or if you decide to take part now, you can later change your mind and withdraw from the study. Your decision will not change the present or future health care or services that you receive. The study doctor or sponsor may terminate your participation in this study any time.

Privacy and Confidentiality:

All the information collected about you during the course of study will be kept confidential to the extent permitted by the law. The code numbers will identify you in the research record. Information from this study may be published but your identity will be confidential in any publication.

Institution / Sponsor's policy:

Does not apply to this research

Financial incentives for participation:

You will not be paid / offered any gift / incentives for participating in the study.

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Principal Investigator: DR AMARENDRA DHARWAR

Guide: DR SHASHI UPPIN

Subject Name : _____

Signature or the Left Thumb Print of Subject : _____

Date:

Witness Name : _____ Signature: _____

Date:

Investigators Name: _____ Signature: _____

Date:

Place:

ANNEXURE – II- PROFORMA

A COMPARATIVE STUDY OF APPENDICITIS INFLAMMATORY RESPONSE SCORE AND ALVARADO SCORE FOR PATIENTS WITH ACUTE APPENDICITIS TERTIARY CARE HOSPITAL, BELGAUM - A PROSPECTIVE ANALYTICAL STUDY

Name & Address of the patient:

_____

Age of the Patient:_____ IP. No. _____

Weight of Patient: _____ Sex. _____

PRE OPERATIVE EVALUATION:

Chief Complaints:

Past History:

- History of
- Diabetes Mellitus:- YES/NO
- Hypertension:- YES/NO
- Asthma:- YES/NO
- PREVIOUS SURGERIES:- YES/NO
- Drug Therapy:YES/NO

Family History:

General Physical Examination:

Weight: Temperature: Pallor: Height:

Cyanosis: Oedema: Clubbing:

Pulse : B.P : RR :

SYSTEMIC EXAMINATION :

Cardiovascular System:

Respiratory System:

Per Abdomen:

Central Nervous system:

INVESTIGATIONS:

CBC: Urine Routine:

Any Other : C-RP

MR

LFT

RFT

USG

RBS

Diagnosis:

Proposed Surgery:

Histopathology Report:

Diagnosis	Alvarado score	AIR score
Vomiting		
Nausea or vomiting		
Anorexia		
Pain in RLQ		
Migration of pain to the RLQ		
Rebound tenderness or muscular defense		
Light		
Medium		
Strong		
Body temperature >37.5°C		
Body temperature >38.5°C		
Leukocytosis shift		
Polymorphonuclear leukocytes		
70–84%		
≥85%		
WBC count		
$>10.0 \times 10^9$/l		
$10.0–14.9 \times 10^9$/l		
$\geq 15.0 \times 10^9$/l		
CRP concentration		
10–49 mg/l		
≥50 mg/l		
Total score		

Light – mildly tender.

Medium – which initiates slight tightening of abdominal muscles.

Strong – severly tender when muscular rigidity becomes obvious.