

KLE UNIVERSITY, BELGAUM, KARNATAKA

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**“EVALUATION OF RIPASA SCORING SYSTEM IN
DIAGNOSIS OF ACUTE APPENDICITIS; ONE YEAR
PROSPECTIVE STUDY”** is a bonafide research work done by
CANDIDATE REG. NO. BH0113005.

Dr. S. S. SHIMIKORE MS
Professor and Head,
Department of Surgery,
J. N. Medical College,
Nehru Nagar, Belgaum – 10

Date:
Place: Belgaum

Dr. N. S. MAHANTSHETTI MD
Principal,
J. N. Medical College,
Nehru Nagar, Belgaum – 10

Date:
Place: Belgaum

LIST OF ABBREVIATIONS USED

/Cumm	-	Per cubic millimeter
/L	-	Per Litre
/min	-	Per minute
⁰ C	-	Degree Centigrade
⁰ F	-	Degree Fahrenheit
AA	-	Acute Appendicitis
cm	-	Centimeter
CRP	-	C-reactive protein
CSSs	-	Clinical scoring systems
CT	-	Computed tomography
DBP	-	Diastolic blood pressure
e.g.,	-	For example,
ED	-	Emergency Department
HPR	-	Histopathological report
i.e.,	-	That is,
IP No.	-	In patient number
MANTRELS	-	Migration to the right iliac fossa, Anorexia, Nausea/ Vomiting, Tenderness in the right iliac fossa, Rebound pain, Elevated temperature (fever), Leukocytosis, and Shift
mm Hg	-	Millimeters of mercury
n	-	Total number
NLR	-	Negative likelihood ratio
NPV	-	Negative predictive value
NRIC	-	National registration identity card

OPD	-	Outpatient department
p	-	Probability
PAS	-	Pediatric Appendicitis Score
PID	-	Pelvic inflammatory disease
PPV	-	Positive predictive value
PR	-	Pulse rate
RIF	-	Right iliac fossa
RIPASA	-	Raja Isteri Pengiran Anak Saleha Appendicitis
RLQ	-	Right lumbar quadrant
ROC	-	Receiver operating characteristic curve
RR	-	Respiratory rate
SBP	-	Systolic blood pressure
Temp	-	Temperature
USG	-	Ultrasound
vs.	-	Versus
WBC	-	White blood cell

ABSTRACT

Background and Objectives

Various scoring systems are being used to aid the diagnosis of acute appendicitis and RIPASA score is the new diagnostic scoring system based on extensive yet simple parameters. The present study evaluated its accuracy in the diagnosis of acute appendicitis.

Methodology

This one year hospital study was conducted in the Department of General Surgery, KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belgaum. A total of 60 patients presenting with right Illiac fossa pain from January 2014 to December 2014 were enrolled. The patients were evaluated for all the variables required to obtain RIPASA scores.

Results

Fifty percent (50%) of the patients each were males and females with male to female ratio of 1:1. Most of the patients (71.67%) were aged between 18 to 30 years and mean age was 27.1 ± 8.81 years. Other than RIF pain, common symptoms were nausea and vomiting (96.67%), pain migration of RIF (80%), anorexia (70%), fever (61.67%) and commonest clinical sign was RIF tenderness (95%). The duration of pain was <48 hours in 88.33% of the patients. Urine analysis was negative in 83.33% while WBC count of 10000 was noted in 65% of the patients. Most of the patients (60%) had RIPASA scores from 11 to 15. The HPR report revealed 53.33% of the patients with acute appendicitis. Significantly higher number of patients with 7.5 RIPASA score were diagnosed

to have acute appendicitis (98.04% vs 33.33%; $p < 0.001$) and showed sensitivity, specificity, positive predictive value and negative predictive value as 94.34%, 85.71%, 98.04% and 66.67% respectively (positive likelihood ratio of 6.60).

Conclusion and interpretation

The RIPASA scoring system which is based on simple parameters that can be ascertained by complete history, clinical examination and few investigations is a valuable scoring system in the diagnosis of acute appendicitis.

Keywords

Acute appendicitis; Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA);
Scoring systems;

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INTRODUCTION

Appendectomy remains the most frequently performed emergency abdominal surgical procedure.¹ The lifetime risk of acute appendicitis for men and women is 8.6% and 6.7%, respectively. However, the lifetime risk of having an appendectomy is 12% for men and 25% for women.^{2,3} The incidence is highest in adolescents and young adults, but the incidence of complicated appendicitis shows little variance between different age groups.⁴

The clinical diagnosis of acute appendicitis relies upon a detailed history and thorough physical examination. The differential diagnosis is that of the acute abdomen as it can mimic the presentation of most abdominal emergencies.⁵

The principal presenting complaint of patients with acute appendicitis is abdominal pain. Murphy was the first to describe the sequence of colicky central abdominal pain followed by vomiting and migration of the pain to the right iliac fossa. This classical presentation is only seen in approximately 50% of patients. The history of pain is usually 24 h of colicky peri-umbilical pain followed by migration of the pain to the right iliac fossa with a progression to a more constant severe pain. This progression results from the initial pain being referred from the visceral innervation of the midgut followed by more defined localization of the pain when the parietal peritoneum is involved by the inflammatory process.⁵

Associated symptoms include loss of appetite and nausea but profuse vomiting is rarely a feature of simple appendicitis and may well represent the development of diffuse peritonitis following perforation. Patients will often have a

low grade fever. It is common for patients to report no change in bowel habit but a range of bowel habit disturbances may be associated with the onset of pain. Cope reported that patients may feel constipated and anticipate relief of pain with defecation but this does not occur.⁶

The appendix can take a variety of anatomical positions and as a result the clinical presentation is influenced by the surrounding structures that become involved in the inflammatory process. Those at the extremes of age often present a significant diagnostic challenge as they may present with atypical signs and symptoms.⁷ Infants may appear listless whilst the elderly may present with confusion. A high index of suspicion is therefore required to make the diagnosis in such cases.⁵

Whilst a clinical diagnosis can often be made there are groups of patients in whom the clinical diagnosis is difficult and these patients provide a degree of diagnostic uncertainty.⁵

Studies reporting the mortality associated with appendicitis have demonstrated a significant increase in mortality associated with perforation.⁸ The rate of perforation is reported to increase by 5% per 12 h period, 36 h after the onset of symptoms, therefore, expedient diagnosis and treatment are required.⁹

Furthermore, high rates of negative appendicectomy (operation without histological confirmation of appendicitis) have been reported with some groups such as females of reproductive age having rates of up to 26%.¹⁰

Hence, delayed or incorrect diagnosis therefore has both clinical and economic consequences and this has resulted in considerable research to identify

clinical, laboratory and radiological findings that are diagnostic of appendicitis and the development of clinical scoring systems (some computer aided) to guide the clinician in making the correct diagnosis.⁵

Several scoring systems have been devised to aid decision making in doubtful cases, including the Ohmann, Alvarado, Eskelinen, Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) and several others.¹¹⁻¹⁵ These scoring systems utilize routine clinical and laboratory assessments and are simple to use in a variety of clinical settings. However, differences in sensitivities and specificities were observed if the scores were applied to various populations and clinical settings, usually with worse performance when applied outside the population in which they were originally created.^{11,12,15} Additionally, geographic variation of the incidence and clinical pattern of the differential diagnosis of acute abdominal pain may impair their applicability.¹⁶

The Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) is the new diagnostic scoring system developed for the diagnosis of Acute Appendicitis.¹⁷ The RIPASA scoring system includes various parameters including clinical features as well as other variables such as age, gender, duration of symptoms prior to presentation.¹⁸ However, being the new scoring system not many studies have been done to evaluate the accuracy of RIPASA in the diagnosis of acute appendicitis. Hence, the present study was undertaken to evaluate accuracy of RIPASA scoring system in the diagnosis of acute appendicitis so as to reduce the delay in diagnosis.

OBJECTIVES

The objective of the present study was to evaluate Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) scoring system in the diagnosis of acute appendicitis.

REVIEW OF LITERATURE

HISTORICAL BACKGROUND

First appendectomy 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. In 1736, he operated on an 11 -year-old boy with a scrotal hernia and a fecal fistula. Within the hernia sac, Amyand found the appendix. He successfully removed the appendix and repaired the hernia.^{19,20}

In 1824, Louyer-Villermay presented a paper before the Royal Academy of Medicine in Paris. He reported on two autopsy cases of appendicitis and emphasized the importance of the condition.²¹

In 1827, Francois Melier, a French physician, expounded on Louyer-Villermay's work. He reported six autopsy cases and was the first to suggest the antemortem recognition of appendicitis. Reginald Fitz, a professor of pathologic anatomy at Harvard, is credited for coining the term "appendicitis". His landmark paper definitively identified the appendix as the primary cause of right lower quadrant inflammation.²²

Fergus, in Canada, performed the first elective appendectomy in 1883. The greatest contributor to the advancement in the treatment of appendicitis is Charles McBurney. In 1889, he published his land-mark paper in the New York Medical Journal describing the indications for early laparotomy for the treatment of appendicitis. It is in this paper that he described McBurney's point as the point of maximum tenderness, when one examines with the fingertips is, in adults, one-half

to two inches inside the right anterior spinous process of the ileum on a line drawn to the umbilicus.²³

McBurney subsequently published a paper describing the incision that bears his name in 1894. However, McBurney later credited McArthur with first describing this incision.²⁴

Semm is widely credited with performing the first successful laparoscopic appendicectomy in 1982.²⁵

Bhattacharjee PK, Chowdhury T, and Roy D in their study on 110 patients of acute appendicitis observed that high Modified Alvarado scoring system score (>5) was found to be a dependable aid both in the pre-operative diagnosis of acute appendicitis and in the reduction of negative appendicectomies in men and children and the same was not true for women who had a high false positive rate for acute appendicitis.²⁶

Malik AA & Wani NA in their study on 106 patients concluded that the high score in men & children were found to be an easy and satisfactory aid in the early diagnosis of acute appendicitis, but a high false positive rate for acute appendicitis was found in women.²⁷

Kalan M, Rich A J, Talbot D, and Cunliffe W J in their series of 49 consecutive patients observed that the presence of a high score was found to be an easy and satisfactory aid to early diagnosis of appendicitis in children and men. However, the false positive rate for appendicitis in women was unacceptably high.²⁸

Saidi HS, and Chavda SK studied 189 patients with acute appendicitis, the proportion of patients with Alvarado scores more than 7 was 40.7% and in them negative appendicectomy rate was 19.7% which was almost equal to overall negative appendicectomy rate of 18% based on clinical suspicion alone. They concluded that the integration of this scoring system does not offer advantage over degree of clinical suspicion.²⁹

Lamparelli MJ, Hoque HM, Pogson CJ, and Ball AB assessed a total of 84 consecutive patients prospectively using the modified Alvarado score. The rate of negative appendicectomy in the study group was 0% compared to 18% in the control group.³⁰

Anatomy of appendix

Embryology of the appendix^{31,32}

At an early embryonic stage it has the same caliber as the caecum and is in line with it. It is formed by excessive growth of the right wall of the caecum which pushes the appendix to the inner side. Congenital absence of the appendix is extremely rare.

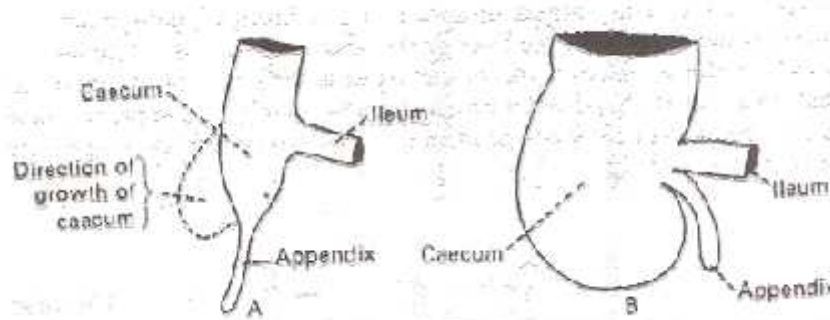


Figure 1. Development of the appendix

Gross Anatomy

The vermiform appendix is a narrow, vermian (worm-shaped) tube which arises from the posteromedial caecal wall, 2 cm below the end of the ileum. It may occupy one of several positions. It may be retrocaecal, retrocolic (behind the caecum or lower ascending colon respectively), pelvic or descending (when it hangs dependently over the pelvic brim, in close relation to the right uterine tube and ovary in females). These are the commonest positions seen in clinical practice. Other positions are occasionally seen especially when there is a long appendix mesentery allowing greater mobility. These include subcaecal (below the caecum); preileal (anterior to the terminal ileum); postileal (behind the terminal ileum).

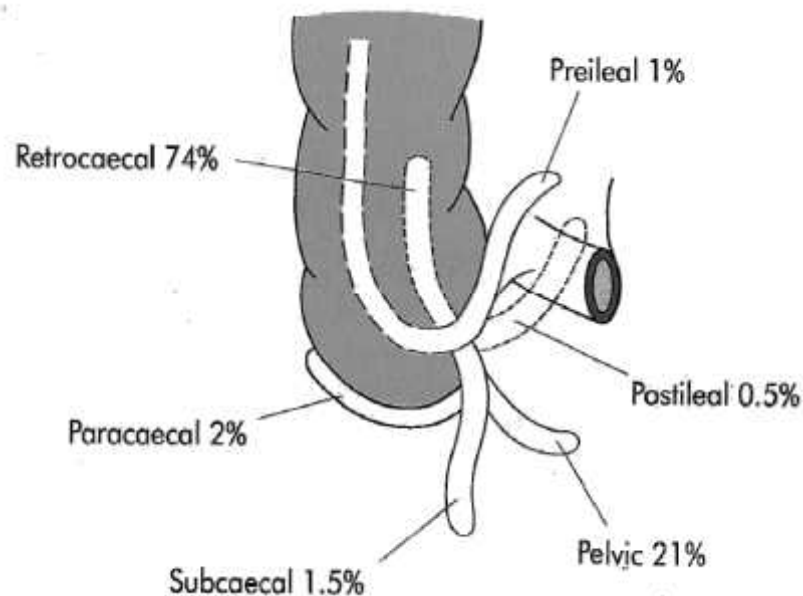


Figure. 2 The various positions of appendix

The three taeniae coli on the ascending colon and caecum converge on the base of the appendix, and merge into its longitudinal muscle. The anterior caecal taenia is usually distinct and can be traced to the appendix, which affords a guide to

its location in clinical practice. The appendix varies from 2 to 20 cm in length: it is often relatively longer in children and may atrophy and shorten after mid-adult life. It is connected by a short mesoappendix to lie in lower part of the ileal mesentery. This fold is usually triangular, extending almost to the appendicular tip along the whole viscus.

The lumen of the appendix is small and opens into the caecum by an orifice lying below and slightly posterior to the ileo-caecal opening. The orifice is sometimes guarded by a semilunar mucosal fold forming a valve. The lumen may be widely patent in early childhood and is often partially or wholly obliterated in the later decades of life. The appendix usually contains numerous patches of lymphoid tissue although these tend to decrease in size from early adulthood.

Vascular Supply And Lymphatic Drainage

Appendicular Artery

The main appendicular artery, a branch from the lower division of the ileocolic artery, runs behind the terminal ileum and enters the mesoappendix a short distance from the appendicular base. Here it gives off a recurrent branch, which anastomoses at the base of the appendix with a branch of the posterior caecal artery. The anastomosis is sometimes extensive. The main appendicular artery approaches the tip of the organ, at first near to, and then in the edge of, the mesoappendix. The terminal part of the artery lies on the wall of the appendix and may be thrombosed in appendicitis, which results in distal gangrene or necrosis. Accessory arteries are common, and many individuals possess two or more arteries of supply.

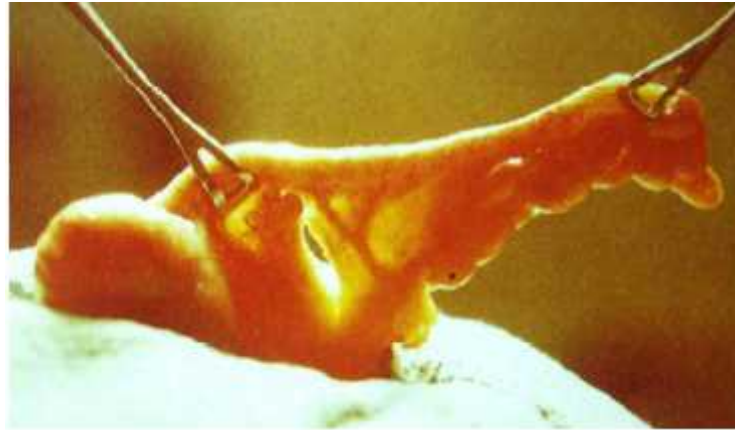


Figure 3. Mesoappendix with appendicular artery appendicular veins

The appendix is drained via one or more appendicular veins into the posterior caecal or ileocolic vein and hence into the superior mesenteric vein.

Lymphatics

Lymphatic vessels in the appendix are numerous: there is abundant lymphoid tissue in its walls. From the body and apex of the appendix 8-15 vessels ascend in the mesoappendix, and are occasionally interrupted by one or more nodes. They unite to form three or four larger vessels which run into the lymphatic vessels draining the ascending colon, and end in the inferior and superior nodes of the ileocolic chain.

Innervation

The appendix and overlying visceral peritoneum are innervated by sympathetic and parasympathetic nerves from the superior mesenteric plexus. Visceral afferent fibres carrying sensation of distension and pressure mediate the symptoms of pain felt during the initial stages of appendicular inflammation. In keeping with other structures derived from the midgut, these sensations are poorly

localized initially, and referred to the central (periumbilical) region of the abdomen. It is not until parietal tissues adjacent to the appendix become involved in any inflammatory process that somatic nociceptors are stimulated, and there is an associated change in the nature and localization of pain.

Mesoappendix

The mesentery of the appendix is a triangular fold of peritoneum around the vermiform appendix. It is attached to the posterior surface of the lower end of the mesentery of the small intestine close to the ileocaecal junction. It usually reaches the tip of the appendix but some times fails to reach the distal third, in which case a vestigial low peritoneal ridge containing fat is present over the distal third. It encloses the blood vessels, nerves and lymph vessels of the vermiform appendix, and usually contains a lymph node.

Caecal Recessess

Several folds of peritoneum may exist around the caecum and form recesses. Paracaecal recesses are common sites for abscess formation following acute appendicitis.

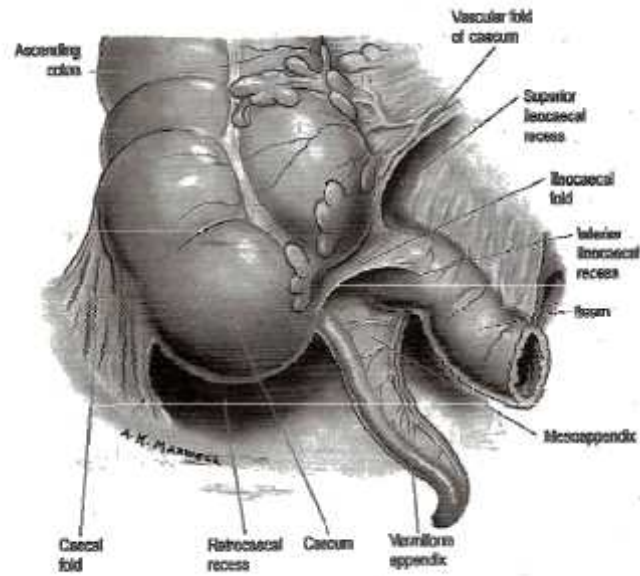


Figure 4. The peritoneal folds and recesses in caecal region.

Superior ileocaecal recess

The superior ileocaecal recess is usually present and best developed in children. It is often reduced and absent in the aged, especially the obese. It is formed by the vascular fold of the caecum, which arches over the anterior caecal artery, supplying the anterior part of the ileocaecal junction, and its accompanying vein. It is a narrow slit bounded in front by the vascular fold, behind by the ileal mesentery, below by the terminal ileum and on the right by the ileocaecal junction. Its orifice opens downwards to the left.

Inferior ileocaecal recess

The inferior ileocaecal recess is well marked in youth but frequently obliterated by fat in adults. It is formed by the ileocaecal fold, which extends from the anteroinferior aspect of the terminal ileum to the front of the mesoappendix (or to the appendix or caecum). It is also known as the 'bloodless fold of Treves',

although it sometimes contains blood vessels and will often bleed if divided during surgery. If inflamed, especially when the appendix and its mesentery are retrocaecal, it may be mistaken for the mesoappendix. The recess is bounded in front by the ileocaecal fold, above by the posterior ileal surface and its mesentery, to the right by the caecum, and behind by the upper mesoappendix. Its orifice opens downwards to the left.

Retrocaecal recess

The retrocaecal recess lies behind the caecum. It varies in size and extent and ascends behind the ascending colon, often being large enough to admit an entire finger. It is bounded in front by the caecum (and sometimes the lower ascending colon), behind by the parietal peritoneum and on each side by caecal folds (parietocolic folds) passing from the caecum to the posterior abdominal wall. The vermiform appendix frequently occupies this recess when in the retrocaecal position.

Histology of the Appendix³²



Figure 5. Normal histology of appendix

Mucosa

The mucosa is covered by a columnar epithelium , and M cells are present in the epithelium that overlies the mucosal lymphoid tissue. Glands (crypts) are fewer in number and thus less densely packed. They penetrate deep into the lymphoid tissue of the mucosal lamina propria.

Sub-Mucosa

The submucosa typically contains many large lymphoid aggregates that extend from the mucosa and obscure the muscularis mucosa layer: consequently this becomes discontinuous. These aggregates also cause the mucosa to bulge into the lumen of the appendix, so that it narrows irregularly . They are absent at birth but accumulate over the first 10 years of life to become a prominent feature. The submucosal lymphoid tissue frequently exhibits germinal centres within its follicles, indicative of B-cell activation, as it is in secondary lymphoid tissue elsewhere . In adults, the normal layered structure of the appendix is lost and the lymphoid follicles atrophy and are replaced by collagenous tissue. In the elderly, the appendix may be filled with fibrous scar tissue.

Muscularis Externa

The muscularis externa has outer longitudinal and inner circular layers of smooth muscle. The longitudinal fibres form a continuous layer but, with the exception of the uniform outer muscle layer of most of the appendix, macroscopically these are aggregated as longitudinal bands or taenia coli. At the base of the appendix, the longitudinal muscle thickens to form rudimentary taeniae

that are continuous with those of the caecum and colon. Between the taeniae coli the longitudinal layer is much thinner, less than half the circular layer in thickness.

Serosa

The serosa forms a complete covering, except along the mesenteric attachment. The longitudinal muscular fibres form a complete layer of uniform thickness, except over a few small areas where both muscular layers are deficient, leaving the serosa and submucosa in contact.

Pathology³³

Morphology

At earliest stages, only a scanty neutrophilic exudate may be found throughout the mucosa, submucosa and muscularis propria. Subserosal vessels are congested and often there is a modest perivascular neutrophilic infiltrate. The inflammatory reaction transforms the normal glistening serosa into a dull, granular, red membrane; this transformation signifies early acute appendicitis for the surgeon. At a later stage, a prominent neutrophilic exudate generates a fibrinopurulent reaction over the serosa.

The histologic criteria for the diagnosis of acute appendicitis are neutrophilic infiltration of the muscularis propria. Usually, neutrophils and ulcerations are also present within the mucosa. Since drainage of an exudate into the appendix from alimentary tract infection may also induce a mucosal neutrophils infiltrate, evidence of muscular wall inflammation is requisite for the diagnosis.



Figure 6. Histology of acute appendicitis

Epidemiology

Appendicitis is the most common acute surgical condition of the abdomen. Approximately 7 percent of the population will have appendicitis in their lifetime, with the peak incidence occurring between the ages of 10 and 30 years.³⁴

Acute Appendicitis (AA) is the most commonly encountered disease in emergency clinics, with about 250,000 cases of appendicitis reported in The United States and 40,000 in England each year.^{35,36}

Epidemiological and demographic studies report the appendicitis incidence to vary according to age, gender, race, socioeconomic status, food culture, and seasonal changes.³⁷⁻⁴⁰ Therefore, the frequency of AA is different in each country.

Studies have demonstrated that AA is seen most commonly in western societies, particularly in youths and males.^{37,40} Consequently only 5% to 10% of acute appendicitis cases are seen in the elderly.⁴¹ The lower incidence of AA and the

less pronounced gender gap in regions such as Africa and Asia is worth mentioning.^{38,42,43}

Appendicitis is most frequently seen in patients in their second through fourth decades of life, with a mean age of 31.3 years and a median age of 22 years.¹⁰

The studies performed in the last decade have reported a decrease in the incidence of AA in western countries⁴⁴ but an increase in some African⁴⁵ and Asian⁴⁶ countries.

In California, the incidence of appendicitis was 137.5 per 100,000 for Caucasian males while this incidence was 162.7 for Hispanics, 98.0 for Asian/others, and 70.7 for blacks. The same was true in female patients with rates per 100,000 of 98.8, 97.5, 64.6, and 49.6 for the above groups respectively.⁴⁴

In India the incidence is lower when compared to western countries. But still it is the third commonest operation in males and second commonest in females. The reason for this fall in incidence is probably due to the change in dietary habits. But no such drop in incidence has been noticed in India so far.

AETIOLOGY⁴⁷

Until the close of the nineteenth century, appendicitis remained unrecognized. Unquestionably, before this time it was a comparatively rare disease, but there can be no doubt that it existed even in remote times, for an acutely inflamed, perforated appendix was found preserved in the mummy of a young royal princess of Egypt.

The riddle of appendicitis – its actual cause and its meteoric rise from an insignificant disease to the most common serious intra- abdominal inflammatory

affection of western civilized races – has been a matter for much speculation. So far no satisfactory explanation has been forthcoming. The following aetiological factors are important, but for the most part they are purely contributory.

There is no unifying hypothesis regarding the aetiology of acute appendicitis. Decreased dietary fibre and increased consumption of refined carbohydrates may be important. As with colonic diverticulitis, the incidence of appendicitis is least in societies with a high dietary fibre intake. In developing countries that are adopting a more refined Western-type diet, the incidence continues to rise. This is in contrast to the dramatic decrease in the incidence of appendicitis in Western countries observed in the past 30 years. No reason has been established for these paradoxical changes; however, improved hygiene and a change in the pattern of childhood gastrointestinal infection related to increased use of antibiotics may be responsible.⁴⁷

Intestinal parasites, particularly *Oxyuris vermicularis* (synonym: pinworm), can proliferate in the appendix and occlude the lumen.⁴⁷

Pathogenesis

The appendix is a long diverticulum that extends from the inferior tip of the cecum. Its lining is interspersed with lymphoid follicles. Most of the time, the appendix has an intraperitoneal location (either anterior or retrocecal) and, thus, may come in contact with the anterior parietal peritoneum when it is inflamed.⁴⁸ Up to 30 percent of the time, the appendix may be “hidden” from the anterior peritoneum by being in a pelvic, retroileal or retrocolic (retroperitoneal retrocecal) position. The “hidden” position of the appendix notably changes the clinical manifestations of appendicitis.³⁴

Obstruction of the narrow appendiceal lumen initiates the clinical illness of acute appendicitis. Obstruction has multiple causes, including lymphoid hyperplasia (related to viral illnesses, including upper respiratory infection, mononucleosis, gastroenteritis), faecoliths, parasites, foreign bodies, Crohn's disease, primary or metastatic cancer and carcinoid syndrome. Lymphoid hyperplasia is more common in children and young adults, accounting for the increased incidence of appendicitis in these age groups.³⁴

CLINICAL FEATURES

Symptoms

Pain

Pain is present in all patients with appendicitis. The initial typical pain is diffuse and dull and is situated in the umbilical or lower epigastric region. Sometimes the pain is moderately severe. Intermittent cramping may superimpose on such pain. Gradually the pain is localised in the right lower quadrant. It takes about 1 to 12 hours for such localisation. In some patients the pain of appendicitis begins in the right lower quadrant and remains there. Variation in the anatomical position of the appendix will account for variation of the principle site of the pain. In case of retrocaecal appendix, pain may be complained of more in the flank. In case of pelvic appendicitis, pain may be referred to the suprapubic region. Malrotation of the appendix will lead to more confusion of the site of pain.³³

Anorexia

Nearly always anorexia is complained of in case of appendicitis. This symptom is so constant that the diagnosis should be questioned if the patient is not anorectic.

Nausea

Atleast of some degree, is present in 9 out of 10 patients with appendicitis. Vomiting is variable in children and teenagers but vomiting appears after the onset of pain. Typically pain, vomiting and temperature constitutes 'Murphy's Triad' of this condition. If vomiting precedes pain the diagnosis should be questioned.

Constipation or diarrhea

As appendicitis progresses, an ileus may develop leading to constipation or at least decreased frequency of the normal bowel habit. Diarrhea in contradiction, is not a common component, except in patients with missed appendicitis and postileal appendix. Diarrhoea may be more common in children than in older patients.⁴⁹

Sequence

Sequence of symptom appearance has great diagnostic value. On over 95% of patients anorexia is the first symptom, followed by abdominal pain and his is followed by nausea and vomiting.

Physical signs

Temperature

Appendicitis may cause rise of temperature, but higher temperature is unusual with uncomplicated appendicitis. Temperature elevation is usually restricted to 90 or 100 °F (39 °C). Normal temperature is often present even with advanced appendicitis. In case of generalised peritonitis following rupture of appendicitis temperature may shoot up.

Pulse rate

The pulse rate is usually normal or slightly elevated. High pulse rate should question the diagnosis. Pulse rate increase in proportion with the temperature of the patient. In case of spreading peritonitis following rupture pulse rate rise up to 100 per minute.

Inspection

The patient looks anxious with pain and the tongue is dry. On careful inspection, in very acute condition, it may disclose some limitation of the respiratory movement of the lower half of the abdomen.

Palpation

Presence of peritoneal inflammation can be suspected if cough or percussion on the abdominal wall elicits pain.

1. Systemic gentle palpation will detect an area of maximum tenderness that corresponds to the position of appendix and is usually located in the right lower quadrant at or near McBurney point.⁵⁰
2. Muscle guarding or resistance to palpation roughly parallel to the severity of the inflammatory process. Early in the disease resistance, if persistent, consists mainly of voluntary guarding. As peritoneal irritation progresses, voluntary muscle guarding increases and is eventually replaced by reflex involuntary rigidity. One must try to differentiate voluntary guarding as opposed to involuntary rigidity. Involuntary rigidity does not diminish during expiration as is seen in voluntary guarding.
3. Cutaneous hyperaesthesia can be found out by light stroking of the skin of the right and left side of the abdomen. In acute appendicitis hyperaesthesia is found over Sherren's triangle (formed by the anterior superior iliac spine, the symphysis pubis, and the umbilicus). This ordinarily is unpleasant and is not a very reliable sign.
4. Rebound tenderness – The classic method of demonstrating peritoneal inflammation is rebound tenderness. In this case gentle pressure is exerted on the inflamed area and sudden release of the hand will cause extreme pain of the patient at the inflamed area. This is called rebound tenderness may be elicited in only half the cases.
5. Rovsing's sign – Pain in the right lower quadrant is complained of when palpation pressure is exerted on the left lower quadrant. It is also called 'referred rebound tenderness' and when present is quite helpful in supporting

the diagnosis. Retrograde displacement of the colonic gas strikes the base of inflamed appendix is the probable explanation of this sign.⁵¹

6. Psoas sign – this test is performed by having the patient lie on his left side. The examiner then slowly extends the patient’s right thigh, thus stretching the iliopsoas muscle. This will produce pain to make the sign positive. This indicated presence of irritative inflamed appendix in close proximity to the psoas muscle. This is possible in retrocaecal appendicitis.
7. Pointing test - When patient is asked to point the site of pain, it usually corresponds with the site of localized tenderness in McBurney’s point that is, at the junction of lateral third with medial two thirds of the spino-umbilical line (McBurney’s sign)⁵⁰
8. Dunphy’s sign - When the patient cough vigorously and hold his or her right lumbar quadrant (RLQ) or refuses to cough because of pain, RLQ peritonitis is confirmed.
9. Blumberg’s sign (Release sign) - Rebound tenderness in the RLQ suggests localized peritonitis.
10. Cope’s obturator test - Flexion and internal rotation of hip in a patient with pelvic appendicitis initiates pain as it lies over obturator internus muscle.
11. Baldwin’s sign - A hand is placed over the right flank and patient is asked to raise the right lower limb with knee extended. In retrocaecal appendicitis this initiates pain.

12. Ligat's sign - Hyperesthesia in Sherrin's triangle (this is formed by lines joining the umbilicus, right anterior superior iliac spine and symphysis pubis) is an occasional but inconstant accompaniment of gangrenous appendicitis.
13. Percussion - Light percussion on Mc Burney's point will elicit pain in case of early appendicitis
14. Auscultation of the abdomen will reveal meagre or no bowel movement on the right iliac fossa. In spreading peritonitis following rupture of appendix abdomen remained absolutely silent and no bowel sound can be heard.
15. Rectal examination - This is important and should be performed in every patients suspected of suffering from appendicitis. Its primary function is to exclude any pelvic lesion particularly in females. Its secondary purpose is to elicit tenderness in cases of pelvic appendicitis. In case of pelvic appendicitis there may not be any tenderness on the anterior abdominal wall, so rectal examination is very essential to exclude such appendicitis. When inflamed appendix lies in the pelvis, presence of a mass or tenderness will be present on the right side of the fornix.

Special features, according to position

Retrocaecal

Rigidity is often absent (silent appendix) and even on deep pressure tenderness may be lacking, the reason being that the caecum, distended with gas, prevents the pressure exerted by the hand from reaching the inflamed stricture, and

gurgling may even be elicited. However, deep tenderness is often present in the loin, and rigidity of the quadrates lumborum may be in evidence.

Psoas spasm, due to the inflamed appendix being in contact with the muscle, may be sufficient to cause flexion of the hip joint may induce abdominal pain when a degree of psoas spasm is sufficient to cause flexion of the hip.

Pelvic

Occasionally early diarrhoea results from an inflamed appendix being in contact with rectum. When the appendix lies entirely within the pelvis there is usually complete absence of abdominal rigidity, and often tenderness over Mc Burney's point is lacking as well. In some instances deep tenderness can be made out just above and right to the symphysis pubis. In either event a rectal examination reveals tenderness in the rectovesical pouch or the pouch of Douglas, especially on the right side. Psoas spasm may also be present when the appendix is in this position: alternatively, spasm of the obturator internus is sometimes demonstrable when the hip is flexed and internally rotated. If inflamed appendix is in contact with the obturator internus, this manoeuvre will cause pain in the hypogastrium. An inflamed appendix in contact with bladder may cause frequency of micturation. A child sometimes postpones micturation as it causes pain.

Post ileal

Although this is rare, it accounts for some of the cases of 'missed appendix. It presents the greatest difficulty in diagnosis because the pain may not shift, diarrhoea is a feature, marked retching may occur and tenderness, if any, is ill-defined, though it may be present immediately to the right of the umbilicus. As the

appendix irritates the lower ileum, the patient usually passes small loose stools soon after eating or drinking.

Maldescended (subhepatic)

The tenderness is in the subhepatic region. It is sometimes mistaken for acute cholecystitis.

Special features, according to age

Acute appendicitis in infants

In infants under thirty-six months of age the incidence of perforation is over 80%, and the mortality is considerably higher than the general mortality; indeed, when acute appendicitis occurs during the first year of life, only 50% of the patients reach their first birthday. One of the reason for rapid onset of diffuse peritonitis is that the greater omentum, being comparatively short and undeveloped, is unable to give much assistance in localising the infection. Even more importance is the difficulty in arriving at early diagnosis, and particularly in differentiating the condition from enteritis also acute appendicitis can complicate enteritis. In addition, acute appendicitis may be associated with acute respiratory infection or one of the exanthemas.

Acute appendicitis in children

It is rare to find a child with appendicitis ho has no vomiting and they usually have complete aversion to food. In addition, they do not sleep during the attack and very often bowel sounds are completely absent in the early stages.

Acute appendicitis in the aged

Gangrene and perforation occur much more frequently in elderly patients. Elderly patients with lax abdominal walls or obesity may harbour a gangrenous appendix with little evidence to it and old people are prone to self-medication with laxatives. In addition, the picture may simulate subacute intestinal obstructions and if enemas are given, peritonitis may spread more widely. The immune system becomes weaker in old age. For all these reasons, acute appendicitis in older age group carries a high mortality.

Acute appendicitis in the obese

Obesity can obscure and diminish all the local signs of acute appendicitis. It is safer to operate on such cases through a generous vertical incision rather than miss a gangrenous appendix.

Acute appendicitis in pregnancy

In pregnancy the appendix shifts to the upper abdomen, thus favouring peritonitis: the nearer to term, the greater the danger, even in cases without perforation. After the 6th month there is a maternal mortality of 20% ten times greater than that in first trimester. As pregnancy advances pain becomes higher and more lateral. Microscopical examination of specimens of urine will help to exclude pyelonephritis, but in doubtful cases it is best to perform early appendicectomy. The pregnant patient with acute perforated appendicitis aborts or goes into premature labour in 50% of cases, while in acute non-perforated appendicitis this figure is reduced to 30%.⁵²

LABORATORY STUDIES⁵³

Laboratory studies demonstrated acute phase reactants to be elevated secondary to acute inflammation.

- C-reactive protein (CRP)
- Total white blood cell (WBC) count
- Differential count

C-reactive protein has been studied and correlated with clinical and pathological findings. In general it is not a clinically useful laboratory study because it is non-specific.

The leucocyte count is usually elevated above 12,000 cells/mm³ on differential count usually there is increase in percentage of neutrophils, the left shift with a normal leucocyte count supports clinical diagnosis of acute appendicitis. A completely normal leucocyte count and differential count is uncommon in patients with appendicitis, but it can be seen.³³

Laboratory studies can be helpful in the diagnosis of appendicitis, but no single test is definitive. A white blood cell count (WBC) is perhaps the most useful laboratory test. Typically, the WBC is slightly elevated in nonperforated appendicitis, but may be quite elevated in the presence of perforation. The clinician must remember, however, that the WBC can be normal in patients with acute appendicitis, particularly in early cases. Serial WBC measurements improve the diagnostic accuracy, with a rising value over time commonly seen in patients with appendicitis.³³

Urinalysis is performed to diagnose other potential causes for abdominal pain, specifically urinary tract infection and ureteric stone. Significant hematuria with colicky abdominal pain suggests ureterolithiasis, and testing directed at this diagnosis is indicated. A urinary tract infection, on the other hand, is not uncommon in patients with appendicitis. Its presence does not exclude the diagnosis of acute appendicitis, but it should be identified and treated. Although pyuria suggests urinary tract infection, it is not uncommon for the urinalysis in a patient with appendicitis to show a few white blood cells solely due to inflammation of the ureter by the adjacent appendix.

In certain patient populations, other laboratory tests are indicated. In women of childbearing age, the urine human chorionic gonadotropin should be checked to alert the clinician to the possibility of ectopic or concurrent pregnancy. Ectopic pregnancy is another cause of right lower quadrant pain that demands emergent diagnosis and treatment.

Radiologic evaluation

The options for radiologic evaluation of patients with suspected appendicitis have expanded in recent years, enhancing and sometimes replacing previously used radiologic studies.

Plain radiographs, while often revealing abnormalities in acute appendicitis, lack specificity and are more helpful in diagnosing other causes of abdominal pain. Likewise, barium enema is now used infrequently because of the advances in abdominal imaging.³⁴

Ultrasound

Graded compression Sonography is relatively inexpensive, rapid, non-invasive, and requires no patient preparation or contrast material administration. Unfortunately, graded compression sonography is operator-dependent and requires a high level of skill and expertise. Sonography is also a dynamic investigation, and photographs of sonographic images cannot be reliably re-evaluated.⁵⁴

An inflamed appendix appears on ultrasound as a non-compressible tubular structure, more than 6 mm in diameter, with a thickened wall.

Ultrasonography may significantly improve the diagnostic accuracy in patients with suspected acute appendicitis and should be performed in some patients in whom the clinical diagnosis is equivocal. The overall sensitivity, specificity and accuracy of ultrasonography in the diagnosis of acute appendicitis were 78%, 92% and 87%, respectively.⁵⁵

Another limitation of ultrasound in the diagnosis of acute appendicitis is the fact that patients cannot be safely be sent home after a negative result unless there are good clinical grounds for their discharge.⁵⁶

Ultrasound is helpful in young females in diagnosis of some gynecological conditions like torsion of ovarian cyst and ectopic pregnancy which may be confused with acute appendicitis.

Contrast-Enhanced CT

CT is a well-established technique in the study of acute abdominal pain and has shown high sensitivity and specificity for diagnosing and differentiating appendicitis, providing an accurate diagnosis in the early stages of disease.⁵⁷

CT is readily available, is supposed to be operator-independent, is relatively easy to perform, and has results that are easy to interpret. Helical CT has reported sensitivities of 90-100%, specificities of 91-99%, accuracies of 94-98%, positive predictive values of 92-98%, and negative predictive values of 95-100%.⁵⁸⁻⁵⁹ Studies have proven that CT without the administration of contrast material in the setting of suspicion of acute appendicitis can be as accurate as those techniques in which oral, rectal, or IV contrast medium is administered.⁶⁰

The typical CT finding of an inflamed appendix is a thickened wall and a non-filling appendix associated with periappendicular inflammatory fluid.⁶⁰

CT scanning of patients with suspected appendicitis may reduce the number of patients admitted for observation and decrease the rate of negative appendectomy.⁶¹

Diagnostic Laparoscopy

Several authors have advocated the use of laparoscopy as a diagnostic modality in the evaluation of a patient suspected of having acute appendicitis. Diagnostic laparoscopy should be viewed as an invasive procedure requiring general anesthesia and having a risk similar to appendectomy. For this reason, it is not preferred as a diagnostic tool. There is a lot of debate whether to remove a normal-

looking appendix during diagnostic laparoscopy or to leave it. Naturally, many surgeons prefer not to come out empty-handed regardless of the gross appearance of the appendix, especially if no other pathology is identified. Many authors advocate removal of appendix regardless of the gross appearance as they believe not all normal-looking appendices are not inflamed and the inflammation may be limited to the mucosa (endo-appendicitis); however, the routine removal of a normal appendix is not a complication-free technique even in laparoscopy.⁶⁰

In a study authors reviewed the literature for the years 1978 to 1998 to analyze the negative appendectomy rates, complication rates, the accuracy of laparoscopic appendix assessment, and the incidence of false negative diagnosis of appendicitis, at surgical and gynaecological laparoscopy. He concluded that, contrary to general opinion, there is no substantial evidence to support the assumption that the macroscopic diagnosis of appendicitis is unreliable. High rates of conflicting diagnoses of excision specimens suggest that endo-appendicitis has little clinical significance. At present, negative appendectomy rates are considerably higher for laparoscopic appendectomy than for the open approach. The role of diagnostic laparoscopy in suspected appendicitis should be reconsidered. It may be useful in particular subgroups of patients, but it is no substitute for good clinical judgement.⁶²

Another report stated that, 3.2% of the intra-operatively normal-appearing appendices demonstrated acute inflammation after pathological examination.⁶³

Furthermore, a prospective study evaluated 109 diagnostic laparoscopies for suspected appendicitis with normal-looking appendices in 100 cases. After a median

follow-up of 4.4 years, only two patients had acute appendicitis and nine had some recurrent pain. Study suggested that it is safe to leave a normal-looking appendix in place when a diagnostic laparoscopy for suspected appendicitis is performed, even if another diagnosis cannot be found at laparoscopy.⁶⁴

Diagnostic laparoscopy may be helpful in equivocal cases or in women of childbearing age, while therapeutic laparoscopy may be preferred in certain subsets of patients (e.g., women, obese patients, athletes),⁶⁵ but it should not be advocated as a routine diagnostic procedure to replace the classical pre-operative work-up usually performed for clinically suspected appendicitis, because it has its own morbidity and in most cases requires general anesthesia.⁶⁰

Despite technologic advances, the diagnosis of appendicitis is still based primarily on the patient's history and the physical examination. It has been estimated that the accuracy of the clinical diagnosis of acute appendicitis is lying between 76% and 92%, with values correlating with the surgeon's experience.⁶⁰

Diagnostic difficulties

Accurate and timely diagnosis of atypical cases remains clinically challenging and one of the most commonly missed problems in the emergency departments. Precocious appendectomy or misdiagnosis of presumed appendicitis is an adverse outcome that leads to unnecessary surgery, serious interruption of patient's daily activities and considerable waste of hospital resources in addition to the recognized postoperative complications. On the other hand, delay in diagnosis may increase the morbidity and cost.⁶⁰

Statistics reported that 1 of 5 cases of appendicitis is misdiagnosed; however, a normal appendix is found in 15-35% of patients who have emergency appendectomy.⁶⁶

Variation in the position of the appendix, age of the patient and degree of inflammation make the clinical presentation of appendicitis inconsistent. Females during childbearing age present diagnostic difficulty and the incidence of misdiagnosis is increased for women of the reproductive age.⁶⁷

Differential diagnosis

Although acute appendicitis is the most common abdominal surgical emergency, the diagnosis at times can be extremely difficult. There are a number of common conditions that it is wise to consider carefully and, if possible, exclude. The differential diagnosis differs in patients of different ages; in women, additional differential diagnoses are diseases of the female genital tract.

Adult

1. Terminal ileitis in its acute form may be indistinguishable from acute appendicitis unless a doughy mass of inflamed ileum can be felt. An antecedent history of abdominal cramping, weight loss and diarrhoea suggests regional ileitis rather than appendicitis. The ileitis may be non-specific, due to Crohn's disease or Yersinia infection. Yersinia enterocolitica causes inflammation of the terminal ileum, appendix and caecum with mesenteric adenopathy. If suspected, serum antibody titres are diagnostic, and treatment with intravenous tetracycline is appropriate. If Yersinia infection is suspected at operation, a mesenteric lymph node should be

excised, divided and half submitted for microbiological culture (including tuberculosis) and half for histological examination.⁴⁷

2. Ureteric colic does not commonly cause diagnostic difficulty, as the character and radiation of pain differs from that of appendicitis. Urinalysis should always be performed and the presence of red cells should prompt a supine abdominal radiograph. Renal ultrasound or intravenous urogram is diagnostic.⁴⁷
3. Right-sided acute pyelonephritis is accompanied and often preceded by increased frequency of micturition. It may cause difficulty in diagnosis, especially in women. The leading features are tenderness confined to the loin, fever (temperature 39⁰C) and possibly rigors and pyuria.⁴⁷
4. Perforated peptic ulcer (duodenal contents pass along the para-colic gutter to the right iliac fossa). As a rule there is a history of dyspepsia and a very sudden onset of pain that starts in the epigastrium and passes down the right paracolic gutter. In appendicitis, the pain starts classically in the umbilical region. Rigidity and tenderness in the right iliac fossa are present in both conditions but, in perforated duodenal ulcer, the rigidity is usually greater in the right hypochondrium. An erect abdomen radiograph will show gas under the diaphragm in 70% of patients. An abdominal CT examination is valuable when there is diagnostic difficulty.⁴⁷
5. Testicular torsion in a teenage or young adult male is easily missed. Pain can be referred to the right iliac fossa, and shyness on the part of the patient may

lead the unwary to suspect appendicitis unless the scrotum is examined in all cases.⁴⁷

6. Acute pancreatitis should be considered in the differential diagnosis of all adults suspected of acute appendicitis and when appropriate excluded by serum or urinary amylase measurement.⁴⁷

7. Rectus-sheath haematoma is a relatively rare but easily missed differential diagnosis. It usually presents with acute pain and localised tenderness in the right iliac fossa, often after an episode of strenuous physical exercise. Localised pain without gastrointestinal upset is the rule. Occasionally, in an elderly patient, particularly one taking anticoagulant therapy, a rectus sheath haematoma may present as a mass and tenderness in the right iliac fossa after minor trauma.⁴⁷

Adult female

It is in women of child-bearing age that pelvic disease most often mimics acute appendicitis. A careful gynaecological history should be taken in all women with suspected appendicitis, concentrating on menstrual cycle, vaginal discharge and possible pregnancy. The most common diagnostic mimics are Pelvic inflammatory disease (PID), Mittelschmerz (Painful Ovulation), torsion or haemorrhage of an ovarian cyst and ectopic pregnancy.⁴⁷

1. Pelvic inflammatory disease: Pelvic inflammatory disease comprises a spectrum of diseases that include salpingitis, endometritis and tubo-ovarian sepsis. The incidence of these conditions is increasing, and the diagnosis should be considered in every young adult female. Typically, the pain is

lower than in appendicitis and is bilateral. A history of vaginal discharge, dysmenorrhoea and burning pain on micturition is a helpful differential diagnostic point. The physical findings include adnexal and cervical tenderness on vaginal examination. When suspected, a high vaginal swab should be taken for *Chlamydia trachomatis* and *Neisseria gonorrhoeae* culture and the opinion of a gynaecologist obtained. Transvaginal ultrasound can be particularly helpful in establishing the diagnosis. When serious diagnostic uncertainty persists, diagnostic laparoscopy should be undertaken.⁴⁷

2. Mittelschmerz: Mid-cycle rupture of a follicular cyst with bleeding produces lower abdominal and pelvic pain, typically mid-cycle. Systemic upset is rare, pregnancy test is negative and symptoms usually subside within hours. Occasionally, diagnostic laparoscopy is required. Retrograde menstruation may cause similar symptoms.⁴⁷
3. Torsion/haemorrhage of an ovarian cyst: This can prove a difficult differential diagnosis. When suspected, pelvic ultrasound and a gynaecological opinion should be sought.⁴⁷
4. Ectopic pregnancy: It is unlikely that a ruptured ectopic pregnancy, with its well defined signs of haemoperitoneum, will be mistaken for acute appendicitis, but the same cannot be said for a right-sided tubal abortion, or still more for a right-sided unruptured tubal pregnancy. In the latter, the signs are very similar to those of acute appendicitis, except that the pain commences on the right side and stays there. The pain is severe and

continues unabated until operation. Usually, there is a history of a missed menstrual period and urinary pregnancy test may be positive. Severe pain is felt when the cervix is moved on vaginal examination. Signs of intraperitoneal bleeding usually become apparent, and the patient should be questioned specifically regarding referred pain in the shoulder. Pelvic ultrasonography should be carried out in all cases in which an ectopic pregnancy is a possible diagnosis.⁴⁷

Elderly

1. Sigmoid diverticulitis: In some patients with a long sigmoid loop, the colon lies to the right of the midline, and it may be impossible to differentiate between diverticulitis and appendicitis. Abdominal CT scanning is particularly useful in this setting and should be considered in management of all patients over the age of 60.⁴⁷
2. Intestinal obstruction: The diagnosis of intestinal obstruction is usually clear; the subtle lies in recognising acute appendicitis as the occasional cause in the elderly.⁴⁷
3. Carcinoma of the caecum: When obstructed or locally perforated, carcinoma of the caecum may mimic or cause obstructive appendicitis in adults. A history of antecedent discomfort, altered bowel habit or unexplained anaemia should raise suspicion. A mass may be palpable and barium enema diagnostic.⁴⁷

Scoring systems

Despite its high prevalence, the diagnosis of appendicitis remains challenging. The diagnosis of appendicitis embodies Sir William Osler's spirit when he stated, "Medicine is a science of uncertainty and an art of probability." The clinical presentation is often atypical and the diagnosis is especially difficult because symptoms often overlap with other conditions.⁶⁸ The fundamental clinical decision in the diagnosis of a patient with suspected appendicitis is whether to operate or not. Ideally, the goal is to expeditiously treat all cases of appendicitis without unnecessary surgical interventions.⁶⁹

Outcomes following a negative appendectomy (i.e., false positive) are less life threatening than the outcome of a false negative diagnosis, in which its mortality rate was high from appendiceal perforation and peritonitis. As a result, an aggressive surgical approach is frequently applied when the diagnosis is in doubt and this sometimes results in the removal of normal appendices. In order to reduce the aggressive management, an accurate and reliable diagnostic test for appendectomy is required to effectively discriminate between patients who require prompt surgical intervention from the patients who need more conservative management.

Imaging modalities have been used to improve diagnostic accuracy. However disadvantages include excessive cost, lack of accessibility (particularly in developing countries), lack of radiologists, examiner-dependent efficacy (e.g., ultrasound), potential harmful ionization (e.g., computerized tomography), and low performance in low or high prevalence populations.⁷⁰

Clinical scoring systems that synthesize clinical information have been developed and may be useful for those countries where imaging is less accessible. These scores have been derived by incorporating clinical signs and symptoms into a mathematical equation which predicts the probability of appendicitis. Various statistical methods have been used to construct a number of diagnostic scoring algorithms, some of which have been validated either internally or externally, while others have been applied without validation. The performance of those scores that have been validated varies from fair to good.⁷⁰

Several scoring systems including computer based models and algorithms have been developed with good initial performance (in the derivation dataset), but this usually falls when validated in the general populations. Nevertheless, these scoring systems have been occasionally applied in general routine practice because of a lack of accuracy of physical examination.⁷⁰

Over the last 3 decades, a number of clinical scoring systems (CSSs) have been developed to assist the clinician in assessing patients presenting with abdominal pain and suspected appendicitis. Several of these scores were specifically derived for children, while others were developed for adults or mixed populations and subsequently validated in children.⁷¹ The best known, such as the Alvarado Score and the Pediatric Appendicitis score, have been studied at length. Lesser known scores such as Kharbanda's Low Risk Score, the Lindberg Score, and the Ohmann Score, among others, are listed as below. Most Scoring Systems include a combination of Historical, Clinical and Laboratory measures.⁷⁰

- Alvarado Score (MANTRELS)

- Tzanakis scoring system
- Ohmann Score
- Lintula Score
- Pediatric Appendicitis Score (Samuel)
- Low Risk for Appendicitis Score (Kharbanda)
- Eskelinen Score
- Fenyo - Lindberg Score
- Christian Score
- RIPASA Score

*Alvarado Score or MANTRELS Score*¹³

		Variable	Value
Symptoms		Migration	1
		Anorexia	1
		Nausea – Vomiting	1
Signs		Tenderness in right lower quadrant	2
		Rebound pain	1
		Elevation of temperature > 37.3 °C	1
Laboratory		Leukocytosis > 10.0 x 10 ⁹ /L	2
		Shift to the left > 75%	1

The score was originally developed by Alfredo Alvarado in 1986 as an aid to the diagnosis of patients with appendicitis. The score was based on a cohort of 305

patients based at the Nazareth Hospital in Philadelphia in the United States of America who presented with suspected appendicitis. The charts of these patients were reviewed retrospectively and the sensitivity and specificity of a number of symptoms, signs and laboratory variables were assessed with those with the greatest diagnostic value being used to form a scoring system. This resulted in the formation of a simple score consisting of three symptoms, three signs and two laboratory markers of inflammation weighted as either one or two based on their importance in diagnosis. These variables could be recalled using the pneumonic MANTRELS. The maximum total score achievable is, therefore, 10. A score of 5 or 6 is compatible with a diagnosis of acute appendicitis, with a score of 7 or 8 indicating probable appendicitis and a score of 9 or 10 indicating a very probable acute appendicitis. It has been suggested that score can used as a guide to determine which patients require further observation and which patients require surgery. Those with a score of 5 or 6 required observation while those with a score of 7 or above needed to proceed to surgery as it was likely that they had appendicitis.

The Alvarado score is the best performing of the clinical scoring systems in current use. The score, however, is not based on a formal mathematical model which has accounted for the variables independent ability to predict a diagnosis. It was also based on retrospective data. These factors have resulted in a number of authors proposing multiple other scoring systems including a variety of other clinical, laboratory and imaging findings.⁷²

Tzanakis scoring system

The Tzanakis scoring system incorporated ultrasound scanning along with clinical and laboratory findings to predict the diagnosis of appendicitis. Following a multivariate logistic regression analysis four variables formed the scoring system (Ultrasound positive for acute appendicitis, tenderness in the right lower quadrant, rebound tenderness and a leukocyte count[12,000/L]).⁷²

The Appendicitis Inflammatory Response Score was constructed from eight independent predictive variables (right lower quadrant pain, rebound tenderness, muscular defense, WBC count, proportion of neutrophils, CRP, body temperature and vomiting) and performed better than the Alvarado score in a sample of 229 patients suspected of appendicitis (Sensitivity 0.97 vs. 0.92, $p=0.0027$ and Specificity 0.93 vs. 0.88, $p=0.0007$).

Ohmann score

The Ohmann score was developed in Germany and was subject to a before and after intervention study and used computer – aided diagnosis. The variables completing the score are tenderness in the right lower quadrant, rebound tenderness, no micturition difficulties, steady pain, leukocyte count[10.0 9 109/L, age\50 years, relocation of the pain to right lower quadrant and rigidity.¹²

The score was developed using stepwise logistic regression analysis of a German database and confirmed on a Dutch database. Following introduction of the score over a 4 month period the rates of delayed appendicectomy (2 vs. 8%) and delayed discharge (11 vs. 22%) decreased significantly ($p\0.02$), however, there were no changes in the number of perforations or complications.⁷²

Lintula score

The Lintula score was developed from 35 symptoms and signs recorded for 131 Finnish children with abdominal pain which were modeled using logistic regression for their predictive value for a diagnosis of acute appendicitis. The score was then validated on a cohort of prospectively collected children with abdominal pain. The score uses gender, intensity of pain, relocation of pain, vomiting, pain in the right lower quadrant, fever, guarding, bowel sounds and rebound tenderness to form a score which if greater than 21 appendectomy was advocated.⁷³

The Lintula score was developed for use in children but has subsequently been validated in adults.⁷⁴ The Fenyo-Lindberg scoring system was developed using a prospectively collected sample of 1,167 patients with suspected appendicitis. The system uses nine clinical and one laboratory variable to form a score. Each variable is given a weight between -15 and +15.⁷⁵ The authors initially reported a reduction in the rate of negative laparotomies associated with the use of the score.

The Christian Score

Probably the simplest of the group, the Christian Score uses a mere 5 criteria. The case group of 58 subjects with suspected appendectomy had surgical intervention if ≥ 4 criteria were met. Fifty-nine appendectomy controls had intervention based solely on surgical staff assessment. Ages ranged from 7 to 56 years. The negative appendectomy rate was significantly less in the Score group than that of the controls (6.5% vs. 17%). This is a rather simple score, which unfortunately does not appear to have been validated or assessed in a pediatric specific population.⁷⁶

The Eskelinen Score

The Eskelinen Score is relatively complex to perform, (requiring factor multiplication) and was originally designed for use within a computer program. Table 8 details the criteria and design.

Zielke et al.⁷⁷ compared the Eskelinen and Ohmann Scores using a pooled database of a total of 5 prospective studies. 2359 patients aged 0 to 95 years with suspected appendicitis were analyzed, of which 2209 were included. 845 of these underwent a laparotomy, with histological diagnosis confirmed in 662. Sensitivity, Specificity, PPV, NPV and accuracy were 70%, 92%, 73%, 90% and 87%.

The Fenyo-Lindberg Score

This score appears to be one of the most complex, incorporating criteria with multiple levels of response that both add to and subtract from the total score. In 1987, Fenyo prospectively evaluated 259 adult patients with suspected appendicitis. The resulting score was further validated in 830 patients, of which 256 had proven appendicitis. Sensitivity, Specificity, PPV and NPV were 90%, 91%, 83% and 95% respectively.⁷⁸

Fenyo and Lindberg prospectively validated their score in 1167 patients with suspected appendicitis. Of these, 392 had histologically proven appendicitis. Using the standard threshold score of -2 to predict appendicitis, the sensitivity was 73% and specificity was 87%, notably less than in the original study. Of note, this study made use of 2 different settings, a district and a university hospital. 30% of the patients included from the University hospital were children (age unknown).⁷⁵

Pediatric Appendicitis Score (PAS)

The Pediatric Appendicitis Score (PAS) was first described by Madan Samuel in 2002. It was based on an analysis of a prospectively collected cohort of 1,170 children aged 4–15 years.⁷⁹ The symptoms, signs and laboratory findings were evaluated for sensitivity, specificity, predictive value and joint probability. A diagnostic index/weight for each clinical feature and investigation was calculated. A stepwise multiple linear regression analysis was then performed on the best independent predictors to develop a scoring system based on eight variables. The variables were given a score of one except for physical signs which were assigned a score of 2 to give a total score of 10. The variables in order of diagnostic index are, cough/percussion/hoping tenderness in the right lower quadrant of the abdomen, anorexia, pyrexia, nausea and emesis, tenderness over the right iliac fossa, leukocytosis, polymorphonuclear neutrophilia and migration of pain. The score was then validated on the cases and was found to have a sensitivity of 1, specificity of 0.92, positive predicted value of 0.96 and negative predictive value of 0.99.⁷²

The PAS has been evaluated in other cohorts of paediatric patients. It has been suggested that it is useful in stratifying the clinical risk of acute appendicitis in those children presenting to the emergency department with abdominal pain and classifying them as low, medium and high risk of acute appendicitis.⁸⁰ A score of less than or equal to 2 was found to have a high validity of ruling out acute appendicitis while a score greater than or equal to 7 was found to have a high validity of predicting acute.

The Low Risk for Appendicitis Score (Kharbanda)

Increased ED wait times, hospital over-crowding and concerns related to radiation exposure from imaging studies have put pressure on clinicians to quickly and accurately decide which children with abdominal pain should be admitted and observed or discharged without a CT evaluation. Kharbanda et al.⁸¹ derived and validated a score to do just that; identify children at low risk for appendicitis.

Kharbanda et al.⁸¹ prospectively enrolled 767 children aged 3 to 18 years with suspected appendicitis who were evaluated by a surgeon. Of these 767, 601 were included (425 derivation set, 176 validation set). Using logistic regression 6 weighted predictors of appendicitis were determined for a total score of 14. Children with a score of ≤ 5 were highly unlikely to have appendicitis (sensitivity 99%, NPV 98%, NLR 0.032 during derivation, 96%, 96% and 0.102 for validation set).

The RIPASA Score

What is probably the newest member to the group of appendicitis scores is the RIPASA Score, named after its hospital of origin in Brunei.^{11,17}

The Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) score^{11,17} is a simple qualitative scoring system based on 14 fixed clinical parameters (two demographics, five clinical symptoms, five clinical signs and two clinical investigations) and one additional parameter (foreign national Identity card).⁷¹

This scoring system was developed through a retrospective study consisting of 400 patients who had undergone an appendicectomy between October 2006 and May 2008, and who were identified from the operation note database of the

Department of Surgery, Raja Isteri Pengiran Anak Saleha (RIPAS) Hospital, Brunei Darussalam. The inclusion criteria were patients of all age groups who presented with right iliac fossa (RIF) pain suspected to be acute appendicitis, and who had undergone emergency appendectomy as the primary procedure. Patients presenting with any form of non-RIF pain, such as lower abdominal pain or right upper quadrant pain, and those who had undergone other emergency laparotomy where appendectomy was also performed as part of the procedure, or elective appendectomy, were excluded. Ethical approval for the study was obtained from the Ethics Committee Review Board of RIPAS Hospital.^{11,17}

Of the 400 patients, only 323 had complete medical records, which were collected from the Medical Record Department of RIPAS Hospital. The medical records of the other 77 patients were not traceable, and hence, these patients were excluded from the study. Out of the 323 patients, only 312 patients satisfied our inclusion and exclusion criteria. The other 11 patients were excluded as they presented with non-RIF pain.

The data collected included the patients' demographics (national registration identity card [NRIC] number, age and gender), the presenting symptoms (RIF pain, the migration of pain to the RIF, nausea and vomiting, anorexia and the duration of symptoms), clinical signs (RIF tenderness, guarding, rebound tenderness, Rovsing's sign and fever) and laboratory investigations (elevated white cell count and negative urinalysis). The inclusion of these 15 parameters was agreed upon by a panel of general surgeons at RIPAS Hospital. These 15 parameters form the basis of the new appendicitis scoring system. The probability of each parameter was calculated and scores of 0.5, 1.0 or 2.0 points were allocated to each parameter based on its

probability, with extra weightage provided to two clinical signs: guarding and Rovsing's signs. Confirmation of acute appendicitis as the final diagnosis was obtained from a histological analysis of the resected appendix at the Department of Histopathology at RIPAS Hospital.^{11,17}

Validity

Several scoring systems, such as the Alvarado and modified Alvarado scoring system, have been introduced since 1986 to help with the clinical decision-making process in achieving an accurate diagnosis of acute appendicitis in the fastest and cheapest way. However, these two scoring systems were created in the West, and when applied in different environments, such as the Middle East and Asia, the sensitivity and specificity levels achieved were very low.¹¹

Khan et al.⁸² applied the Alvarado scoring system in an Asian population and only achieved a sensitivity and specificity of 59% and 23%, respectively, with a negative appendicectomy rate of 15.6%.

Another study by Al-Hashemy et al.⁸³ in 2004 using the modified Alvarado scoring system in a Middle Eastern population reported a similarly low sensitivity of 53.8% and a specificity of 80%.

The sensitivity of the Alvarado score achieved when applied in an oriental population, at the suggested cut-off threshold of 7.0, was similarly low at 50.6%, but achieved a high specificity of 94.5%.⁸⁴ However, this improved when the cut-off threshold was lowered to 6.0, with a sensitivity and specificity of 88.3% and 94.5%, respectively, suggesting a definite ethnic difference with regard to the Alvarado score.⁸⁴

Both the Alvarado and modified Alvarado scores lack parameters that have been shown to be important determinants in the diagnosis of acute appendicitis, such as age, gender and the duration of symptoms. Wani et al.¹⁸ have shown that the sensitivity and specificity of the Alvarado scoring system vary with age, gender and the duration of symptoms.

The RIPASA study has confirmed the presence of age differences and differences in the duration of symptoms in histologically confirmed cases of acute appendicitis. Furthermore, gender differences in the occurrence of acute appendicitis were also found in our study, with male patients being 1.4 times more likely than female patients to be diagnosed, and this is in keeping with published data.¹¹

This new appendicitis scoring system includes the three parameters mentioned above as well as four other new parameters deemed important in our local settings, including clinical signs of RIF guarding, Rovsing's sign, negative urinalysis and foreign NRIC status.¹¹

Guarding and Rovsing's sign were included as the panel of general surgeons felt that these two clinical signs are earlier indicators of a local inflammatory process such as acute appendicitis, while rebound tenderness is a much later sign when the peritoneum is involved with peritonism. Negative urinalysis was also included to exclude urinary causes of RIF pain, as 60% of our general surgical admission was urological in nature.¹¹

Lastly, foreign NRIC was included as an additional parameter as the authors had found a high probability (0.8) of acute appendicitis in foreign nationals presenting with RIF pain. There is a large foreign labour workforce in Brunei

Darussalam who must pay for their medical treatment at RIPAS Hospital. For this reason, foreign nationals tend to present much later when the symptoms are more severe.¹¹

The minimum and maximum total scores achievable with this new appendicitis scoring system were 2 and 16, respectively. The sensitivity and specificity achieved were 88% and 67%, respectively, with a diagnostic accuracy of 81%, which is comparable to the Alvarado score when the latter was applied in a Western population.¹¹

This was a definite improvement from the Alvarado score (sensitivity 50.6%–59.0%, specificity 23.0%–94.5%) and modified Alvarado score (sensitivity 53.8%, specificity 80%) when applied to Middle Eastern, Asian or Oriental populations. The PPV and NPV for the new appendicitis score, at 93% and 53%, respectively, are also comparable to those achieved with the Alvarado and modified Alvarado scores.¹¹

Using the new appendicitis scoring system, the predicted negative appendicectomy rate was 6.9%, which was a 9.4% reduction from the raw data, and highly significant statistically ($p = 0.0007$).¹¹

This new appendicitis scoring system was specifically developed for our local patient group, but it is likely to be applicable to the South East Asian region, which has populations of similar ethnic origins and diets. The additional parameter of foreign NRIC can be included in the score in countries where there is a large foreign workforce who has to pay for healthcare treatments. This new appendicitis

scoring system is easy and simple to apply as the majority of the parameters can be obtained from a routine history and clinical examination.¹¹

The new appendicitis scoring system described was referred to as the RIPAS Appendicitis score, or 'RIPASA' score in short, is promising and has good sensitivity, specificity and diagnostic accuracy. It is simple and easy to use, and has been specifically developed for our local patient group, which is reflective of the South East Asian region in terms of diet and ethnic origin. The prospective evaluation of the RIPASA score is ongoing, and the authors aimed to recruit 100–150 patients prospectively.¹¹

Literature

A study¹⁷ prospectively compared the RIPASA score with the Alvarado score for the diagnosis of acute appendicitis on 200 consecutive patients who presented to the Accident and Emergency Department with right iliac fossa pain. Both the RIPASA and Alvarado scores were derived, but decisions for appendicectomy were based on clinical judgment. Only 192 out of the 200 patients who satisfied the inclusion and exclusion criteria were included in the analysis. At the optimal cut-off threshold score of 7.5 derived from the ROC, the sensitivity, specificity, PPV, NPV and diagnostic accuracy of the RIPASA score were 98.0%, 81.3%, 85.3%, 97.4% and 91.8%, respectively. At the cut-off threshold score of 7.0 for the Alvarado score, the sensitivity, specificity, PPV, NPV and diagnostic accuracy were 68.3%, 87.9%, 86.3%, 71.4% and 86.5%, respectively. The RIPASA score correctly classified 98 percent of all patients confirmed with histological acute appendicitis to the high-probability group (RIPASA score greater than 7.5)

compared with 68.3 percent with the Alvarado score (Alvarado score greater than 7.0; p-value less than 0.0001). Study concluded that the RIPASA score at a cut-off threshold total score of 7.5 is a better diagnostic scoring system than the Alvarado score for the diagnosis of acute appendicitis in our local setting.

Recently a prospective study⁸⁵ from Mangalore, Karnataka applied and compared Alvarado and RIPASA score in the diagnosis of acute appendicitis in Indian population among 206 patients. Both scores were calculated for patients who presented with right iliac fossa pain during the study period. Depending on clinical judgment appendicectomy was done. Post operative histopathology report was correlated with the scores. A score of 7.5 is the optimal cut off threshold for RIPASA and 7 for Alvarado scoring system. Sensitivity, specificity, positive predictive value (PPV) and negative predictive (NPV) for RIPASA & Alvarado system was done. The sensitivity and specificity of RIPASA score were 96.2% and 90.5% respectively. The sensitivity and specificity of Alvarado score were 58.9% and 85.7% respectively. RIPASA score correctly classified 96 percent of all patients confirmed with histological acute appendicitis to the high probability group (RIPASA score greater than 7.5) compared with 58.9% with Alvarado score (Alvarado score greater than 7.0; p-value less than 0.001). Authors concluded that, RIPASA scoring system is more convenient, accurate, and specific scoring system for Indian population than Alvarado scoring system.

In another study⁸⁶ data was collected from 96 patients with complaints of right iliac fossa pain over a period of 2 years. All patients were categorised using the RIPASA SCORE. The preoperative and histological findings were compared with the preoperative diagnosis. Histopathologically 91 patients were in appendicitis

groups and 5 patients were in no appendicitis group. On Evaluation of scoring system in the present study, RIPASA system was found sensitive (97.80%), specificity of RIPASA score (77%). Positive predictive value of score came out to be 98.89% in RIPASA. Negative predictive value of RIPASA system was 66.67%. Accuracy is 89.04% in RIPASA system. Predictive negative appendectomy rate by application of score is 0.7% by RIPASA system. ROC analysis was done to depict the cut off with maximum sensitivity and specificity. RIPASA cut off was found to be 8.5 as compared to the original cut off 7.5. It was observed that there has been an increase in mean scores in the scoring system, with an increase in histopathological severity. Presence of gangrene was found statistically significant at RIPASA score 12. Study concluded that there is high possibility to find gangrenous appendix when the RIPASA score are greater than 12. On considering the above fact it is observed that RIPASA score is more accurate and more sensitive to diagnose acute appendicitis than other scoring system.

Recently a cross-sectional study⁸⁷ was done to determine the usefulness of RIPASA score for the diagnosis of acute appendicitis using histopathology as a gold standard from September 2011 to March 2012 on 267 patients. Authors showed that, RIPASA score at a cut-off total score of 7.5 was a useful tool to diagnose appendicitis, in equivocal cases of pain.

Furthermore, several other CSSs have been developed for patients with suspected appendicitis. Some of these include the Teicher Score, Arnbjornsson Score, Izbicki Score, and DeDombal Score. However, they do not appear to have been formally evaluated and as a result are not further reviewed.⁷¹

Treatment

The treatment of acute appendicitis is appendectomy. In the absence of appendicular mass, appendix should be removed at the earliest as the operative mortality is almost negligible but it may increase several fold if operation is delayed.

The appendectomy may be either open or laparoscopic. Unlike Laparoscopic cholecystectomy, laparoscopic appendectomy has failed to establish itself as minimally invasive procedure of choice both in children and adults.⁸⁸

Open Appendectomy

Conventional-appendectomy

Done by standard methods with the help of either of the available incisions (Grid Iron, Rutherford-Morrison's, Rockey Davis, Lanz, Paramedian, Midline).⁸⁸

Mini-appendectomy

This is done with the help of small transverse incision 2 to 2.5 cms starting from lateral border of rectus abdominis muscle and extended towards Mc Burney's point. Anterior sheath is cut in line of skin incision, rectus muscle retracted medial and blended posterior sheath/peritoneum cut in line of skin incision. Once peritoneum is approached, with little manipulation appendix is delivered towards wound site and appendectomy completed as per standard protocol. Appendiceal stump is not buried and we do not close posterior peritoneum, retracted rectus muscle comes to its place once anterior sheath is closed. Skin is approximated with silk/clips/subcuticular prolene.⁸⁸

Laparoscopic-Appendectomy

Laparoscopic appendectomy counts almost 30 years of presence, and its introduction has met with more hurdles than that of laparoscopic cholecystectomy. Especially during the last two decades numerous studies tried to define the role of laparoscopic appendectomy in the treatment of suspected acute appendicitis.⁸⁸

Laparoscopy seems to be as safe as open appendectomy for acute appendicitis. Laparoscopy has many advantages, such as higher diagnostic yield, fewer postoperative wound infections, less postoperative pain, shorter hospital stay, earlier return to normal and full activity, better cosmesis, and probably decreased late complications such as adhesion formation and incisional hernias. Also one cannot overemphasize the superior visualization of the abdominal cavity and the possibility of not only diagnosing other pathologies but also dealing with them without having to use a bigger incision. Fertile women can profit the most from these advantages. But also elderly, overweight and employed patients seem to profit from laparoscopy. If the safety of leaving a macroscopically innocent appendix in situ is clarified by future studies the value of laparoscopy as a diagnostic tool will be enhanced. One expects that the further expansion of laparoscopy will lead to much more experienced surgeons, and that the progress in technology will facilitate this approach even more in the future.⁸⁸

The reported higher incidence of intraabdominal abscesses with laparoscopy in some series could be experience- or technique-related and is likely to decrease with the evolution of laparoscopic skills among surgeons that leads to more precise operative maneuvers, and the standardisation of surgical technique. The higher

operative costs in most institutions can perhaps be outweighed by a shorter hospital stay, and quicker return to normal activities with the laparoscopic approach, as well as by the possible decrease in late complications. Operative costs themselves can be reduced by the application of reusable instruments, application of loops instead of staplers, and further reduction of operating times. Finally it is important to reduce negative laparoscopies. The exact role of imaging modalities, inflammatory parameters and scoring systems in this purpose has yet to be defined.⁸⁸

METHODOLOGY

The present study was conducted in the Department of General Surgery, KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belgaum over a period, from January 2014 to December 2014.

Study design

The study design was hospital based study.

Study period and duration

The present study was done for one year from January 2014 to December 2014.

Place

The present study was carried done in the Department of General Surgery, KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belgaum a teaching hospital attached to KLE University's Jawaharlal Nehru Medical College, Belgaum.

Source of Data

Patients presenting with right Illiac fossa pain to General Surgery OPD of KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belgaum were included in the study.

Sample size

A total of 60 patients presenting with right Iliac fossa pain were enrolled.

Sampling procedure

Based on pilot study requirements the sample size was calculated using the following formula.

$$n = (Z_a)^2 * \text{sensitivity} * (1 - \text{sensitivity}) / d^2 * \text{Prevalence}$$

Where Z_a – Constant i.e, 1.96 for 95% confidence interval

Sensitivity – 85%^{11,17}

d – Standard error allowed in estimation of sensitivity (5%)

Prevalence – 6.8% (Based on hospital statistics)

Therefore

$$n = 1.96^2 \times 85 \times 15 / 5^2 \times 6.8$$

$$n = 28.81 \quad 30$$

The minimum effect size required for the evaluation of accuracy was 30. However, during the study period 60 patients fulfilled selection criteria hence were enrolled. Based on systematic random sampling depending on the data available and the sample size second patient in every six patients was chosen with right iliac fossa pain in this study.

Selection criteria

Inclusion

- Patients presenting with right iliac fossa pain.

- Patients aged between age of 18 to 50 years

Exclusion

Patients with following condition were excluded

- Immunodeficiency disease
- Received systemic antibiotics within two weeks of proposed surgery
- History of prior intake of steroids
- Pre-existing systemic/local infection
- Patients with perforation, peritonitis and/or other apparent foci of active abdominal infection.

Ethical clearance

Prior to the commencement, the study was approved from the Ethical and Research Committee, Jawaharlal Nehru Medical College, Belgaum.

Informed Consent

The patients who presented with right iliac fossa pain were informed about the purpose and nature of the study. Those fulfilling selection criteria were enrolled after obtaining a written informed consent (Annexure I).

Method of collection of data

Patients were interviewed and demographic data such as age and sex were noted. Patients were evaluated for presenting features including right iliac fossa pain, migration of right lower quadrant pain, anorexia, nausea and vomiting along the duration of symptoms. Further patients were subjected to general examination and

systemic examination where surgeon assessed for clinical signs including right illiac fossa tenderness, right illiac fossa guarding, rebound tenderness, Rovsing's sign and fever. These findings were recorded on a predesigned and pretested proforma (Annexure II).

Investigations

The patients were subjected to following investigations.

- Total count
- Urine Routine

However those who underwent operative procedure were assessed for following parameters

- Haemoglobin
- Total count
- Direct count
- Erythrocyte sedimentation rate
- Urine Routine
- Blood urea nitrogen
- Serum creatinine

Estimation of RIPASA Score

The data obtained from the clinical presentation and examination findings were fitted into the RIPAS appendicitis score model developed by Chong CF. et al.¹¹

To calculate total RIPASA score, the observations were scored as per the following scoring index

Demographic data

- Sex - Score of 0.5 for females; Score of 1 for Males.
- Age - Score of 0.5 if age < 39.9 years; Score of 1 for age > 40 years.

Clinical symptoms

- RIF pain – Score of 0.5 if present
- Pain migration to RIF – Score of 0.5 if present
- Anorexia – Score of 1 if present
- Nausea and vomiting – Score of 1 if present
- Duration of symptoms - Score of 1 if < 48 hours; Score of 0.5 if > 48 hours.

Clinical signs

- Right illiac fossa tenderness - Score of 1 if present
- Right illiac fossa guarding - Score of 2 if present
- Rebound tenderness - Score of 1 if present
- Rovsing's sign - Score of 2 if present
- Fever ($>37^{\circ}\text{C}$ to $<39^{\circ}\text{C}$) - Score of 1 if present

Investigations

- Raised WCC - Score of 1 if present
- Urine analysis - Score of 1 if negative

Based on these parameters, maximum RIPASA score can be 15. Chong CF. et al. reported that, a cut-off point of 7.5 to discriminate acute appendicitis.

Procedure

Based on the RIPASA scores diagnosis of acute appendicitis was made and the management was done as below.

Management according to total score

- Patients with score of < 5 were observed in the A&E day ward and evaluation of score was repeated after one to two hours as score of < 5 is regarded as having acute appendicitis unlikely. If the scores showed reducing trend then the patients was discharged. If scores showed increasing trend during repeat assessment patients were treated according to the score following scores.
- Patients with scores from 5.0 to 7.0 were regarded as having low probability of acute appendicitis and observed in the A & E day ward and evaluation of score was repeated after one to two hours or these patients were subjected to abdominal ultrasound investigations to rule out acute appendicitis and further informed to the on-call surgeon as patients may require admission for observations.
- Patients having scores from 7.5 to 11.0 were regarded as having high probability of acute appendicitis and refer patient to on-call surgeon for admission and repeat score in one to two hours time. If scores remained high, patients were prepared for appendicectomy procedure. In female patients, abdominal ultrasound investigations were sought to rule out gynaecological causes of RIF pain.

- Patients with scores of >12 were regarded to have definite acute appendicitis and referred them to the surgeon on-call for admission and appendicectomy.

In case if the patient was discharged and has not undergone operative procedure, then the patient was followed up subsequently either on OPD basis or by contacting on Phone

Accuracy of RIPASA score

The final diagnosis was done based on the histopathological report. The accuracy of RIPASA score was determined in comparison with Gold Standard, i.e. Histopathological Report.

Statistical analysis

The data obtained was coded and entered in Microsoft Excel Spreadsheet. The categorical data was expressed as rates, ratios and percentages and comparison was done using chi-square test. Continuous data was expressed as mean \pm standard deviation. The accuracy of RIPASA score in predicting acute appendicitis was determined by calculating sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV). A 'p' value of less than or equal to 0.050 was considered as statistically significant at 95% confidence interval.

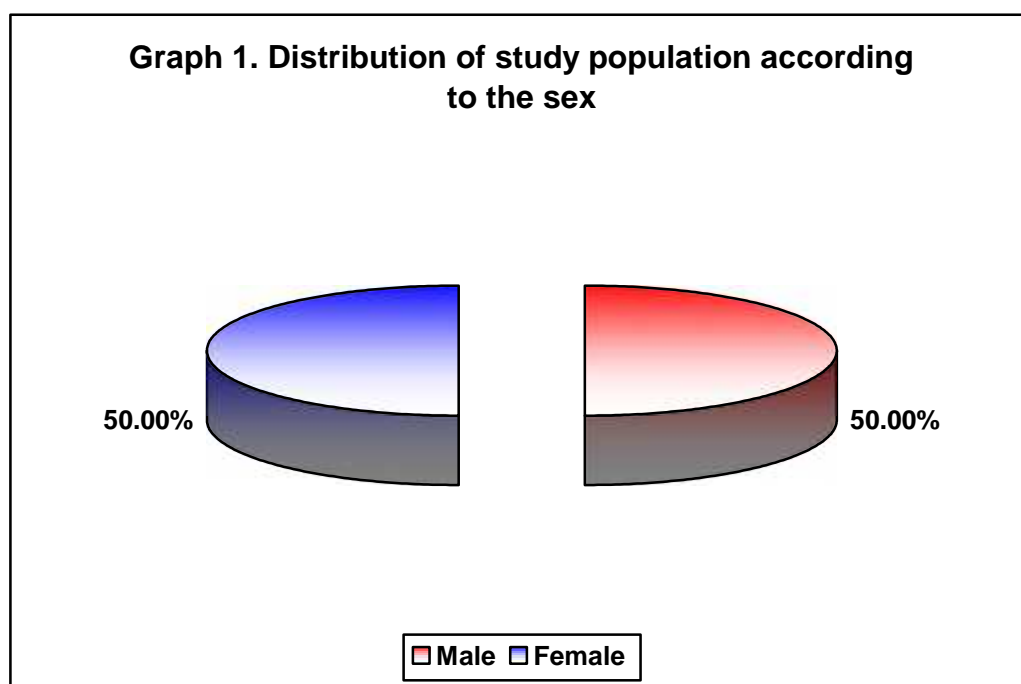
RESULTS

The present hospital study was conducted in the Department of General Surgery, KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belgaum over a period, from January 2014 to December 2014.

A total of 60 patients who presented with right Illiac fossa pain to the General Surgery OPD were studied. The patients were evaluated for the clinical signs and symptoms and accordingly the RIPASA scores were calculated. The data obtained was analysed and the final results and observations were tabulated as below.

Table 1. Distribution of study population according to the sex

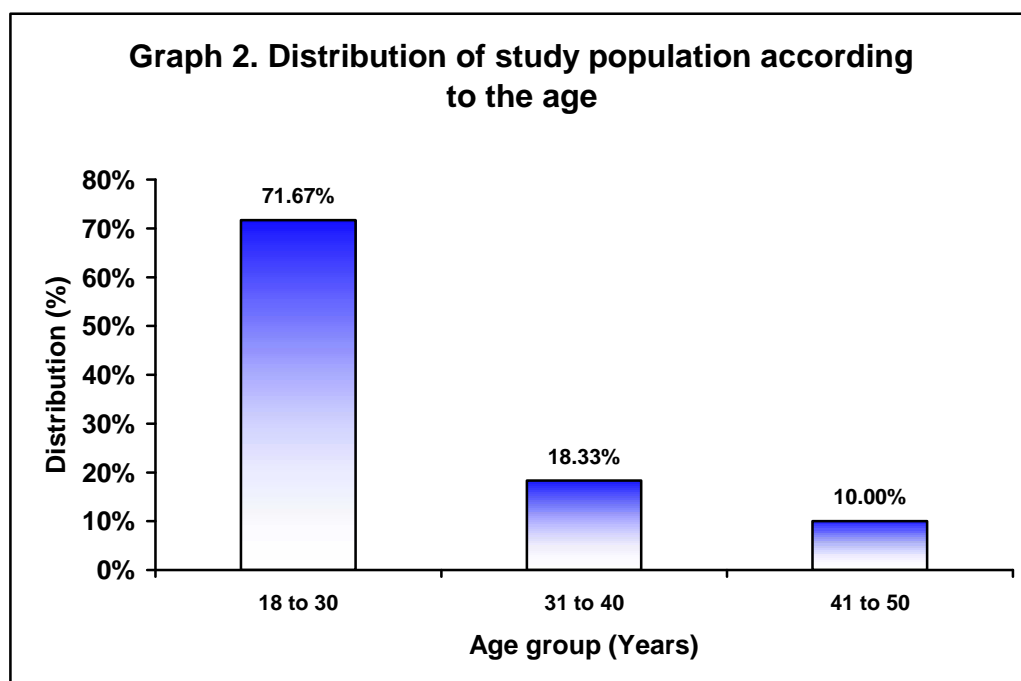
Sex	Distribution (n=60)	
	Number	Percentage
Male	30	50.00
Female	30	50.00
Total	60	100.00



In the present study 50% of the patients each were males and females with male to female ratio 1:1.

Table 2. Distribution of study population according to the age

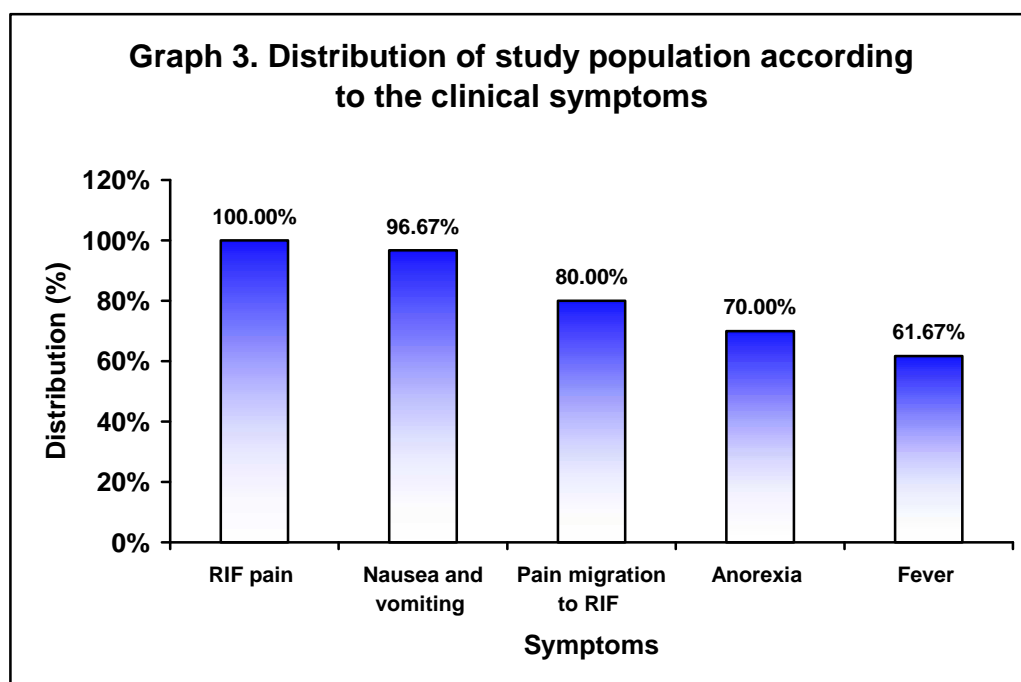
Age group (Years)	Distribution (n=60)	
	Number	Percentage
18 to 30	43	71.67
31 to 40	11	18.33
41 to 50	6	10.00
Total	60	100.00



In this study majority of the patients (71.67%) presented with age between 18 to 30 years. The mean age was 27.1 ± 8.81 years and median age was 24.5 years with range being 18 as minimum and 50 as maximum.

Table 3. Distribution of study population according to the clinical symptoms

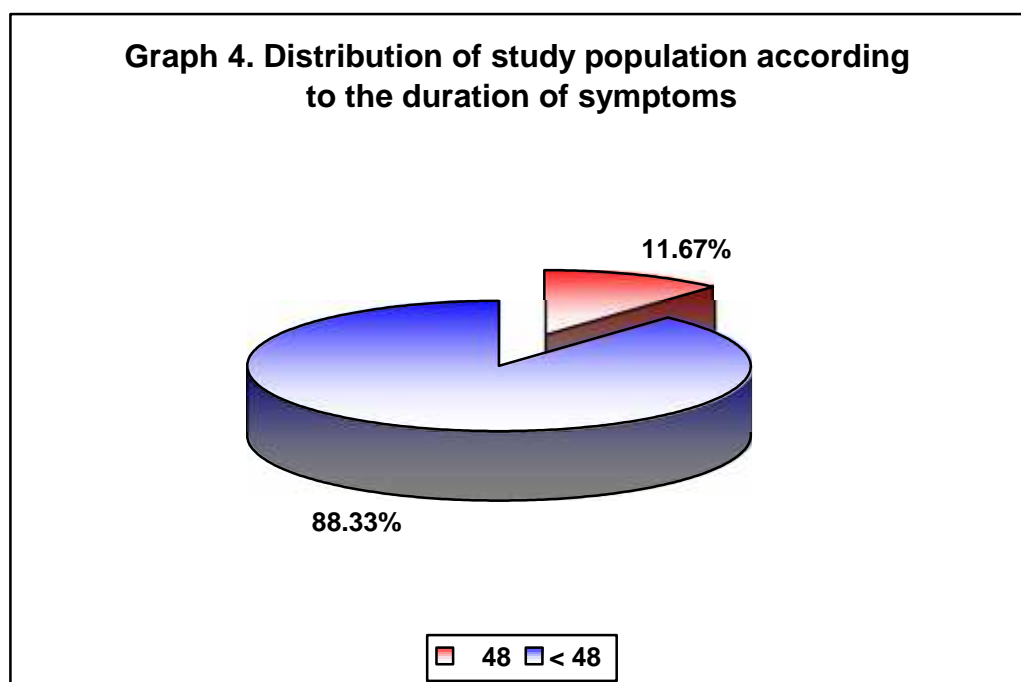
Symptoms	Distribution (n=60)	
	Number	Percentage
Right iliac fossa pain	60	100.00
Nausea and vomiting	58	96.67
Pain migration to RIF	48	80.00
Anorexia	42	70.00
Fever	37	61.67



In the present study by inclusion, RIF pain was present in all the patients. The next common symptom was nausea and vomiting (96.67%) followed by pain migration of RIF (80%), anorexia (70%) and fever (61.67%).

Table 4. Distribution of study population according to the duration of symptoms

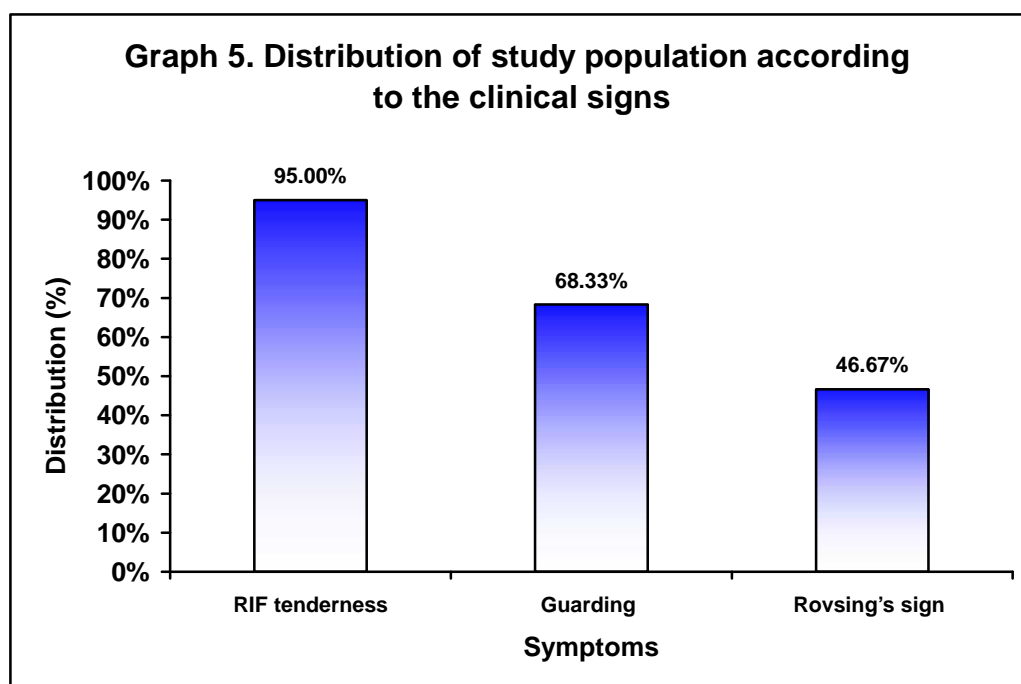
Duration (hours)	Distribution (n=60)	
	Number	Percentage
< 48	53	88.33
48	7	11.67
Total	60	100.00



In this study 88.33% of the patients reported duration of symptoms as <48 hours while 11.67% had duration of 48 hours.

Table 5. Distribution of study population according to the clinical signs

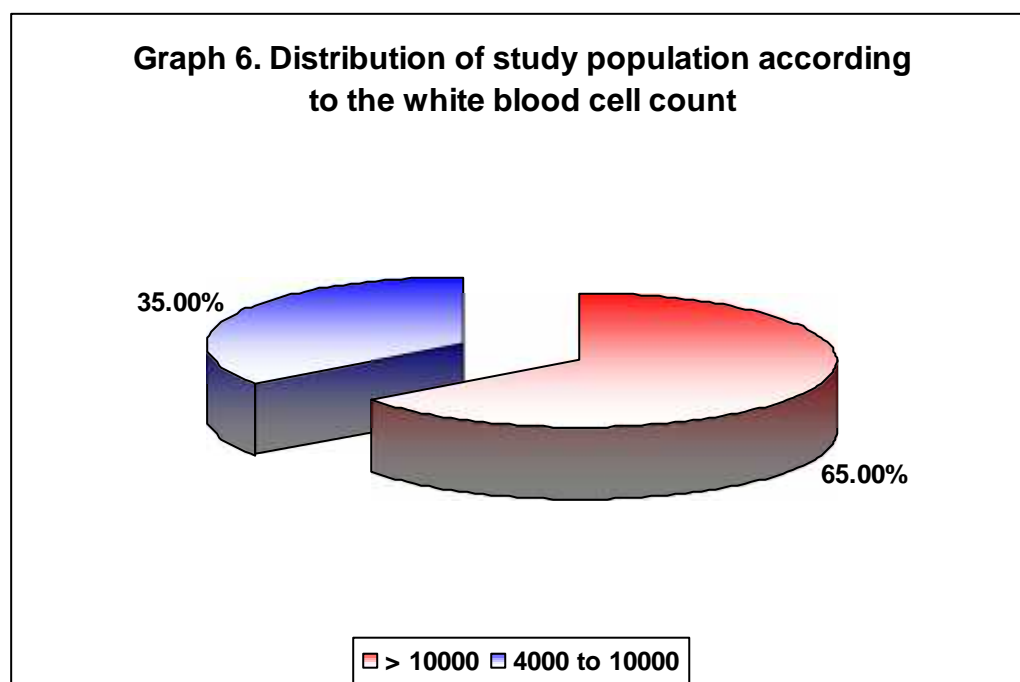
Symptoms	Distribution (n=60)	
	Number	Percentage
RIF tenderness	57	95.00
Guarding	41	68.33
Rovsing's sign	28	46.67



In the present study, on examination, majority of the patients had RIF tenderness (95%) followed by guarding (68.33%) and Rovsing's signs (46.67%).

Table 6. Distribution of study population according to the white blood cell count

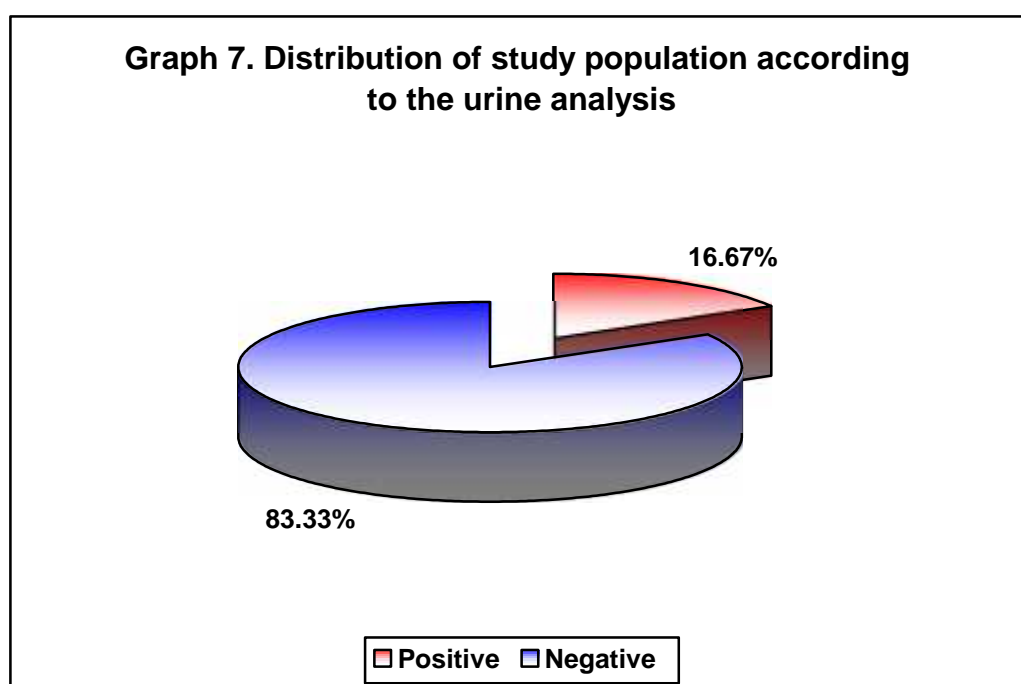
WBC count (/Cumm)	Distribution (n=60)	
	Number	Percentage
> 10000	39	65.00
4000 - 10000	21	35.00
Total	60	100.00



In this study WBC count of > 10000/Cumm was noted in 65% of the patients and 35% of the patients had WBC count between 4000 to 10000 /Cumm.

Table 7. Distribution of study population according to the urine analysis

Urine analysis	Distribution (n=60)	
	Number	Percentage
Positive	10	16.67
Negative	50	83.33
Total	60	100.00



In this study urine analysis was positive in 16.67% of the patients and negative in 83.33% of the patients.

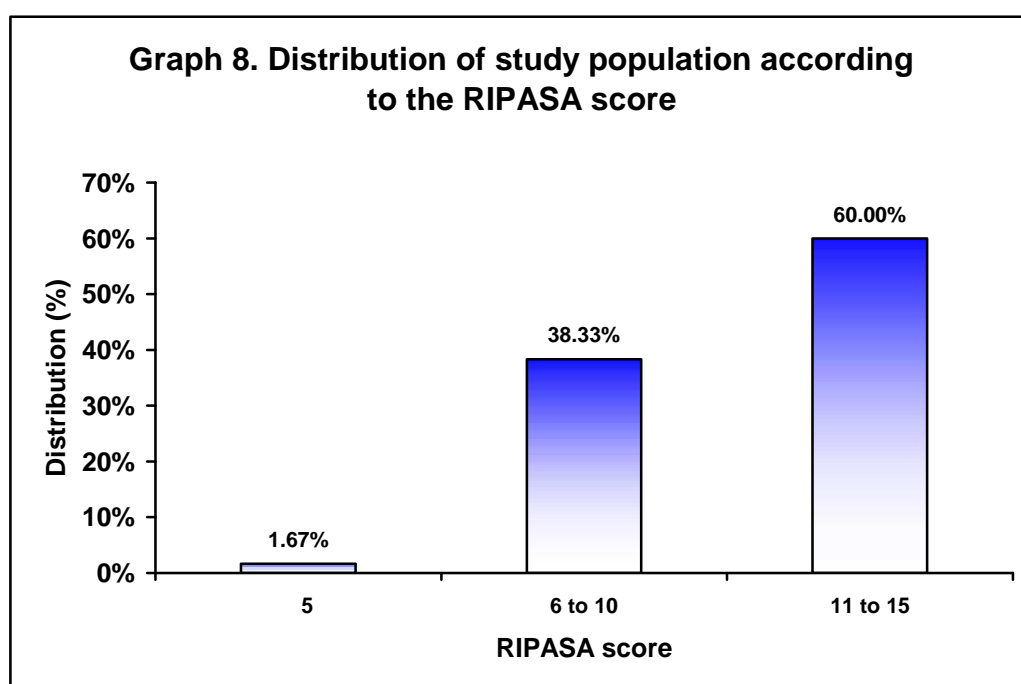
Table 8. Clinical and biochemical profile of the patients

Variables	Mean (n=192)		Median	Range	
	No.	%		Minimum	Maximum
Age (Year)	27.68	10.53	24.50	18.00	65.00
Pulse rate (/Minute)	86.90	5.39	87.00	78.00	100.00
Respiratory rate (/Minute)	19.97	1.90	20.00	16.00	24.00
SBP (mm Hg)	119.57	10.55	120.00	110.00	150.00
DBP (mm Hg)	78.53	9.12	80.00	70.00	110.00
Total count (/Cumm)	10616.67	1968.15	11000.00	7000.00	15000.00
RIPASA score	10.98	2.64	11.50	3.50	15.00

The clinical and biochemical characteristics of the study population are as shown in table 8.

Table 9. Distribution of study population according to the RIPASA score

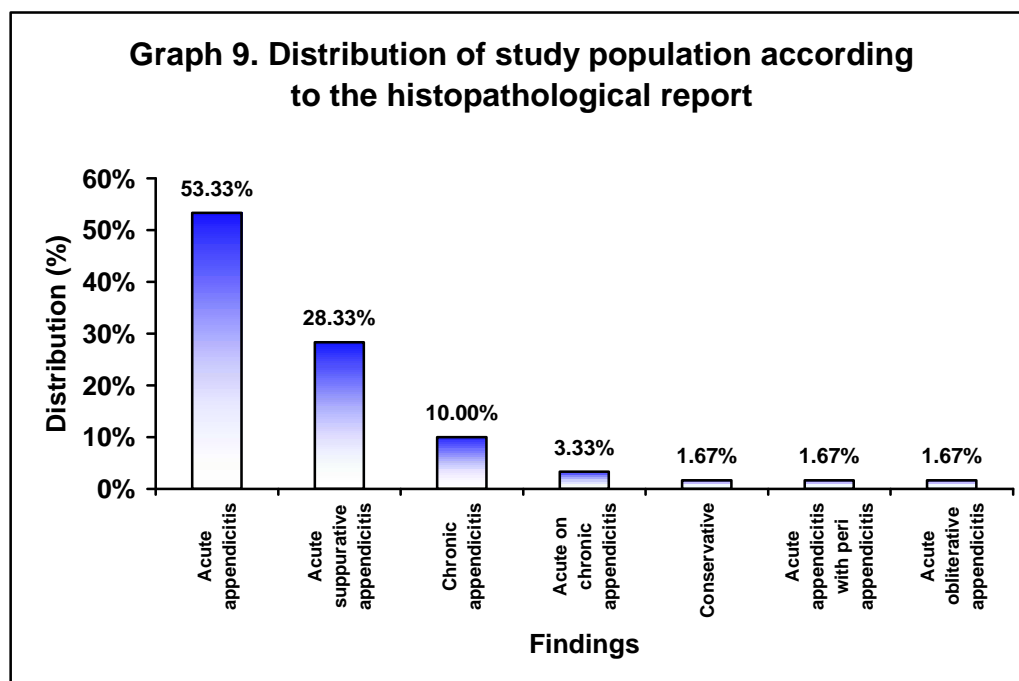
RIPASA score	Distribution (n=60)	
	Number	Percentage
5	1	1.67
6 to 10	23	38.33
11 to 15	36	60.00
Total	60	100.00



In this study, RIPASA scores were from 11 to 15 in 60% of the patients while 38.33% and 1.67% of the patients had RIPASA scores between 6 to 10 and 5 respectively.

Table 10. Distribution of study population according to the histopathological report

Findings	Distribution (n=60)	
	Number	Percentage
Acute appendicitis	32	53.33
Acute suppurative appendicitis	17	28.33
Chronic appendicitis	6	10.00
Acute on chronic appendicitis	2	3.33
Conservative	1	1.67
Acute appendicitis with peri appendicitis	1	1.67
Acute obliterative appendicitis	1	1.67
Total	60	100.00

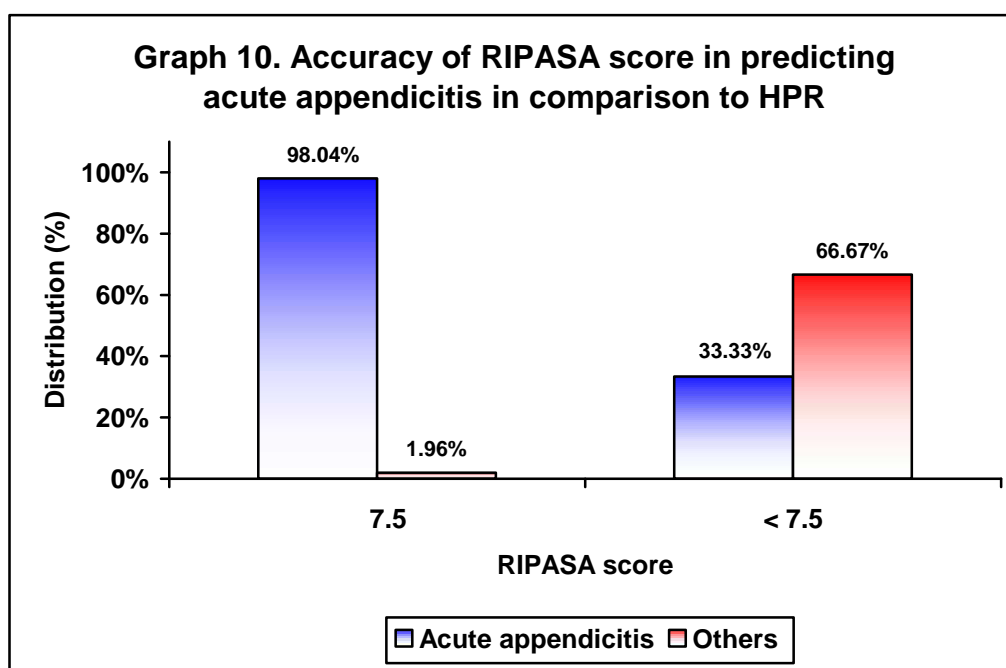


In this study histopathological reports revealed most of the patients with acute appendicitis (53.33%).

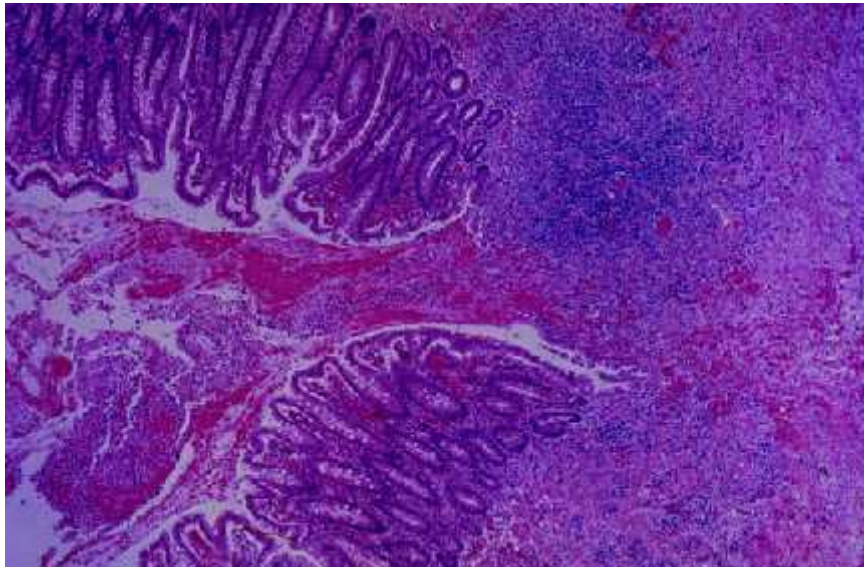
Table 11. Accuracy of RIPASA score in predicting acute appendicitis in comparison to HPR

RIPASA score	Histopathological findings				Total	
	Acute appendicitis		Others		No.	%
	No.	%	No.	%		
7.5	50	98.04	1	1.96	51	100.00
< 7.5	3	33.33	6	66.67	9	100.00
Total	53	88.33	7	11.67	60	100.00

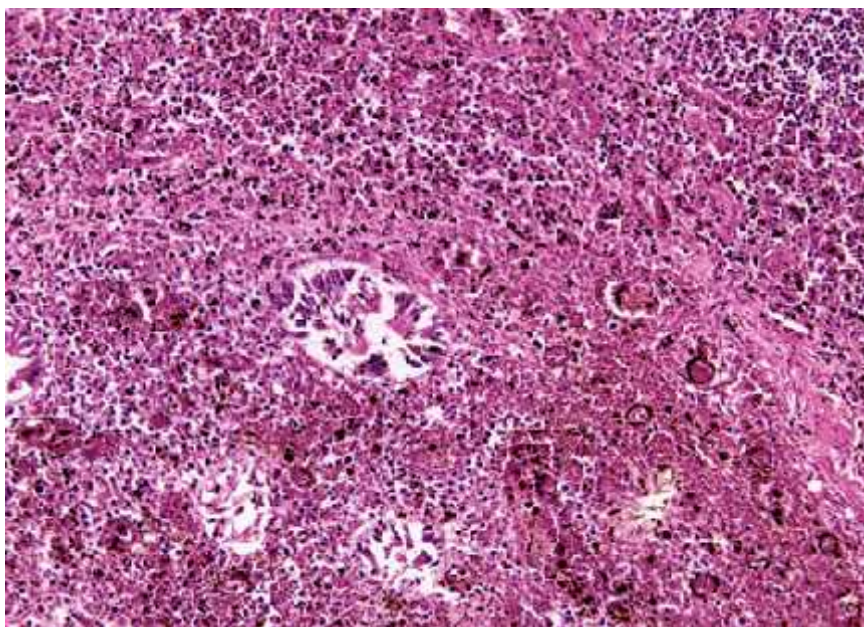
p<0.001



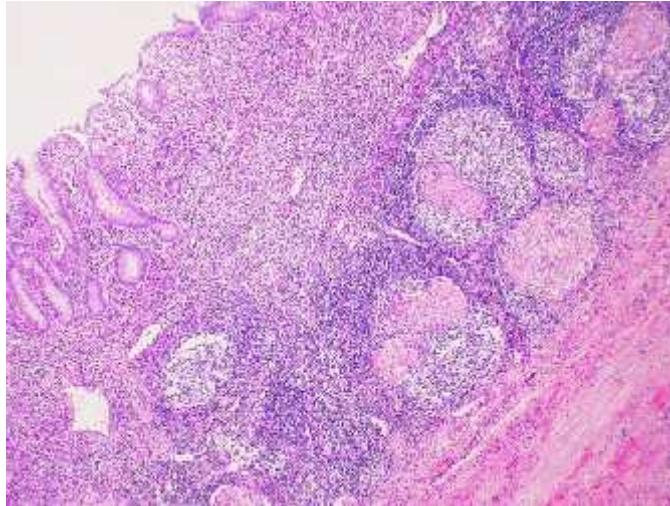
In the present study of the 51 patients with 7.5 RIPASA score, significantly higher number of patients were diagnosed to have acute appendicitis (98.04% vs 33.33%; p<0.001). The sensitivity, specificity, positive predictive value and negative predictive value were 94.34%, 85.71%, 98.04% and 66.67% respectively with positive likelihood ratio of 6.60.



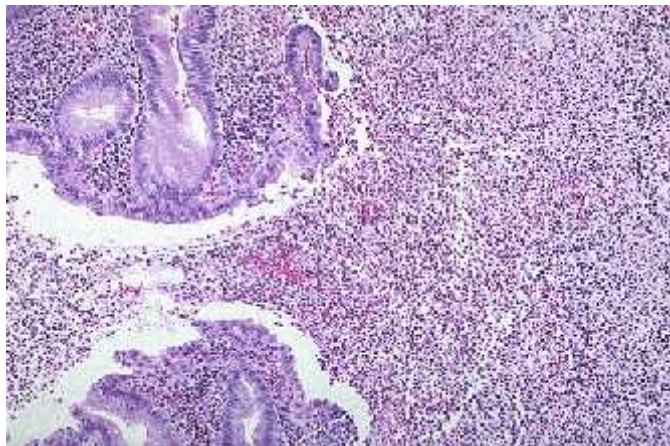
Photograph 1. Acute Suppurative Appendicitis



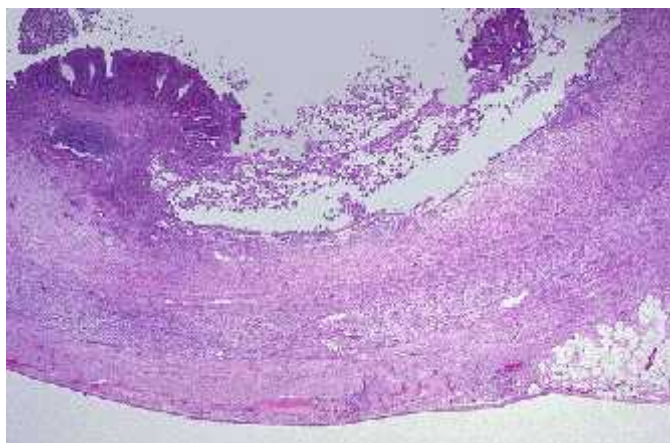
Photograph 2. Acute Suppurative Appendicitis



Photograph 3. Chronic Appendicitis



Photograph 4. High Power-Extensive Neutrophilic Exudate With Mucosal Ulceration



Photograph 5. Low Power-Marked Mucosal Inflammation & Necrosis

DISCUSSION

Acute appendicitis is the most common and challenging surgical emergency. It can lead to appendiceal perforation and peritonitis, which is concomitant with high mortality and morbidity. The decision for a surgical operation based only on the patient's signs and symptoms results in removing normal appendices (negative appendectomy). Hence the rational approach is to decrease the negative appendectomy as well as appendiceal rupture rates. A decrease in unnecessary appendectomies should not cause an increase in perforation rates.⁸⁷

Currently the diagnosis of acute appendicitis relies on the ultrasound examination and Computed Tomography. Ultrasound is the non-invasive, easily available and cost-effective, and can accomplish more than computed tomography scans. However, there is no certainty about its effect on the clinical outcomes of patients, and it is operator dependent. Counting the neutrophils as a parameter of the Alvarado scale is not routine in many laboratories. Computed tomography imaging also aids in making a definite diagnosis and have been reported to have high sensitivity (94%) and specificity (95%) for diagnosing acute appendicitis.⁸⁷ Moreover all these methods are not cost effective, time consuming and not readily available.

Various scoring systems are being used to aid the diagnosis of acute appendicitis and bring down the NA rates. These include but not limited to, Alvarado, Samuel, Tzanakis, Ohmann, Eskelinen, Fanyo, Lindberg, logistic score of Kharbanda et al and so on.⁷¹ The most known of these is Alvarado score, which was

developed in 1986.¹³ It contains eight predictive factors and said to be practical and easy to use.

However, these two scoring systems were developed in the West, and when applied in different environments, such as the Middle East and Asia, the sensitivity and specificity levels achieved were very low.⁸⁷

A study by Al-Hashemy et al.⁸³ in 2004 using the modified Alvarado scoring system in a Middle Eastern population reported a low sensitivity of 53.8% and a specificity of 80%.

Khan et al.⁸² applied the Alvarado scoring system in an Asian population and achieved a sensitivity and specificity of 59% and 23%, respectively, with a negative appendicectomy rate of 15.6%. The sensitivity of the Alvarado score achieved when applied in an oriental population, at the suggested cut-off threshold of 7.0, was also low at 50.6%, but achieved a high specificity of 94.5%. However, this improved when the cut-off threshold was lowered to 6.0, with a sensitivity and specificity of 88.3% and 94.5%, respectively, suggesting a definite ethnic difference with regard to the Alvarado score.⁸⁹

RIPASA score is a more extensive yet simple additive scoring system consisting of 14 fixed parameters and an additional parameter (NRIC) that is unique to Asian population setting. All these 15 parameters are easily obtainable from a good clinical history, examination and investigations. Being the new scoring system not many studies have been done to evaluate the accuracy of RIPASA in the diagnosis of acute appendicitis. Hence, the present study was undertaken to evaluate accuracy of RIPASA scoring system in the diagnosis of acute appendicitis.^{11,17}

This one year hospital based study was done at Department of General Surgery, KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belgaum. A total of 60 patients presenting with right Illiac fossa pain to the General Surgery OPD from January 2014 to December 2014 were studied. These patients were evaluated for the demographic features, clinical signs and symptoms and other parameters required to calculate the RIPASA scores.

In the present study sex distribution pattern revealed equal number of males and females (50% each) with male to female ratio 1:1. In contrast, earlier studies have reported male preponderance. A study conducted by Al-Omran, Mcleod Institute for Clinical Evaluative Sciences, Toronto in 1998 on epidemiological features of acute appendicitis showed that appendicitis is more common in males, in those aged 11-20 years.⁹⁰ Another study by Karan M. et al.⁸⁶ from Meerut, India to evaluate significance of RIPASA scoring system in the diagnosis of acute appendicitis reported 71 males and 25 female. The variation of sex distribution pattern noted in the present study compared to other studies can be explained by varying sample size and selection criteria of the study population.^{86,90}

Previous literature reported that, the incidence of appendicitis gradually rises from birth, peaks in the late teen years, and gradually declines in the geriatric years.⁹¹ In this study based on selection criteria, age of the patients ranged between 18 to 50 years. The commonest age group was 18 to 30 years (71.67%) and mean age was was 27.1 ± 8.81 years and median age was 24.5 years. These findings suggest that, acute appendicitis is common in younger age group. These findings were consistent with a recent study by Lohar HP. et al.⁹² in D Y Patil Medical College, Pune who reported 44.65% of the cases between 11 to 20 years and 36.1%

between 21 to 30 years age group. The mean age observed in the present study was sharply in agreement with a study from Mangalore by Nanjundaiah N. et al.⁸⁵ who reported mean age of 27.82 ± 9.26 years.

In the present study included all the patients with RIF pain (100%). The commonest symptoms other than RIF pain was nausea and vomiting (96.67%) followed by pain migration of RIF (80%), anorexia (70%) and fever (61.67%). Karan M. et al.⁸⁶ from Meerut, India also reported RIF pain in all cases (100%) followed by nausea and vomiting (71.8%), migration of pain to the RIF (43.75%) and anorexia (86.45%). In a study by Anderson RE et al.,⁹³ nausea and vomiting and pain migration to the RIF were common symptoms.

In this study on examination, majority of the patients had RIF tenderness (95%) followed by guarding (68.33%) and Rovsing's signs (46.67%). Similar findings were reported by Karan M. et al.⁸⁶ where RIF tenderness was present in all the cases (100%), rebound tenderness (69.79%), Rovsing's sign (23.95%) and guarding (20.83%).

In this study with regard to other variables of RIPASA score, that is duration of symptoms, WBC count and urine analysis, majority of the patients (88.33%) reported duration of symptoms as <48 hours, WBC count of 10000 /cumm was noted in 65% of the patients and urine analysis was negative in 83.33% of the patients. The histopathological reports showed most of the patients with acute appendicitis (53.33%).

In this study, RIPASA scores ranged from 3.5 to 15.0. The mean RIPASA scores were 10.98 ± 2.64 . Most of the patients had RIPASA scores between 11 to 15

(60%) while 38.33% and 1.67% of the patients had RIPASA scores between 6 to 10 and respectively. Based on the cut-off value of 7.5, 51 patients were diagnosed to have acute appendicitis. Among them diagnosis of acute appendicitis was confirmed on HPR in 50 patients (98.04%; $p < 0.001$). The sensitivity, specificity, positive predictive value and negative predictive value of RIPASA score in the diagnosis of acute appendicitis was 94.34%, 85.71%, 98.04% and 66.67% respectively with positive likelihood ratio of 6.60.

Comparison of accuracy with other studies

Study	Sensitivity	Specificity	PPV	NPV
Present study	94.34%	85.71%	98.04%	66.67%
Nanjundaiah N. et al. ⁸⁵	96.2%	90.5%	98.9%	73.1%
Karan M. et al. ⁸⁶	97.8%	77.0%	98.89%	66.67%
Butt MQ et al. ⁸⁷	96.7%	93.0%	94.8%	95.54%
Chong CF. et al. ¹¹	88.46%	66.67%	93%	53%
Chong CF. et al. ¹⁷	97.47%	81.82%	83.52%	96.43%

The comparison of accuracy of RIPASA score with other studies is as shown in Table. It was observed that, the sensitivity, specificity, PPV and NPV noted in the present study were comparable to the studies by Nanjundaiah N. et al.,⁸⁵ Karan M. et al.,⁸⁶ Butt MQ et al.⁸⁷ and Chong CF. et al.^{11,17}

The RIPASA score is a simple and easy to use quantitative scoring system. Most of these clinical parameters are easily obtained from a good clinical history and examination. This also include a urinalysis which can be easily performed on the spot. Hence a score can be obtained quickly and a rapid diagnosis made without

having to wait for the full investigations to be available when a score of >7.5 is obtained. The additional parameter which is unique to our local population consists of foreign nationality. Although the RIPASA score is specifically developed for local population, the fixed clinical parameters are general to all the populations and hence the RIPASA score can be applied in any country.^{11,17,84,85,86}

Overall, the RIPASA score is a simple scoring system with high sensitivity and specificity for the diagnosis of acute appendicitis. Thus, the operating surgeon can make a quick decision upon seeing patients with right iliac fossa pain, by RIPASA scoring system with a score > 7.5 to be operated, while patients with a RIPASA score < 7.0 can either be observed in the unit's day ward or discharged with an early clinic review appointment. Unnecessary and expensive radiological investigations can be avoided by using RIPASA score and thus reducing health care expenditure.

CONCLUSION

The RIPASA scoring system is a simple, low cost and highly accurate in the diagnosis of acute appendicitis as the sensitivity, specificity, positive predictive value and negative predictive value was high (94.34%, 85.71%, 98.04% and 66.67% respectively) with positive likelihood ratio of 6.60. The information of parameters of the RIPASA score are simple and can be obtained by taking a complete history, and conducting clinical examination and investigations.

SUMMARY

Various scoring systems are being used to aid the diagnosis of acute appendicitis and bring down the NA rates. The RIPASA score is the new diagnostic scoring system developed for the diagnosis of acute appendicitis. It is more extensive yet simple additive scoring system consisting of 14 fixed parameters and an additional parameter unique to Asian population setting. The present study was undertaken to evaluate the accuracy of RIPASA scoring system in the diagnosis of acute appendicitis.

This hospital study was conducted in the Department of General Surgery, KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belgaum over a period of one year from January 2014 to December 2014. A total of 60 patients presenting with right Illiac fossa pain were enrolled. The patients were evaluated for the parameters pertaining to find RIPASA and scores were calculated.

There was equal distribution of sex as 50% of the patients each were males and females (male to female ratio 1:1). The commonest age group was 18 to 30 years (71.67%) and mean age was 27.1 ± 8.81 years. As all the patients with RIF pain were included the common symptom was nausea and vomiting (96.67%) followed by pain migration of RIF (80%), anorexia (70%) and fever (61.67%). Majority of the patients (88.33%) reported the duration of symptoms as <48 hours. The commonest clinical sign was RIF tenderness (95%). The WBC count of 10000 was noted in 65% of the patients and urine analysis was negative in 83.33% of the patients. Most of the patients (60%) had RIPASA scores from 11 to 15. The HPR report revealed 53.33% of the patients with acute appendicitis. Of the 51

patients with 7.5 RIPASA score, significantly higher number of patients were diagnosed to have acute appendicitis (98.04% vs 33.33%; $p < 0.001$). The sensitivity, specificity, positive predictive value and negative predictive value were 94.34%, 85.71%, 98.04% and 66.67% respectively with positive likelihood ratio of 6.60.

The RIPASA scoring system which is based on simple parameters that can be ascertained by complete history, clinical examination and few investigations is a valuable scoring system in the diagnosis of acute appendicitis.

BIBLIOGRAPHY

1. David RF, Thomas DK. Evaluating diagnostic accuracy in appendicitis using administrative data. *J Sur Res* 2005;123:257-61.
2. Shelton T, McKinlay R, Schawrtz RW. Acute appendicitis: Current diagnosis and treatment. *Curr Surg* 2003;60:502-5.
3. Khairy G. Acute appendicitis: Is removal of a normal appendix still existing and can we reduce its rate?. *Saudi J Gastroenterol* 2009;15:167-70.
4. Sammalkorpi HE, Mentula P, Leppäniemi A. A new adult appendicitis score improves diagnostic accuracy of acute appendicitis--a prospective study. *BMC Gastroenterol* 2014;14:114.
5. Humes DJ, Simpson J. Acute appendicitis. *BMJ* 2006;333(9):530-4.
6. Cope Z. Early diagnosis of the acute abdomen. 20th edn., Oxford: University Press; 2000
7. Paulson EK, Kalady MF, Pappas TN. Suspected appendicitis. *N Engl J Med* 2003;348(3):236-42.
8. Blomqvist PG, Andersson RE, Granath F, Lambe MP, Ekbohm AR. Mortality after appendectomy in Sweden, 1987-1996. *Ann Surg* 2001; 233:455-60.
9. Bickell NA, Aufses JAH, Rojas M, Bodian C. How time affects the risk of rupture in appendicitis. *J Am Coll Surg* 2006;202:401-6.

10. Flum DR, Morris A, Koepsell T, Dellinger EP. Has misdiagnosis of appendicitis decreased over time? A population-based analysis. *JAMA* 2001;286(14):1748-53.
11. Chong CF, Adi MI, Thien A, Suyoi A, Mackie AJ, Tin AS, et al. Development of the RIPASA score: a new appendicitis scoring system for the diagnosis of acute appendicitis. *Singapore Med J* 2010;51:220-5.
12. Ohmann C, Yang Q, Franke C. Diagnostic scores for acute appendicitis. Abdominal Pain Study Group. *Eur J Surg* 1995;161:273-81.
13. Alvarado A. A practical score for the early diagnosis of acute appendicitis. *Ann Emerg Med* 1986;15:557-64.
14. Eskelinen M, Ikonen J, Lipponen P. Contributions of history-taking, physical examination, and computer assistance to diagnosis of acute small-bowel obstruction. A prospective study of 1333 patients with acute abdominal pain. *Scand J Gastroenterol* 1994;29:715-21.
15. Erdem H, Çetinküner S, Da K, Reyhan E, De er C, Aziret M, et al. Alvarado, Eskelinen, Ohhmann and Raja Isteri Pengiran Anak Saleha Appendicitis scores for diagnosis of acute appendicitis. *World J Gastroenterol* 2013;19(47):9057-62.
16. Sitter H, Hoffmann S, Hassan I, Zielke A. Diagnostic score in appendicitis. Validation of a diagnostic score (Eskelinen score) in patients in whom acute appendicitis is suspected. *Langenbecks Arch Surg* 2004;389:213-8.

17. Chong CF, Thien A, Mackie AJ, Tin AS, Tripathi S, Ahmad MA, et al. Comparison of RIPASA and Alvarado scores for the diagnosis of acute appendicitis. *Singapore Med J* 2011;52(5):340-5.
18. Wani MM, Yousaf MN, Khan MA, BabaAbdul A, Durrani M, Wani M, et al. Usefulness of the Alvarado scoring system with respect to age, sex and time of presentation, with regression analysis of individual parameters. *Internet J Surg* 2007;11(2):
19. Shah J, Pukar M, Mishra V, Mewada SG. Modified Alavardo score in management of acute appendicitis. *Int J Res Health Sci* 2014;2(2):570-6.
20. Amyand C. Of an inguinal rupture, with a pin in the appendix caeci, incruited with stone; and some observations on wounds in the guts. *Philosophical Transactions of the Royal Society of London*; 1736;39:329-36.
21. Ellis H. Appendix. In: Schwartz SI (eds). *Maingot's Abdominal Operations*. 8th ed., Norwalk: Appleton Century-Crofts 1985;2:1255.
22. Fitz RH. Perforating inflammation of the vermiform appendix: With Special reference to its early diagnosis and treatment *Trans Assoc Am Phys* 1886;1:107
23. McBurney C. Experience with early operative interference in cases of diseaseof the vermiform appendix. *NY State Med J* 1889;50:676.
24. McBurney C. The incision made in the abdominal wall in cases of appendicitis, *Ann Surg* 1894;20:38.

25. Semm K: Endoscopic appendectomy. *Endoscopy* 1983;15:59.
26. Bhattacharjee PK, Chowdhary T, Roy D. Prospective evaluation of Modified Alvarado score for diagnosis of acute appendicitis. *J Indian Med Assoc* 2002;100(5):310-4
27. Malik AA, Wani NA. Continuing diagnostic challenge of acute appendicitis, evaluations through modified Alvarado score. *Aust NZ J Surg* 1998;68(7):504-5.
28. Kalan M, Talbot D, Cunliffe WJ, Rich AJ. Evaluation of the modified Alvarado score in the diagnosis of acute appendicitis, a prospective study. *Ann R Coll Surg Engl* 1994;76:418-9.
29. Saidi HS, Chawda SK. Use of a Modified Alvarado score in the diagnosis of acute appendicitis. *East Afr Med J* 2003;80(8):411-4.
30. Lamparelli MJ, Hoque HM, Pogson CJ, Ball AB. A prospective evaluation of the combined use of the Modified Alvarado score with selective laparoscopy in adult females in management of suspected appendicitis. *Ann R Coll Surg Engl* 2000;82(3):192-5.
31. Standring S. *Grays anatomy – The anatomical basis of clinical practice*. 39th ed., UK: Elsevier Churchill Living Stone: 2005.
32. Kumar V, Fausto N, Abbas A. *Robbins and Cotran – Pathologic basis of disease*. 7th ed., Philadelphia: Pennsylvania. Elsevier; 2004.

33. Zinner MJ, Ellis H, Nathanson KL. Appendix and Appendectomy. Maingot's Abdominal Operations. 10th ed., Appleton and Lange 1997;39:1191-227.
34. Hardin MD. Acute Appendicitis: Review and Update. Am Fam Phys 1999;60(7);2027-34.
35. Deng Y, Chang DC, Zhang Y, Webb J, Gabre-Kidan A, Abdullah F. Seasonal and day of the week variations of perforated appendicitis in US children. Pediatr Surg Int 2010;26(7):691-6.
36. Simpson J, Samaraweera AP, Sara RK, Lobo DN. Acute appendicitis--a benign disease? Ann R Coll Surg Engl 2008;90(4):313-6.
37. Sulu B, Gunerhan Y, Ozturk B, Arslan H. Is long-term hunger (Ramadan model) a risk factor for acute appendicitis? Saudi Med J 2010;31(1):59-63.
38. Oguntola AS, Adeoti ML, Oyemolade TA. Appendicitis: Trends in incidence, age, sex, and seasonal variations in South-Western Nigeria. Ann Afr Med 2010;9(4):213-7.
39. Ergul E. Heredity and familial tendency of acute appendicitis. Scand J Surg 2007;96(4):290-2.0
40. Noudeh YJ, Sadigh, N, Ahmadnia AY. Epidemiologic features, seasonal variations and false positive rate of acute appendicitis in Shahr-e-Rey, Tehran. Int J Surg 2007;5(2):95-8.
41. Jones BA, Demetriades D, Segal I, Burkitt DP. The prevalence of appendiceal fecaliths in patients with and without appendicitis. A

- comparative study from Canada and South Africa. *Ann Surg* 1985;202(1):80-2.
42. Ajao OG. Appendicitis in a tropical African population. *J Natl Med Assoc* 1979;71(10):997-9.
43. Walker AR, Segal I. Appendicitis: an African perspective. *J R Soc Med* 1995;88(11):616-9.
44. Andersson RE. Changing trends in surgery for acute appendicitis. *Br J Surg* 2008;95(9):1187-8.
45. Chavda SK, Hassan S, Magoha GA. Appendicitis at Kenyatta National Hospital, Nairobi. *East Afr Med J* 2005;82(10):526-30.
46. Lee JH, Park YS, Choi JS. The epidemiology of appendicitis and appendectomy in South Korea: national registry data. *J Epidemiol* 2010;20(2): 97-105.
47. Russel RCG, Williams NS, Bullstrode CJK. *Bailey and Love's - Short practice of surgery* 24th ed., London: Hoddre Arnold Publication; 2004.
48. Guidry SP, Poole GV. The anatomy of appendicitis. *Am Surg* 1994;60:68-71.
49. Horwitz JR, Gursoy M, Jaksic T, Lally KP. Importance of diarrhea as a presenting symptom of appendicitis in very young children. *Am J Surg* 1997;173:80-2.
50. Lumley JS. *Hamilton Bailey's demonstration of physical signs in clinical surgery*. 18th ed., Oxford: Hodder Arnold Publication; 1997.
-

51. Townsend MC, Beauchamp DR, Evers MB, Mattox KL. Sabiston textbook of surgery. New Delhi: Elsevier; 2005.
52. Mourad J, Elliott JP, Erickson L, Lisboa L. Appendicitis in pregnancy: new information that contradicts long – held clinical beliefs. *Am J Obstet Gynecol* 2000;182:1027-9.
53. Zinner MJ, Ashely SW. Manigot’s abdominal operations, 11th ed., New York: McGraw Hill; 2007.
54. Poortman P, Lohle PN, Schoemaker CM, Oostvogel HJ, Teepen HJ, Zwinderman KA, et al. Comparison of CT and sonography in the diagnosis of acute appendicitis: a blinded prospective study. *AJR Am J Roentgenol* 2003;181:1355-9.
55. Skaane P, Amland PF, Nordshus T, Solheim K. Ultrasonography in patients with suspected acute appendicitis: a prospective study. *Br J Radiol* 1990;63:787-93.
56. Douglas CD, MacPherson NE, Davidson DM, Gani JS. Randomized controlled trial of ultrasonography in diagnosis of acute appendicitis incorporating Alvarado’s Score. *BMJ* 2000;321:919.
57. Pinto LN, Pereira JM, Cunha R, Pinto P, Sirlin C. CT evaluation of appendicitis and its complications: imaging techniques and key diagnostic findings. *AJR* 2005;185:406-17.
58. Jacobs JE, Birnbaum BA, Macari M, Megibow AJ, Israel G, Maki DD, et al. Acute appendicitis: comparison of helical CT diagnosis focused technique

- with oral contrast material versus nonfocused technique with oral and intravenous contrast material. *Radiology* 2001;220:683-90.
59. Stroman DL, Bayouth CV, Kuhn JA. The role of computed tomography, in the diagnosis of acute appendicitis. *Am J Surg* 1999;178:485-9.
60. Mohamed AA, Bhat NA. Acute Appendicitis Dilemma of Diagnosis and Management. *Internet J Surg* 2009;23(2):DOI: 10.5580/18e0.
61. Wilson EB, Cole JC, Nipper ML, Cooney DR, Smith RW. Computed tomography and ultrasonography in the diagnosis of appendicitis: when are they indicated? *Arch Surg* 2001;136:670-5.
62. Kraemer M, Ohmann C, Leppert R, Yang Q. Macroscopic assessment of the appendix at diagnostic laparoscopy is reliable. *Surg Endosc* 2000; 14:625-33.
63. Walker SJ, West CR, Colmer MR. Acute appendicitis: does removal of a normal appendix matter, what is the value of diagnostic accuracy and is surgical delay important? *Ann R Coll Surg Engl* 1995;77:358-63.
64. Van den Broek WT, Bijnen AB, de Ruiter P, Gouma DJ. A normal appendix found during diagnostic laparoscopy should not be removed. *Br J Surg* 2001;88:251-4
65. Geis WP, Miller CE. Laparoscopic appendectomy for acute appendicitis: rationale and technical aspects. *Contemp Surg* 1992;40:13-9.

66. Bisard D, Rosenfield JC, Estrada F, Reed JF. Institutioning a clinical guideline practice to decrease the rate of normal appendectomies. *Am Surg* 2003;69:796-8.
67. Marcia LM, David Z, Darshani N, Melinda AM, Clifford Y. Negative appendectomy rate: Influence of CT scans. *Am Surg* 2005;71:803-8.
68. Andersson RE. Meta-analysis of the clinical and laboratory diagnosis of appendicitis. *Br J Surg* 2004;91(1):28-37.
69. Shogilev DJ, Duus N, Odom SR, Shapiro NI. Diagnosing appendicitis: evidence-based review of the diagnostic approach in 2014. *West J Emerg Med* 2014;15(7):859-71.
70. Wilasrusmee C, Anothaisintawee T, Poprom N, McEvoy M, Attia J Thakkinstian A. Diagnostic Scores for Appendicitis: A Systematic Review of Scores' Performance. *Br J Med Res* 2014;4(2):711-30.
71. Thompson G. Clinical Scoring Systems in the Management of Suspected Appendicitis in Children, *Appendicitis - A Collection of Essays from Around the World*. Available from: <http://www.intechopen.com/books/appendicitis-a-collection-of-essaysfrom-around-the-world/clinical-scoring-systems-in-the-management-of-suspected-appendicitis-in-children>. Access Date: 15.07.2015
72. Humes DJ, Simpson J. Clinical Presentation of Acute Appendicitis: Clinical Signs-Laboratory Findings-Clinical Scores, Alvarado Score and Derivate

- Scores. In: Keyzer C, Geveno PA. (eds.), *Imaging of Acute Appendicitis in Adults and Children*. Berlin Heidelberg: Springer-Verlag; 2011.
73. Lintula H, Pesonen E, Kokki H, Vanamo K, Eskelinen M. A diagnostic score for children with suspected appendicitis. *Langenbeck's Arch Surg* 2005;390(2):164-70
74. Lintula H. Diagnostic score in acute appendicitis. Validation of a diagnostic score (Lintula score) for adults with suspected appendicitis. *Langenbeck's Arch Surg* 2010;395(5):495-500.
75. Fenyö G, Lindberg G, Blind P, Enochsson L, Oberg A. Diagnostic decision support in suspected acute appendicitis: validation of a simplified scoring system. *Eur J Surg* 1997;163(11):831-8.
76. Christian F, Christian GP. A simple scoring system to reduce the negative appendicectomy rate. *Ann R Coll Surg Engl* 1992;74(4): 281-285
77. Zielke, A., Sitter, H., Rampp, T. A., Schäfer, E., Hasse, C., Lorenz, W., & Rothmund, M. (1999). [Validation of a diagnostic scoring system (Ohmann score) in acute appendicitis] *Der Chirurg; Zeitschrift für alle Gebiete der operativen Medizen*, 70(7), 777–83; discussion 784.
78. Fenyö G. Routine use of a scoring system for decision-making in suspected acute appendicitis in adults. *Acta Chir Scand* 1987;153(9):545-51.
79. Samuel M. Pediatric appendicitis score. *J Pediatr Surg* 2002;37(6):877-81.

80. Goldman RD, Carter S, Stephens D, Antoon R, Mounstephen W, Langer JC. Prospective validation of the pediatric appendicitis score. *J Pediatr* 2008;153(2):278-82
81. Kharbanda AB, Taylor GA, Fishman SJ, Bachur RG. A clinical decision rule to identify children at low risk for appendicitis. *Pediatrics* 2005;116(3):709-16.
82. Khan I, ur Rehman A. Application of alvarado scoring system in diagnosis of acute appendicitis. *J Ayub Med Coll Abbottabad* 2005;17: 41-4.
83. Al-Hashemy AM, Seleem MI. Appraisal of the modified Alvarado Score for acute appendicitis in adults. *Saudi Med J* 2004;25:1229-31.
84. Jang SO, Kim BS, Moon DJ. Application of alvarado score in patients with suspected appendicitis. *Korean J Gastroenterol* 2008;52:27-31.
85. Nanjundaiah N, Mohammed A, Shanbhag V, Ashfaque K, Priya SA. A Comparative Study of RIPASA Score and ALVARADO Score in the Diagnosis of Acute Appendicitis. *J Clin Diagn Res* 2014;8(11):NC03-5.
86. Karan M, Mukesh MK, Atul K, Vijay A, Deepak K, Jain A, et al. Significance of RIPASA Scoring System in Diagnosis of Acute Appendicitis. *International J Healthcare Sci* 2015;3(1):4-10.
87. Butt MQ, Chatha SS, Ghumman AQ, Farooq M. RIPASA score: a new diagnostic score for diagnosis of acute appendicitis. *J Coll Physicians Surg Pak* 2014;24(12):894-7.

88. Bhasin SK, Khan AB, Kumar V, Sharma S, Saraf R. Vermiform Appendix And Acute Appendicitis. *J K Sci* 2007;9(4):167-70.
89. Terasawa T, Blackmore CC, Bent S, Kohlwes RJ. Systematic review: computed tomography and ultrasonography to detect acute appendicitis in adults and adolescents. *Ann Intern Med* 2004;141:537-46.
90. Al-Omran M, Mamdani M, McLeod RS. Epidemiologic features of acute appendicitis in Ontario, Canada. *Can J Surg* 2003;46:263-8.
91. Galindo Gallego M, Fadrique B, Nieto MA, Calleja S, Fernández-Aceñero MJ, et al. Evaluation of ultrasonography and clinical diagnostic scoring in suspected appendicitis. *Br J Surg* 1998;85(1):37-40.
92. Lohar HP, Asger Calcuttawala MA, Nirhale DS, Athavale VS, Malhotra M, Priyadarshi N. Epidemiological aspects of appendicitis in a rural setup. *Med J DY Patil Univ* 2014;7:753-7.
93. Anderson RE. Resolving appendicitis is common: further evidence. *Ann Surg* 2008;247(3):553.

ANNEXURE I – CONSENT FORM

Mr / Mrs /Miss. _____ we are requesting you to enrol yourself in study titled **“EVALUATION OF RIPASA SCORING SYSTEM IN DIAGNOSIS OF ACUTE APPENDICITIS; ONE YEAR PROSPECTIVE STUDY IN KLES HOSPITAL & MRC,BELGAUM”** conducted by Dr. ****
**** **, Post Graduate in M.S. General Surgery under the guidance of Dr. ****
*****. Professor, Department of General Surgery, J.N. Medical College, Belgaum under KLE university, Belgaum.

Respected Sir/Madam, We request you to enroll yourself to participate in our study as you are eligible for participating in the study. During the study your operative outcome will be accessed by some questions which will be answered by your operating surgeon.

Purpose of the study

Despite being a common problem, acute appendicitis remains a difficult diagnosis to establish, particularly among the young, the elderly and females of reproductive age group. A delay in performing an appendicectomy increases the risk of developing perforation and sepsis. The opposite is also true where with decreased diagnostic accuracy the negative appendicectomy rates increase. USG and CT help in confirming the diagnosis; however they are expensive and sometimes inaccessible.

In an effort to avoid the above mentioned problems, this study has been under taken to evaluate the efficacy of a new, alternate technique of Calculating Score by new system. In this study patients signs and symptoms will be evaluated by new scoring system i.e. RIPASA to rule out acute appendicitis. About 60 patients with Right Illiac Fossa Pain will be enrolled in this study.

Procedure Involved

If you agree to enroll yourself in my study, I will ask your present & past history. You will undergo step wise physical examination and your routine blood and urine investigation will be carried out and according to that your findings will be classified and will be given mark as per Scoring System.

If you agree to participate in this study, Post operatively, if you undergo any, your will be examined for any signs of infection and your Operated Appendix will be sent for Histo-Pathology Reporting. The further treatment will then be initiated depending on the report.

Risks and Benefits

There is no risk involved.

Benefit-It will help in better preparation for surgery to handle risks.

Alternatives

Even if you decline the participation in the study, your operative outcomes will not be documented. Your participation in this research is voluntary. You may choose not to enrol yourself in this study. Your decision will not change present or future health care services offered to you at K.L.E.S. Dr. Prabhakar Kore Hospital. If you decide to participate you are free to withdraw at any time.

Privacy and Confidentiality

The only people to know that you are a research subject are members of the research team. No information about you or information provided by you during the research will be disclosed to other without your written permission except:

1. In emergency to protect your rights and welfare.
2. If required by law.

Institutional/sponsors policy

There is no possibility of any harm or injury during your participation in this study.

Financial Incentives for participation

No financial incentives are being offered to enrolled patients. It is purely being done with the idea of research and all the cost of the study will be borne by the investigator.

Authorization to Publish Results

When the results of the research are published or discussed, in a conference, no information will be displayed that would disclose your identity. Any information that is obtained in connection with this study and that can be identified with your identity remaining confidential.

Questions

In case you have any questions related to the study, in future or in case of study related injury or illness, you can contact Dr. ***** *****, Department of General Surgery, KLES Hospital and MRC, Belgaum, phone number: *****. Or Dr. ***** **, Professor, Dept Of General Surgery, KLES Hospital and MRC, Belgaum Ph: ***** **.

If you have any queries about your rights as a study subject, you may call Dr. ***** **, Professor, Department of Pathology and Chairman, J.N. Medical College Institutional Ethical Committee for Human Subjects Research, Phone number- ***** **, or extension ***** at J.N. Medical College, Belgaum.

**“EVALUATION OF RIPASA SCORING SYSTEM IN DIAGNOSIS OF
ACUTE APPENDICITIS ;ONE PROSPECTIVE STUDY IN KLES
HOSPITAL & MRC,BELGAUM.”**

Consent for participation in prospective study

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.

Subject Name : _____

Signature or the Left Thumb Print of Subject : _____

Date:

Witness Name: _____

Signature: _____

Date:

Investigators Name: _____

Signature: _____

Date:

Place: _____

ANNEXURE II – PROFORMA

**Title: ONE YEAR PROSPECTIVE ANALYTICAL STUDY FOR
EVALUATION OF RIPASA SCORING SYSTEM IN DIAGNOSIS OF
ACUTE APPENDICITIS**

Name: Age: Sex:
Address: IP No.:
Ward: Education:
Religion: Marital Status:
Occupation: Socio-Economic Status:

HISTORY

When did the patient first notice the pain?

Details:

Associated features and duration

Fever:

Vomiting:

Other:

Previous history of use of antibiotics/steroids

Past History

Personal History

Family History

GENERAL PHYSICAL EXAMINATION

Built and Nourishment:

Weight:

Pallor:

Icterus:

Cyanosis /Clubbing:

Edema:

Lymphadenopathy:

Vital Signs

PR: /min;

BP: mmHg;

RR: /min; Temp:

SYSTEMIC EXAMINATION

Per Abdomen examination:

Respiratory System:

Central Nervous System:

Vascular System:

INVESTIGATIONS

ANNEXURE III – KEY TO MASTER CHART

/Cumm	-	Per cubic millimeters
AA	-	Acute appendicitis
AAP	-	Acute appendicitis with periappendicitis
AOC	-	Acute on chronic
AOP	-	Acute obliterative appendicitis
ASA	-	Acute suppurative appendicitis
BP	-	Blood pressure
CA	-	Chronic appendicitis
CNS	-	Central nervous system
Con	-	Conservative
CVS	-	Cardiovascular system
F	-	Female
HPR	-	Histopathological report
M	-	Male
N	-	No
RIF	-	Right iliac fossa
RIPASA	-	Raja Isteri Pengiran Anak Saleha Appendicitis
RS	-	Respiratory system
Rx.	-	Treatment
WBC	-	White blood cell
Y	-	Yes