# Study Of Platelet Indices In Clinically **Diagnosed Acute Appendicitis Using The Alvarado Score**

**By**

**DR.Sidiya Mirji**

**Dissertation submitted to**

**In partial fulfillment for the degree of**

**DOCTOR OF MEDICINE**
**IN**
**PATHOLOGY**

**Under the guidance of**

**DR. Potekar RM M.D.**

**PROFESSOR**

**DEPARTMENT OF PATHOLOGY**

**BLDE (DEEMED TO BE UNIVERSITY)**

**SHRI B. M. PATILMEDICAL COLLEGE, HOSPITAL & RESEARCH CENTRE**

**VIJAYAPUR – 586103**

**2019**

## LIST OF ABBREVATIONS USED

| | |
|---|---|
| AA | Acute appendicitis |
| MPV | Mean Platelet Volume |
| PDW | Platelet Distribution Width |
| P-LCR | Platelet Large Cell Ratio |
| PCT | Plateletcrit |
| RIF | Right Iliac Fossa |
| CRP | C-Reactive Protein |
| TLC | Total Leucocyte Count |
| USG | Ultrasonography |
| CT | Computed tomography |
| IL | Interleukin |
| N% | Neutrophil percentage |
| L% | Lymphocyte percentage |
| PLT | Platelet count |
| NLR | Neutrophil-to-Lymphocyte Ratio |
| PLR | Platelet-to-Lymphocyte Ratio |
| IgA , IgG | Immunoglobulin A, Immunoglobulin G |
| EDTA | Ethylenediaminetetraacetic acid |

## ABSTRACT

**INTRODUCTION-**

Acute appendicitis (AA) is an acute abdominal condition in all age groups, worldwide. If not treated on time this may result in life-threatening complications like perforation of the appendix and that may lead to peritonitis. Early clinical diagnosis and appropriate management on time can reduce the morbidity and mortality rates effectively. In this study, we attempted to find out simple and cost-effective markers which will aid in the clinical diagnosis of acute appendicitis diagnosed by using, the most commonly used the Alvarado scoring system.

**OBJECTIVE-**

To determine and compare diagnostic utility of platelet indices (i.e. MPV, PDW, Plateletcrit and P-LCR) in clinically diagnosed cases of acute appendicitis using the Alvarado score with platelet indices of healthy controls.

**MATERIALS AND METHODS-**

Patients from both out-patient and in-patient departments, referred to the Department of Pathology in BLDE (Deemed to be University) Shri B.M.Patil Medical College, Hospital and Research centre, Vijayapura were included in the study. All the blood samples of cases, who were clinically diagnosed as acute appendicitis on the bases of the Alvarado scoring system and healthy controls were collected in di-potassium EDTA vacutainers and were processed by Sysmex XN1000 haematology analyser.

**RESULTS**–

The study group comprised of 102 cases clinically diagnosed as acute appendicitis using the Alvarado scoring system, out of which 84 cases histopathologically confirmed as acute appendicitis. The mean age of presentation of acute appendicitis was 31±11.5 years. The male to female ratio was 3.1:1. PDW and P-LCR were found to have higher statistically significant values in the cases compared to healthy controls (11.5± 2.2fl vs 10.6±1.3fl and 24.8± 6.6% vs 22.0± 5.2%). On ROC curve analysis mean cut off for PDW and P-LCR were 10.65fl and 22.9% respectively. Sensitivity and specificity of PDW were found to be 60% and 73% respectively and for P-LCR, sensitivity was 58% and specificity was 56%. However, WBC count showed the highest sensitivity and specificity of 77% and 75% respectively, proving it to be specificity wise a more better biomarker. The NLR and PLR were significantly higher (p value <0.001) in acute appendicitis cases.

**CONCLUSION-**

In the present study it is emphasized that platelet indices like PDW and P-LCR can be used as supportive aid for the clinical diagnosis of acute appendicitis along with all other clinical components of the Alvarado scoring system, NLR and PLR values.

**KEY WORDS-** Appendicitis, Alvarado score, Platelet indices

## TABLE OF CONTENTS


| Sl. No. | Contents | Page No. |
|---|---|---|
| **1** | INTRODUCTION | 1 |
| **2** | OBJECTIVE | 3 |
| **3** | REVIEW OF LITERATURE | 4 |
| **4** | MATERIALS AND METHODS | 39 |
| **5** | RESULTS | 43 |
| **6** | DISCUSSION | 57 |
| **7** | SUMMARY | 73 |
| **8** | CONCLUSION | 75 |
| **9** | REFERANCES | 76 |
| **10** | ANNEXURES-I | 87 |
| **11** | ANNEXURES-II | 89 |
| **13** | MASTER CHART | 92 |

## LIST OF TABLES


| Sl. No. | Title of tables | Page No. |
|---|---|---|
| **1** | Bacterial infections seen in acute appendicitis | 13 |
| **2** | Components of the Alvarado scoring system | 19 |
| **3** | Differential diagnosis of acute appendicitis | 23 |
| **4** | Platelets ultrastructure and functions | 29 |
| **5** | Distribution of cases by the Alvarado score and histopathology report | 44 |
| **6** | Analysis of sensitivity, specificity, positive predictive value and negative predictive value of the Alvarado scoring system compared to histopathology report | 45 |
| **7** | Distribution of mean age between the cases and controls | 46 |
| **8** | Age distribution in cases | 46 |
| **9** | Distribution of cases according to gender | 48 |
| **10** | Distribution of mean of various hematological parameters between the cases and controls | 50 |
| **11** | Platelet indices distribution in cases and controls | 52 |
| **12** | Mean of platelet indices distribution according to the Alvarado score | 53 |
| **13** | ROC curve analysis of all parameters in predicting acute appendicitis | 55 |
| **14** | Comparison of sensitivity, specificity, positive predictive value and negative predictive value of the Alvarado scoring system with other studies | 59 |
| **15** | Comparison of gender wise distribution of acute appendicitis cases with other studies | 59 |
| **16** | Comparison of mean age distribution in acute appendicitis cases and controls with other studies | 60 |

| | | |
|---|---|---|
| **17** | Comparison of mean value, cutoff, sensitivity and specificity of Total Leucocyte Count, Neutrophil percentage and Lymphocyte percentage with other studies | 61 |
| **18** | Comparison of mean of platelet count with other studies | 63 |
| **19** | Comparison of mean value, cutoff, sensitivity and specificity of Neutrophil-to-Lymphocyte Ratio with other studies | 63 |
| **20** | Comparison of mean value, cutoff, sensitivity and specificity of Platelet-to-Lymphocyte Ratio with other studies | 65 |
| **21** | Comparison of MPV in acute appendicitis with other studies | 66 |
| **22** | Comparison of cutoff, sensitivity and specificity of MPV in acute appendicitis with other studies | 67 |
| **23** | Comparison of PDW in acute appendicitis with other studies | 68 |
| **24** | Comparison of cut off value, sensitivity and specificity of PDW in acute appendicitis with other studies | 69 |
| **25** | Comparison of plateletcrit in acute appendicitis with other studies | 70 |
| **26** | Comparison of P-LCR in acute appendicitis with other studies | 71 |
| **27** | Comparison of PDW according to the Alvarado score with other studies | 72 |

# LIST OF FIGURES


| Sl. No. | TITLES OF FIGURES | Page No. |
|---|---|---|
| **1** | Embryonal stages of development of appendix | 5 |
| **2** | Various anatomical positions of appendix | 7 |
| **3** | Arterial supply of appendix | 8 |
| **4** | Photomicrograph of a cross section through the appendix | 10 |
| **5** | Diagrammatic representation of ultrastructure of platelet | 30 |
| **6** | Platelet histogram | 34 |
| **7** | Bar graph showing distribution of cases by the Alvarado score and histopathology report | 44 |
| **8** | Bar graph showing distribution of cases according to age | 47 |
| **9** | Pie chart showing distribution of gender among the acute appendicitis cases | 48 |
| **10** | Bar graph showing distribution of mean of various hematological parameters between the cases and controls | 50 |
| **11** | Bar graph showing distribution of mean of platelet indices between the cases and controls | 52 |
| **12** | Bar graph showing distribution of mean of platelet indices according to the Alvarado score | 54 |
| **13** | ROC curve analysis showing all parameters in predicting acute appendicitis | 56 |

# INTRODUCTION

Acute appendicitis (AA) is one of the commonest cause of emergency abdominal surgeries. The diagnosis is done mainly on the basis of clinical presentation. However, the etiology of appendicitis is not clear, it is considered to be multifactorial. A patient presenting as simple appendicitis may end up in developing perforation of the appendix, that may lead to much higher morbidity and mortality, the surgeon is solely to decide whether to operate the case on the probable diagnosis or wait until it is certain.[1,2]

The surgical principle about acute appendicitis which states "when in doubt, take it out", is not correct as such the procedure often comes out with accompanied few complications. Though AA is a common problem, its diagnosis continues to be a challenge for physicians. A confirmed diagnosis is possible at the surgery and after histopathological examination of an appendectomy specimen. Hence, it is quite difficult to get a preoperative definitive diagnosis. According to the world literature the rate of negative appendectomy is about 20-40%, the associated morbidity rate with it is about 10%.[3,4]

The probable clinical diagnosis of AA can be done by various scoring systems, among all scoring systems the most commonly followed scoring system is the Alvarado scoring system, based on the clinical history, physical examination and few hematological parameters like total WBC count, shift to left. This system is simple to apply and to calculate the score accordingly.[5]

The circulating platelets play an important role in the inflammatory mechanism. Several studies have shown the role of platelets in the pathogenesis of many diseases where inflammation plays a crucial role. These research studies have shown a correlation between the variation in platelet indices and the activation of the coagulation system, severe infection, trauma, systemic inflammatory reaction syndrome, and thrombotic diseases.[6]

Although imaging technologies such as ultrasonography (USG), computed tomography (CT) and magnetic resonance imaging (MRI) are promising but they are not adequate. The main disadvantage of these investigations is that they are costly and these are more helpful in the emergency conditions rather than routine. Many laboratory parameters have been studied such as white blood cell count, neutrophil percentage (N %) and C-reactive protein. However, none of them were solely accepted for the diagnosis of acute appendicitis.[7]

The main aim of the surgeon is to take out the appendix before any complications sets in so the morbidity rate must be reduced.[8] Various studies have been carried out in this regard, few of them have even claimed the role of mean platelet volume (MPV) as an indicator of the severity in cases of perforated appendicitis.[9]

Thus the search for the new biomarkers is the need of the hour for the clinical diagnosis of acute appendicitis. Platelet indices are easy to record and can be done routinely along with the complete blood count using an automated analyzer. So, we undertook this study to evaluate the utility of platelet indices in the diagnosis of acute appendicitis.

## OBJECTIVE OF THE STUDY

To determine and compare diagnostic utility of platelet indices i.e. Mean Platelet Volume (MPV), Platelet Distribution Width (PDW), Plateletcrit (PCT) and Platelet Large Cell Ratio (P-LCR) in clinically diagnosed acute appendicitis cases using the Alvarado scoring system with platelet indices of healthy controls.

# REVIEW OF LITERATURE

## HISTORY OF APPENDIX

The appendix was described as an anatomical structure by the physician-anatomist, Berengario Da Carpi, in 1521. Leonardo da Vinci clearly illustrated the appendix in 1492, in his anatomical drawings, but it was published in the 18$^{th}$ century. The normal appendix has been narrated by Andreas Vesalius's work, "De Humani Corporis Fabrica" published in 1543.

Jean Fernel was the first to describe the history of appendicitis in a paper published in 1544. Bright and Addison, comprehensibly narrated the characteristic symptoms of appendicitis and indicated that the appendix was responsible for most of the right iliac fossa inflammatory conditions, in their test book entitled as Volume I of "Elements of Practical Medicine" published in 1839. [10]

In 1886, Dr. Reginald H. Fitz, a professor of pathologic anatomy at Harvard did an analysis of 257 cases of perforating inflammation of the appendix and 209 cases of typhilitis or perityphilitis and stressed that most of the right lower quadrant inflammatory illness starts in the appendix. He narrated the obvious clinical characteristics of appendicitis and used the term "appendicitis" for the first time. [11]

In 1889, Charles McBurney described the McBurney's point i.e. the point of maximum tenderness at the junction of a line drawn from umbilicus to right anterior superior iliac spine. He also advised an early operative intervention to prevent complications.[12]

## EMBRYOLOGY

The appendix starts developing at the distal end of caecum as an outpouching i.e.cecal bud, during the sixth week of intrauterine life. Caecum lies immediately below the right lobe of the liver during the early phases of fetal development. The caecum gradually falls into the right iliac fossa in subsequent developmental phases.(Figure 1)

As the appendix develops along with the descent of the colon, its most common position lies posterior to caecum or colon. So these positions are called retrocaecal or retrocolic, respectively.[13]

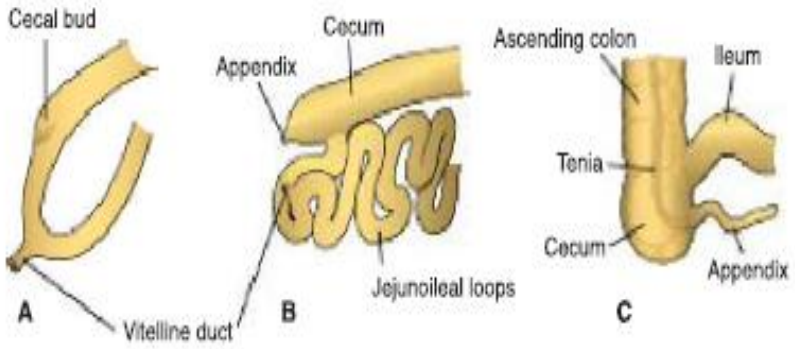



**Figure 1- Embryonal stages of development of appendix**[13]

## ANATOMY

The vermiform appendix is a narrow, tubular structure having a blind end.[5] It is situated on the caecum's posteromedial aspect. The three taenia coli coalesce at about 2cm below the ileocaecal junction.[14]

The various positions the appendix can be seen are retrocaecal, retrocolic, pelvic, subcaecal, pre-ileal and post-ileal (Figure 2). The appendix can be traced during an operative procedure by tracing along the course of the anterior taenia coli that will lead the operator to the appendix base. The appendix base position is constant, which is at the point where the three taenia coli merge and result in longitudinal muscle formation.[5]

The usual length of the appendix in the adults lies in between 6 to 10 cm. In children the length is relatively longer and as the age advances the length shortens. The appendix may get atrophied with age. The lumen is usually wide patent in childhood, with advancing age the lumen may get obliterated.

Ileal mesentery, a short triangular fold is connected to the appendix which is also known as the mesoappendix. It extends upto the whole length of the appendix upto the tip. It encloses blood vessels, nerves and lymphatics of the appendix. [14]

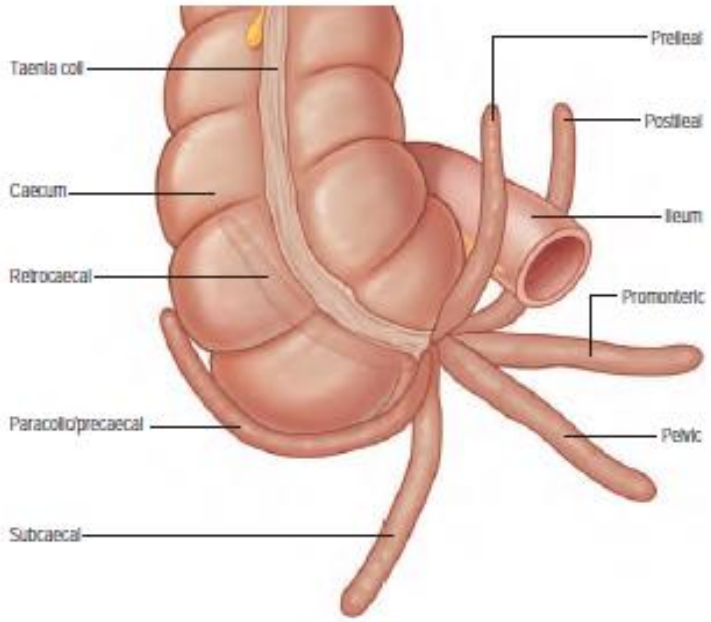



**Figure 2- Various anatomical positions of appendix**[14]

## VASCULAR SUPPLY

### Arterial

The appendix is mainly supplied by the appendicular artery which is a branch of the lower branch of the ileocolic artery. It passes behind the ileum and reaches the mesoappendix, closer to the appendix base, where it gives off a recurring branch that anastomoses with the posterior caecal artery branch. The main artery's terminal branch lies along the appendix wall. This vessel may get thrombosed in acute appendicitis, resulting in the development of appendix tip necrosis or gangrene. Many individuals may have an accessory appendicular artery.[5,14] (Figure 3)

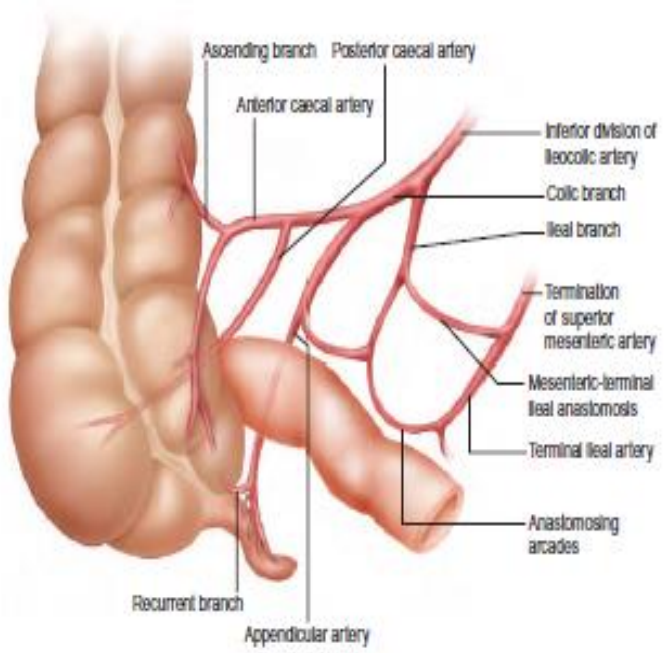



**Figure 3- Arterial supply of appendix**[14]

**Venous supply**

The venous supply is by the appendicular vein, which combines with the caecal vein to become the ileocolic vein.[14]

**LYMPHATICS**

There are numerous lymphatic vessels are located within the appendicular wall, about 8-15 in number which ascends in the mesoappendix, occasionally interrupted by one or more nodes. These lymphatics unite together and results in the formation of three to four large vessels, which drain into ileocolic nodes of the ascending colon.[14]

## NERVE INNERVATION

The appendix is innervated by both sympathetic and parasympathetic nerves arising from the superior mesenteric plexus.[14]

## HISTOLOGY

The histology of the appendix is similar to that of the large intestine. The appendix is comprised of four layers, from inwards to outwards i.e. mucosa, submucosa, muscularis propria and serosal layer. [15,16]

The **mucosal layer** is lined by columnar cells. It also comprised of enterocytes and goblet cells, a lamina propria and a muscularis mucosae layer. Many macrophages are found in abundant amount in lamina propria followed by immunoglobins like IgA or IgG-producing plasma cells.[16]

S**ubmucosal layer** is made up of connective tissue and many lymphoid follicles, that extends from the submucosa to the lamina propria. [15]

**Muscularis propria,** the longitudinal muscle fibers form a full evenly dense layer, except in a few tiny regions where both muscle layers are deficient, leaving serosa in touch with submucosa. The longitudinal muscle densifies at the base to form the rudimentary taeniae. The circular muscle fibers form a thicker layer separated by connective tissue.[16]

The **serosal layer** completely covers the appendix except along the mesentery attachment areas and it comprises a subserosal layer of connective tissue.[15](figure 4)

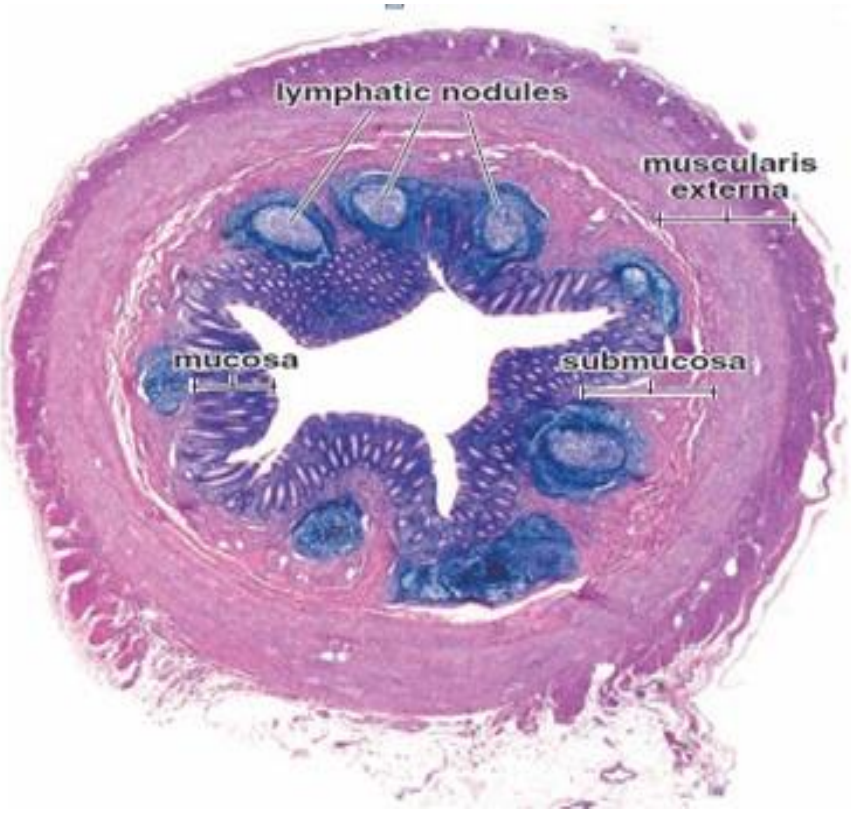



**Figure 4 - Photomicrograph of a cross-section through the appendix** x**10.**[15]

## INCIDENCE OF ACUTE APPENDICTIS

The incidence of developing acute appendicitis ranges from 8.6 to 11 cases per 10,000 person-years.[17]

This condition has a slight preponderance towards the male population. Acute appendicitis occurs most commonly in the 2nd decade of life and decreases with the advancing age.[18]

Before puberty the male and female ratio of developing appendicitis is equal, while in the young adults the ratio is increased to 3:2 for the male and female respectively.[5] The lifetime risk of acute appendicitis in males is 8.6% and in females 12%. The incidence of individuals undergoing an appendectomy in males and females is reported to be 6.7% and 25% respectively.[19]The incidence of misdiagnosis is higher in females.[17]

The incidence appears to have increased considerably till the mid of the 20th century, especially in western countries. Thereafter at the turn of the 21st century, the incidence started to increase in the newly industrialized countries.[20] However, the epidemiology of disease may vary based on race, geography, climate, and dietary intake of fibres.[21]

Approximately, 19% of acute appendicitis cases may result in perforation of the appendix, which is being the leading cause of patient death. Perforated appendicitis has a bimodal distribution with a predilection for patients at extremes of age. Though acute appendicitis is relatively less common in older age group i.e. patient older than 65years, perforated appendicitis can be seen in up to 50% of the patients.[22]

## ETIOLOGY

As described by various authors there is no conclusive unifying factor that has been labeled as the cause for the development of acute appendicitis.

The **luminal obstruction** by fecolith is considered to be the most important cause for the development of the etiopathogenesis of appendicitis. The incidental finding of a fecolith is a relative indication for prophylactic appendectomy.[23]

Less commonly obstruction can occur following obstruction of the lumen by tumor growth, particularly carcinoma of caecum, which can occasionally lead to the formation of acute appendicitis in middle-aged to elderly patients.

The other factors which may play an important role are a reduced intake of dietary fibres and increased dietary intake of refined carbohydrates.[24,25]

**Infectious causes**- Plays an important role in appendicitis in children.[26]

**<u>Bacteriology</u>:**

The bacterial population of the normal appendix is similar to that of the normal colon. The bacteria cultured in cases are therefore similar to those seen in other colonic infections such as diverticulitis. [27] (Table 1)

| Aerobic | Anaerobic bacteria |
|---|---|
| Escherichia coli | Bacteroides fragilis |
| Pseudomonas | Other Bacteroides species |
| Streptococcus viridans | Peptostreptococcus species |
| Group D streptococuss | Fusobacterium species |

**Table 1- Bacterial infections seen in acute appendicitis[27]**

Adenovirus and rotavirus are the most common viruses involved in etiology of appendicitis.[26]

## PATHOGENSIS

As described earlier obstruction plays an important role in the etiopathogenesis of the development of appendicitis. The length of appendix is larger than that of the luminal diameter this variation in the sizes predisposes to a close-loop obstruction.[27]

Once the obstruction sets in there occur continued mucus secretion, which distends the lumen resulting in increased pressure inside the lumen. As luminal pressure increases proportionate to it venous pressure also increases, resulting in occlusion of the capillaries and venules, but the arterial inflow continues which leads to vascular engorgement and congestion.[28]

The appendix mucosa is susceptible to the impaired blood supply. These events cause mucosal ischemia, which may favour secondary invasion by bacterias, necrosis and thrombosis of vessels resulting in gangrene or appendicular perforation. Thus, leading to peritonitis.[27,28]

## CLINICAL PRESENTATION

The clinical history and physical examination findings are considered to be the most important cornerstone for the diagnosis of acute appendicitis.

### History

The usual triad of presentation is pain, anorexia or vomiting and fever, which is well known as Murphy's triad. [5]

### Symptoms & signs

### Pain

Most frequently, the patient presents with a dull aching diffuse abdominal pain, which occurs as a consequence of irritation to the parietal peritoneum.[27] The pain becomes more localized to the right lower quadrant of the abdomen within 12 to 24 hours of initiation. Migration in the site of pain is the classical clinical sign of acute appendicitis.[29]

### Anorexia, nausea and vomiting

These symptoms set in following pain. Usually, most patients have one or two episodes of vomiting.[5] Children most commonly presents with anorexia.[30]

**Fever**

The patient may present with low-grade fever. Occasionally fever may be associated with chills and rigor, this may raise the suspicion of perforation.[17]

## CLINICAL EXAMINATION

The clinical diagnosis of acute appendicitis depends more on the thorough abdominal clinical examination.

The cardinal features are those of an unwell patient with low-grade pyrexia, localized abdominal tenderness, muscle guarding and rebound tenderness.[29]

**Inspection**

- Abdominal breathing movements are limited and reduced.
- The patient is questioned where the pain started and where it moved (the point sign)[5]

**Palpation**

The gentle palpation of the surface of the abdomen, starting from the left iliac fossa moving anticlockwise to the right iliac fossa, detects muscle guarding over the point of maximum pain, the classical point of Mcburney.

The otherwise usually mobile appendix is inflamed at any point on a 360-degree circle around the base of the caecum. Thus, the site of maximal pain and tenderness can vary.[27]

Peritoneal irritation can be elicited by voluntary and involuntary guarding, percussion or rebound tenderness via physical examination.

Acute appendicitis or peritonitis are associated with various signs which may get aggravated by movements, even on coughing (Dunphy's sign), the intensity of pain may increase. Palpation of the left lower quadrant may lead to pain in the right lower quadrant (Rovsing's sign). If the appendix is located in retrocaecal position, internal rotation of hip elicits pain in pelvis (obturator sign).[29]

**Auscultation**

Usually, normal bowel sounds heard.[5]

**PER RECTAL AND PELVIC EXAMINATIONS**

Most likely to be negative. However, if the appendix is situated within the pelvis, on the abdominal examination, tenderness may be minimal.[29]

Currently in use investigations for the diagnosis of acute appendicitis are:

**LABORATORY TESTS**

**Total leucocyte count**

The total leucocyte (TLC) count over 10,000 per $mm^3$ can be seen in around 90% of acute appendicitis cases. A neutrophil count of above 75% can occur in approximately 78% of patients of acute appendicitis.[31]

Total leucocyte count is regarded as a sensitive test for acute appendicitis diagnosis but it lacks specificity.[32] However, perforated appendicitis have an increased neutrophil count as compared to non-perforated cases.[33]

**C-reactive protein (CRP)**

It is an acute phase reactant synthesized by the liver.[34]

A meta-analytical study done by S. Hallan & A. Asberg[35]showed that CRP has a sensitivity of 40-60% and specificity of 27-90% for the diagnosis of appendicitis.

Sengupta *et al*[36] in their study concluded that, raised white cell count and CRP were poor positive predictors of appendicitis, both alone and in combination, and are correlated poorly with the development of complications.

CRP has no definite value for predicting acute appendicitis in either its absolute or categorical forms, though a significantly elevated level is strongly suggestive of an abscess.[37] Thus, C-reactive protein is considered to be an inferior marker when compared with WBC count.

**Urine examination**

Performed to rule out other conditions of abdominal pain such as urinary tract infection, pyelonephritis and ureteric calculi.[27]

## THE CLINICAL SCORING SYSTEMS

Various clinical scoring systems are available for the diagnosis of acute appendicitis such as the Tzanakis scoring system, Kalam modified Alvarado scoring system, RIPASA (The Raja Isteri Pengiran Anak Saleha Appendicitis) scoring system and Anderson scoring system.[38] These can help the surgeon to diagnose and to assess the appropriate management of the patient. Amongst the all available scoring systems, the Alvarado scoring system is used most commonly in the clinical diagnosis of acute appendicitis.[5]

The Alvarado scoring system was first described by Alfredo Alvarado in 1986. A study was, conducted on 305 patients admitted with complaint of abdominal pain and were suspected of having acute appendicitis. It included clinical signs and symptoms such as migratory right iliac fossa (RIF) pain, anorexia, nausea and vomiting, tenderness in the right iliac fossa, rebound tenderness and laboratory parameters like white blood cell count and shift to left.

Based on the results of this study values were assigned to all the parameters. The parameters of more importance were given a score of 2 and all the other parameter have given a value of 1, this gives a total score of 10.(Table 2)

However, Alfredo Alvarado stated that “as other abdominal conditions can mimic the acute appendicitis this system does not give a 100% accuracy for the diagnosis of acute appendicitis”.[39]

**The Alvarado scoring system**

| Symptoms | Score |
|---|---|
| **M**igratory RIF pain | 1 |
| **A**norexia | 1 |
| **N**ausea & vomiting | 1 |
| **Signs** | |
| **T**enderness in RIF | 2 |
| **R**ebound tenderness in RIF | 1 |
| **E**levated temperature | 1 |
| **Laboratory findings** | |
| **L**eucocytosis | 2 |
| **S**hift to left | 1 |
| **Total** | **10** |

**Table 2- Components of the Alvarado scoring system**[4]

Interpretation

- Score 7-10 : High probability of acute appendicitis
- Score 4-6 : Equivocal probability of acute appendicitis
- Score 1-3 : Unlikely of acute appendicitis[4,5]

This scoring system is simple to apply in clinical use and easy to assess. Thus, it can be performed even on the patients attending the outpatient unit.

## RADIOLOGICAL INVESTIGATIONS

### Plain abdominal x-ray

There is no radiological sign which is specific for the diagnosis of acute appendicitis. However, an abdominal plain x-ray may show appendiceal stones.

The other signs that can be seen are gas in appendix, a generalized haziness in the right lower quadrant, air-fluid levels, lumbar spine sclerosis occurring due to abscess formation in the right lower quadrant, loss of the ipsilateral psoas shadow and localized obliteration of the right flank stripe.[40,41]

### Ultrasonograpy (USG)

The inflamed appendix is visualized ultrasonographically by using the "graded compression" technique. The technique was described by Puylaert in 1986.

USG signs for diagnosis of acute appendicitis are

- Appendix anteroposterior diameter >6mm
- Thickened appendix wall, appearing as cross-sectional, non-compressible luminal framework called as a target lesion.
- Appendicolith
- Periappendicular fluid/mass, can be seen in advanced cases.[42]

The reported sensitivity and specificity for the diagnosis by ultrasonography showed a sensitivity range from 44% to 100%; specificity range from 47% to 99%.[43]

This technique has the advantage of being a non-invasive, easily repeatable investigation and prevents unnecessary exposure to non-ionizing radiation.

Disadvantages of ultrasonography include operator-dependent precision and difficulty in interpreting the images by those other than the operator.[42,43]

**Computed tomography (CT) scan**

It is the most common radiological investigation of choice in adults used for the diagnosis of acute appendicitis. The new imaging techniques such as 5-mm-sections have improved the accuracy rate of the CT scanning results or diagnosis of acute appendicitis by having a sensitivity rate of about 90% and a specificity rate of about 80-90%.[27]

CT scan features in acute appendicitis

- Diameter >6mm
- Periappendicular inflammation
- Cecal or appendicular wall thickening
- Appendicoliths , in approximately 50% of cases
- Periappendicular fluid collection[44]

## DIAGNOSTIC LAPAROSCOPY

This technique is used in cases where other investigation fails to provide any conclusive diagnosis. It is most commonly used in reproductive age group females.

Advantage- Direct examination of appendix condition and to look for any other abdominal pathology.[45]

## DIFFERENTIAL DIAGNOSIS OF ACUTE APPENDICITIS

| Age group | Differential diagnosis |
|---|---|
| **Children** | Gastroenteritis<br>Mesenteric lymphadenitis<br>Meckel's diverticulitis<br>Intussusception<br>Pneumonia<br>Omental infraction<br>Henoch-Schönlein purpura |
| **Adults** | Terminal ileitis<br>Crohn's disease<br>Ureteric colic<br>Right-sided pyelonephritis<br>Perforated peptic ulcer<br>Testicular torsion<br>Urinary tract infection<br>Acute pancreatitis<br>Sigmoid diverticulitis<br>Intestinal obstruction<br>Carcinoma of the caecum<br>Lymphoma |
| **Adult females** | Torsion of ovary<br>Pelvic inflammatory disease (PID)<br>Hemorrhage of an ovarian cyst<br>Ectopic pregnancy<br>Mittelschmerz<br>Endometriosis |

**Table 3: Differential diagnosis of acute appendicitis** [46,47]

The rate of misdiagnosis is higher in females as compared to males, the rate being 22.8% in females and 9.2% in males. Hence, pelvic ultrasonography is a must in female patients. [48]

## PATHOLOGY OF ACUTE APPENDICITIS

### MACROSCOPY

It is not constant, and the gross appearance may not give any correlation with the microscopic changes of the condition like the extent of inflammation. Loss of the glistening of the serosal surface of the appendix along with the injection of the serosal vasculature is one of the earliest macroscopic feature of acute appendicitis. Edema and hyperemia may be seen with the advancement of the inflammation. Occasionally, the serosal surface may show fibrinous or purulent exudation.

On cut section, the mucosa may appear hyperemic associated with it intraluminal pus and decrease in the luminal diameter may be seen.[49,50]

### MICROSCOPIC FEATURES

The features can vary, this can range from localized small foci of inflammation to complete appendicular wall necrosis. The inflammation comprised of neutrophils begins at the base of the crypts, often adjacent to a small defect in the epithelium. As the inflammatory process advances the inflammation spreads to the submucosa and later it involves the whole of the appendix. [49]

**Acute suppurative appendicitis-**

It is comprised of neutrophilic infiltration in the appendicular wall. Generally, circumferential involvement of muscularis propria is seen, along with associated mucosal ulceration and crypt abscesses.[25]

**Gangrenous appendicitis-**

Characterised by transmural inflammation, large areas of hemorrhagic ulceration along with necrosis. Necrosis is the pathognomic feature, that can extend up to the serosa.[25,49]

**Perforated appendicitis-**

It is comprised of, features of gangrenous appendicitis accompanied with rupture of the appendix i.e.perforation.[49]

**COMPLICATIONS OF ACUTE APPENDICITIS**

**Gangrenous Appendicitis**

It occurs following intramural and arterial thrombosis.[51]

**Perforation of appendix**

The mucosal ischemia due to the impaired blood supply may result in perforation.[27]

**Peritonitis**

This could be either local or diffuse. During the development of the etiopathogenesis, the infection may spread throughout the thickness of the appendicular wall resulting in the

inflammation of the lining peritoneum. Whereas in the cases where appendix perforates or in elderly patients or patients with bad immunity the infection may spread to the entire peritoneum resulting in diffuse peritonitis formation.[27,28]

**Appendicular abscess**

It is one of the commonest complications which occurs following perforation. Associated fever and features of toxicity may be seen.[5]

**Appendicular mass**

It is an inflammatory mass, usually seen in instances that occur late in the acute appendicitis course. It is made up of inflamed appendix, omentum and loops of the intestine. In the right iliac fossa, the clinical presentation is a tender mass, smooth, firm, well localized, not moving with respiration, immobile, well circumscribed and resonant on percussion.[52]

**Intestinal obstruction**

It is one of the delayed and rare complications of appendicitis. Entrapment of distal ileum in a periappendicular mass may result in obstruction.[51]

## PLATELETS

The French public health physician and microscopist Alfred Donné (1842), was the first to illustrate the structure of platelets in drawings.

Prat described a new method for the counting of platelets(1905) which was later improvised by Wright (1910-1911).

In 1910- Duke published a platelet function test which is popularly known as Duke bleeding test.[53]

### The basic structure of platelets

Human platelets are the anucleate, disc-shaped cells of the blood circulation. These are heterogeneous in size, having dimensions of 0.5x3μm. The platelet plasma membrane is smooth except for regular invaginations that delineate the open channel system (OCS) entrances, a complex network of interwinding membrane tubes permeating the cytoplasm of the platelet. A large concentration of transmembrane receptors is located at the lipid bilayer of the platelet plasma membrane.

The glycoprotein receptors for the von willebrand factor (VWF) are physiologically more significant receptors.The major serpentine receptors for ADP, thrombin, epinephrine, and thromboxane A2; the Fc receptor FcγRIIA; and the β3 and β1 integrin receptors for fibrinogen and collagen.[54]

**The anatomy of platelets is divided into three major regions:**

**Peripheral zone:**

It comprises of external and internal membrane structures that provide the exposed surface of the platelets and walls of the tortuous channels that make up the open channel system connected to the surface.

Glycocalyx or an exterior coat-

The outer layer of the peripheral zone is rich in glycoproteins. Its chemical is the provision of receptors for stimuli that trigger platelet activation and the substrates for adhesion-aggregation reactions. A typical unit membrane which is rich in asymmetrically distributed phospholipids that provides an essential surface for interaction with coagulation proteins, make up the middle layer of the peripheral zone.

The region inside the unit membrane constitutes the peripheral zone's third element. It is tightly connected to the unit membrane and translates the received signals on the outside surface into chemical messages and physical modifications needed to activate the platelet.

The internal membrane system –

It includes the open canalicular system, even though it is continuous with, and part of the external membrane system. Channels of the dense tubular system (DTS) and the membrane complexes (MC) formed by elements of the OCS and DTS are internal membrane systems, but they function with peripheral zone and are considered part of the same.

**The sole-gel zone:**

This is the platelet cytoplasm matrix. It includes various fiber systems in different polymerizations states that support the unaltered platelet discoid shape and provides a

contractile system involving a change in shape, pseudopod extension, internal contraction and secretion. Contractile system elements makeup about 30-50%, of the total platelet protein and appear to be major components.

**The organelle zone:**

It is comprised of granules, electron-dense bodies, peroxisomes, lysosomes, glycosomes and mitochondria randomly dispersed in the cytoplasm. It serves in metabolic processes and for the storage of enzymes, non-metabolic adenine nucleotides, serotonin, variety of secretion destined protein constituents and calcium.[55,56] (figure 5)

**Table 4: Platelets ultrastructure and functions**

| Zone | Components | Function |
|---|---|---|
| **Peripheral** | Glycocalyx- proteins, phospholipids, Mucopolysaccharides | Adhesion & aggregation |
| | Phospholipid bilayer Phospholipid | Source of arachidonic acid |
| | Integral proteins Glycoproteins Ib/IC, IIb/IIIa Enzymes | Adhesion aggregation & activation |
| **Structural** | Microtubules Cytoskeletal network Cytoplasmic network- actin, myosin Actin binding proteins | |
| **Organelle** | Granules | Non protein mediators |
| | Dense bodies | Protein mediators |
| | Alpha granules | Enzymes |
| | Lysosomes | Breakdown of $H_2O_2$ |
| | Microperoxisomes | |
| **Membrane systems** | Open canalicular system | Secretion of granule contents |
| | Dense tubular system | Calcium storage sites |

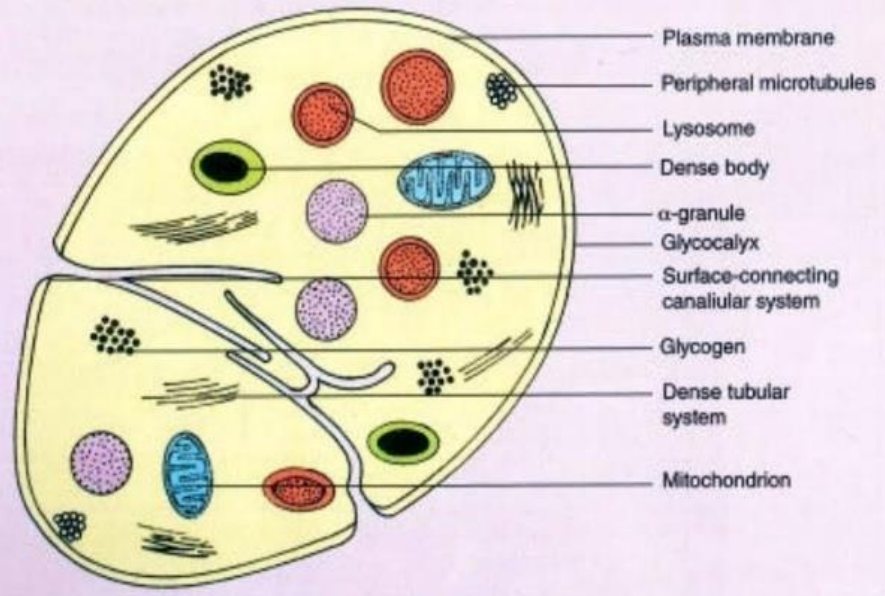



**Figure 5: Diagrammatic representation of ultrastructure of platelet**[57]

## ROLE OF PLATELETS IN HAEMOSTASIS

The platelets act as the first defense of the body against any kind of vascular injury resulting in hemorrhage. Whenever there is a break in the continuity of the endothelium lining vessel wall, it acts as a stimulus for platelet to accumulate by developing pseudopods, they become sticky and get attached to the injury site.

A unique series of events takes place via which blood platelets get attached to the injury site and play an important role in controlling the bleeding at the injury site. These events begin with platelet adhesion to the wounded vessel wall and end with platelet activation, characterized by intercellular chemical signals generated by platelet adhesion.

**Platelet adhesion:**

Injury to vessel wall results in exposure of endothelial cells that line blood vessel walls to a rich matrix of subendothelial proteins by the help of adhesion receptors on platelets like GP Ib-V-IX complex, Integrins especially $\alpha IIb\beta_3$ (GP IIb-IIIa) and $\alpha_2\beta_1$ , GPVI, GPIV etc.

**Platelet aggregation:**

When the circulating platelets come into contact with the damaged subendothelium, agonists that activate platelets are exposed, generated or released. This response results in a change in the shape of platelets from discoid shaped to pseudopods, which happens because of the alteration in the actin structure polymerization resulting in aggregation of platelets, which is mainly attributed to the integrin αIIbβ3 receptor. The aggregation mechanism includes two receptors of integrin αIIbβ3 on distant platelets that bind to the same molecule of fibrinogen.

**Platelet activation:**

Through ADP and ATP sensitive receptors, thromboxane A2 (TXA2), thrombin, PAR1 and PAR4, the activated state of adhered and aggregated platelets will secrete ADP and ATP abundantly from dense granules.

**Platelet release:**

Upon activation, platelets release their granular ADP contents, ATP, calcium, serotonin, PDGF, fibronectin, fibrinogen, vWF, epinephrine and TXA2. Weak agonists require (ADP and epinephrine) cyclooxygenase activity to induce secretion whereas strong agonists (collagen and thrombin) induce secretion independent of cyclooxygenase activity.

**Clot formation:**

This is the key result of haemostasis. The GPIIb-IIIa complex holds fibrin strands on the platelet surface and brings them together to ensure a strong immobilizing fibrin clot.[55,58]

## ROLE OF PLATELETS IN INFLAMMATION

Platelets play an important role in inflammatory responses and are associated with a variety of reactions involved in inflammatory diseases. At inflammatory site, edema develops due to the enhanced vascular permeability by platelets. Edema is one of the cardinal signs of inflammation other features are redness, heat, pain and loss of function.

These cardinal signs occur as a result of the release of inflammatory mediators such as immunomodulatory cytokines, chemokines and other mediators from the platelets. After the platelet activation, platelet-derived inflammatory and immune mediators are rapidly released from platelet granules. Platelets can even synthesize cytokines such as interleukin-1α (IL-1α) and interleukin-1β (IL-1β), platelet factor 4 (PF-4) which plays an important role in inflammation by signaling leucocyte migration, infiltration and differentiation.

Inflammation of blood vessels is triggered by interactions between platelets, leucocytes and endothelial cells resulting in autocrine and paracrine activation, this is followed by this there is leucocyte recruitment occurs in the vascular wall and the release of proinflammatory compounds induces an inflammatory response. When a pathogen is detected at an inflammatory site, platelets come in action immediately and start to participate in the inflammatory response.

Toll-like receptors (TLR) activates the platelet by pathogen associated molecular patterns resulting in the release of other cytokines such as platelet factor 4 (PF-4) and RANTES (Regulated upon activation normal T cell expressed and secreted) that leads to recruitment of inflammatory cells in circulation. The activated platelets are larger, as they penetrate the site of inflammation and the intracellular granules releases large amounts of proinflammatory substances. The activated platelets roll along and adhere to inflamed endothelium and interact with neutrophils, which is mediated by P-selectin. Neutrophil recruitment can be promoted by thromboxane A2 (TXA2) and by platelet independently promoting aggregation through E-selectin.[59]

**Principle of Autoanalyzer**

**Impedance measurement principle**

Cells are passed through a capillary opening. The passing cell generates an electrical resistance that is proportionate to its volume and thus an electronic signal is produced. Based on their size, the cells are recognized and displayed in a volume distribution curve.[60]

**PLATELET INDICES**

Recent advances in the working principle in automated blood cell analyzers have enabled automatic access to the various blood parameters. However, platelet indices such as mean platelet volume (MPV), platelet distribution width (PDW) and platelet large cell ratio (P-LCR) provide some important information about platelet kinetics but are not used for routine purposes. Platelet indices are cost-effective, provide early results, easy to perform and rule out any kind of bias, by use of an automated analyzer. These parameters can be used as early indicators of complications in various diseases and might become significant laboratory tests.[61](Figure 6)

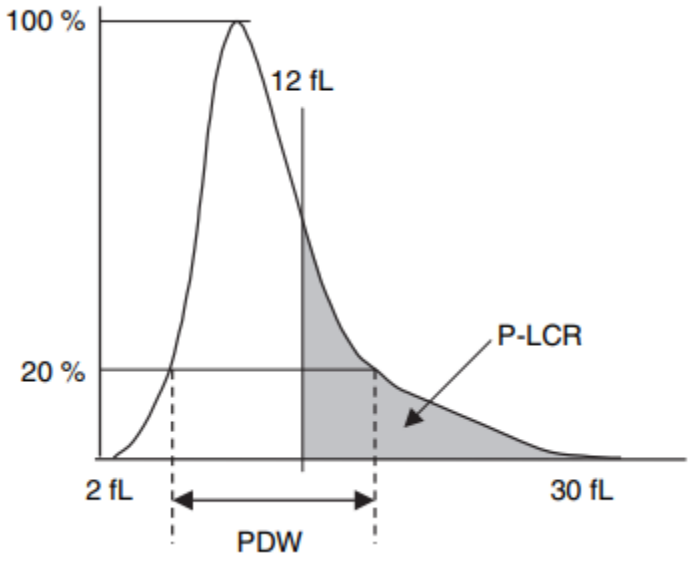



**Figure 6 - Platelet histogram**[61]

**Mean platelet volume (MPV)**

It is a measurement of platelet average size, usually measured using automated analyzers. It is meant to show the relationship between platelet synthesis in the bone marrow and cell destruction. MPV is determined in megakaryocyte i.e.the progenitor cell of the bone marrow. In conditions where platelet production is reduced as a consequence young platelets become bigger and more active result in an increased MPV level.[62] This increased platelet diameter can be used as a marker of platelet production rate and platelet activation. During this process platelet shape changes from discoid to spherical, and there will be the formation of pseudopods which leads to increased MPV during the platelet activation. This action is being mediated by the cytokines like interleukin 6, interleukin 11 and thrombopoietin.[6,57]

**Platelet distribution width (PDW)**

PDW is an indicator of volume variability in the platelet size and is increased in the presence of platelet anisocytosis. It is the distribution range at a frequency rate of 20% with the peak taken as 100%. The PDW reported varies markedly, with reference intervals ranging from 10-14fl. PDW directly measures variability in platelet size, changes with platelet activation and reflects the heterogeneity in platelet morphology. [6,57]

PDW helps distinguishing reactive thrombocytosis from essential thrombocytosis, particularly when mathematically coupled with MPV and platelet counts to achieve a discriminating function.[63]

**Plateletcrit (PCT)**

It is the ratio of the platelet volume to the whole blood volume. Under physiological conditions, the amount of platelets in the blood is maintained in an equilibrium state by regeneration and elimination.[6,57]

**Platelet large cell ratio(P-LCR)**

It is the percentage of the platelets with a size of >12fL which is presented as a percentage. It has also been used to monitor platelet activity.[6]

## VARIATIONS OF PLATELET PARAMETERS IN VARIOUS DISEASES:

Platelet parameters were used for diagnostic purpose in studies of various diseases.

MPV is significantly increased in Idiopathic Thrombocytopenic Purpura, Iron Deficiency Anemia, Acute Post Streptococcal Glomerulonephritis, Renal failure and Cyanotic Congenital Heart Disease. The MPV is normal in Aplastic Anemia and Acute leukemias. In cases of pregnancy the normal vaginal delivery cases showed no change in MPV, whereas MPV was increased in spontaneous premature rupture of membranes, abortions and pregnancy-induced hypertension cases.[64]

In the studies conducted by Manchanda *et al*[65] and Shilpi K *et al*[66] it was observed that increased platelet indices such as raised MPV and PDW helps to diagnose the prothrombotic risk in acute coronary syndromes and type 2 diabetes mellitus, respectively.

The cases with high disease activity Rheumatoid Arthritis (RA) showed decreased MPV, PDW and significantly raised platelet count as compared to moderate disease activity RA and healthy controls. Hence platelet parameters can be utilized as an inflammatory marker for the disease activity in RA.[67]

A study titled "Mean Platelet Volume: A Link Between Thrombosis and Inflammation?" done by Gasparyan *et al*[68] evaluated that during the periods of high activity the MPV tends to decrease in inflammatory diseases and during the low activity MPV value increases.

Danses *et al*[69] in his study done one inflammatory bowel disease claimed that decrease in MPV occurs due to the consumption and sequestration of large active platelets in vascular segments of the inflamed bowel. An increase in PCT levels and significant reduction in MPV,

PDW has been observed in a study done on patients with active Ulcerative Colitis and Crohns Disease. However, decreased MPV, raise in PDW and PCT levels were noted in the remission phase of disease.[70]

An independent association of MPV and PDW is observed in gall bladder cancer,[71] and a study conducted on bone marrow infiltration by solid tumor showed a decrease in MPV in the patient group when compared with the patients without metastasis.[72]

## EVALUATION OF PLATELET INDICES IN ACUTE APPENDICITIS

The platelet activation plays an important role in the pathophysiology of various diseases associated with inflammation and thrombosis.[6] As explained already, an increase in the production of young platelets and an increase in the number of larger platelets that are hyperaggregable in nature are usually indicated by an increased MPV value. Hence, MPV has been considered as an indicator of platelet activation. The reactivity of larger platelets is more as compared to the smaller platelet. As we know platelet size is determined at the level of the progenitor cell (i.e. megakaryocyte), megakaryocytic ploidy can get affected by cytokine such as interleukin-3 or interleukin-6, which can lead to more reactive, larger platelet production. Thus, platelet volume has been used as an indirect marker of increased platelet reactivity. During infections, the activated platelets also release certain antibacterial peptides. On the contrary, it is proved that bacterial pathogens may exploit activated platelets to spread by binding on platelet surfaces, thus platelets serve as a vehicle for trafficking. Based on the results of many previous studies MPV and various non-infectious inflammatory activities showed an association, which may indicate disease severity in inflammation represented by changes in MPV values.[73]

A study was done by Kucuk *et al*[74] on 60 patients diagnosed previously as acute appendicitis. They determined the WBC count and MPV values of each patient at the onset of acute appendicitis and compared them with a previous non- inflammatory state WBC count and MPV values and their results showed a significant difference in both the values. Hence, they concluded that MPV reduces in acute appendicitis and it can be used as a supportive parameter for the clinical diagnosis of acute appendicitis.

Erdem *et al*[75] did a retrospective study on histopathologically confirmed cases of acute appendicitis and patients admitted for elective herniorraphy were taken as the control group. They evaluated that MPV is a significant parameter for diagnosis of acute appendicitis and got a cutoff of 7.4 ± 0.9 fL (5.6-10.6fl) for acute appendicitis cases for which sensitivity was 74% and specificity was 80%.

A study conducted by Aydogan *et al*[76], found that MPV and PDW values were significantly higher in perforated cases when compared with the non perforated cases, thus they concluded that MPV and PDW may be used as an important marker for the early detection of the risk of perforation. However, a study conducted by Albayrak *et al*[77] evaluated that MPV was significantly decreased (7.25±0.85fL) in acute appendicitis cases as compared to the healthy controls (9.01±1.33fl, $p$ <0.001).

Aktimur *et al*[78] conducted a study "Mean platelet volume is a significant biomarker in the differential diagnosis of acute appendicitis" on acute appendicitis cases and they noted significantly increased MPV levels in the acute appendicitis group when compared to the cases with a normal appendix. Hence, they concluded that increased MPV values may be used as a valuable diagnostic parameter for the diagnosis of acute appendicitis. Studies done by Dinc *et*

*al*[79] and Boshnak *et all*[80] showed there was a significant increase in PDW levels in cases of acute appendicitis and concluded that it can be used as an important biomarker in its diagnosis.

In most clinical laboratories, automated cell counters have made the platelet count and platelet indices available routinely. The MPV may represent changes in either platelet stimulation level or platelet production rate. The discordance between the outcome of the distinct cell counter and the same cell counter results limits MPV use. This may explain partially why platelet indices are not displayed in hematological laboratories. There is scope to make better use of the platelet parameters generated. However, their role has significantly improved in various thrombotic and inflammatory conditions. MPV and PDW have emerged as a reliable platelet function marker. P-LCR and plateletcrit are yet to be fully explored with respect to its significance.[81]

## MATERIALS AND METHODS

**Source of data**:

A cross sectional hospital based study was carried out on patients fulfilling the inclusion and exclusion criteria attending either outpatient or inpatient department referred to the Department of Pathology in B.L.D.E (Deemed to be University) Shri B. M. Patil Medical College, Hospital and Research Centre, Vijayapura.

Study period: 1st December, 2017 to 30th June, 2019

**Methods of collection of data**

- The study was carried out on patients clinically diagnosed as acute appendicitis by using the Alvarado scoring system.
- All the clinically diagnosed acute appendicitis cases and healthy subjects underwent complete clinical evaluation.
- Venous blood samples were collected in di-potassium EDTA tubes.
- The samples were run within two hours of venepuncture using the 6 part differentiated automated Hematoanalyzer (Sysmex XN-1000) and complete blood count analysis of the samples including the platelet indices (MPV, PDW, PCT and P-LCR) was performed in the study group and the control group.
- The patients who underwent appendectomy in the Department of General Surgery at B.L.D.E. (Deemed to be University) Shri B. M. Patil Medical College, Hospital and Research centre, Vijayapura. The appendectomy specimen of such patients were sent to the Histopathology section of the Department of Pathology for histopathological examination.

**Statistical analysis**

- All characteristics were summarized descriptively.
- For continuous variables, the summary statistics of mean± standard deviation (SD) were used. For categorical data, the number and percentage were used in the data summaries and diagrammatic presentation.
- Chi-square ($\chi^2$) test was used for association between two categorical variables.
- The difference of the means of analysis variables between two independent groups was tested by unpaired t-test.
- ROC curve analysis with Sensitivity- specificity was done to check relative efficiency.
- The p-value <0.05, was considered to be statistically significant.
- Data were analyzed using SPSS software v.23.0. and Microsoft office 2007.

**Inclusion criteria**

- Clinically diagnosed patients of acute appendicitis using the Alvarado scoring system.
- Healthy controls
- Only patients with histopathological report suggestive of acute appendicitis were included for the calculation of platelet indices.

**Exclusion Criteria**

- Subjects on antiplatelet drugs such as aspirin and clopidogrel.
- Patients of age <15years.
- Subjects with thrombocytopenic conditions such as dengue, malaria.
- Subjects with any diagnosed malignancy.

# RESULTS

A total of 102 cases clinically diagnosed as acute appendicitis using the Alvarado scoring system were chosen, out of which 84 cases were histopathologically confirmed as acute appendicitis. The results were analyzed for histopathologically confirmed acute appendicitis cases only i.e.84 cases. These patients' platelet indices parameters such as MPV, PDW, PCT and P-LCR were compared with the 84 age and sex matched healthy controls.

## DISTRIBUTION OF CASES BY ALVARADO SCORE AND HISTOPATHOLOGICAL REPORT

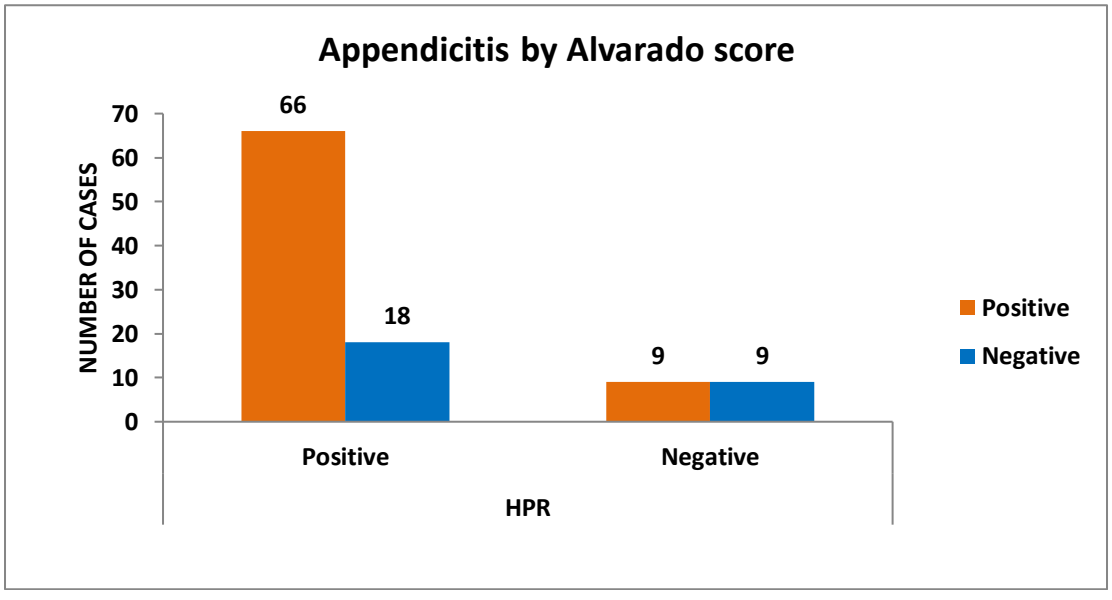
In the present study for assessment, the patients were categorized into two groups patients with score >7 were considered as positive i.e.cases with clinically high predictivity of acute appendicitis and negative i.e. cases which had an equivocal probability of acute appendicitis.

In a total of 102 cases, 75 cases had the Alvarado score of >7 in which 66 cases were histopathologically confirmed as acute appendicitis and 9 cases reported as chronic appendicitis. Twenty-seven cases had the Alvarado score of ≤7 out of which 18 and 9 cases were histopathologically reported as acute and chronic appendicitis respectively. (Table 5 & Figure 7)

**TABLE 5: DISTRIBUTION OF CASES BY THE ALVARADO SCORE AND HISTOPATHOLOGY REPORT**

| Alvarado score | Histopathology report | | Total |
|---|---|---|---|
| | Acute appendicitis | Chronic appendicitis | |
| **Positive (Score >7)** | 66 | 9 | **75** |
| **Negative (Score ≤7)** | 18 | 9 | **27** |
| **Total** | **84** | **18** | **102** |

**FIGURE 7: BAR GRAPH SHOWING DISTRIBUTION OF CASES BY THE ALVARADO SCORE AND HISTOPATHOLOGY REPORT**



**ANALYSIS OF SENSITIVIY, SPECIFICITY, POSITIVE PREDICTIVE VALUE AND NEGATIVE PREDICTIVE VALUE OF THE ALVARADO SCORING SYSTEM COMPARED TO HISTOPATHOLOGY REPORT**

Our present study showed sensitivity 93.33%, specificity 80%, positive predictive value 88%, and negative predictive value 84.21% for the Alvarado scoring system for the cases which got clinically diagnosed as acute appendicitis.(Table 6)

**TABLE 6: ANALYSIS OF SENSITIVIY, SPECIFICITY, POSITIVE PREDICTIVE VALUE AND NEGATIVE PREDICTIVE VALUE OF THE ALVARADO SCORING SYSTEM COMPARED TO HISTOPATHOLOGICAL RESULTS**

| | |
|---|---|
| **Sensitivity** | 93.33% |
| **Specificity** | 80.00% |
| **PPV** | 88.00% |
| **NPV** | 84.21% |

**DISTRIBUTION OF MEAN AGE BETWEEN THE CASES AND CONTROLS**

In the present study, age ranged from 16 to 55years, the mean age of patients and controls was 31±11.5 years and 31±11.5 years respectively. In both the study groups, no statistical difference was note. (Table 7)

**TABLE 7: DISTRIBUTION OF MEAN AGE BETWEEN THE CASES AND CONTROLS**

| PARAMETERS | CASE | | CONTROL | |
|---|---|---|---|---|
| | **Mean** | **SD** | **Mean** | **SD** |
| Age (yrs) | 31.2 | 11.5 | 31.1 | 11.5 |

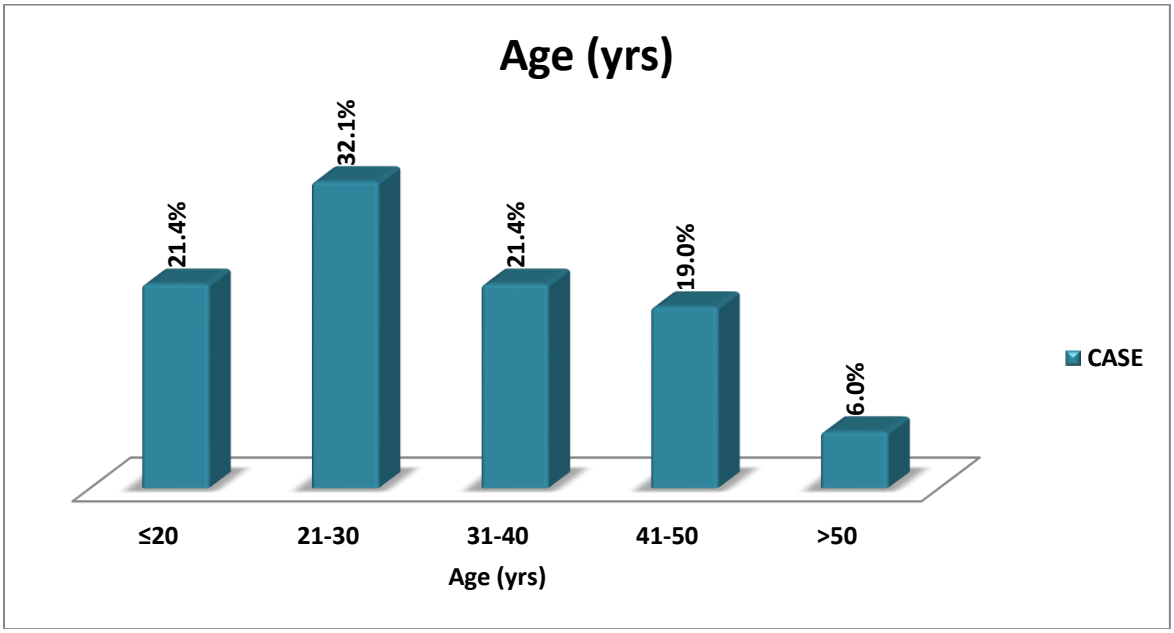
**AGE DISTRIBUTION IN CASES**

Majority of the patients diagnosed with acute appendicitis were in the 2nd to 3rd decades of their life. (Table 8 and Figure 8))

**TABLE 8: AGE DISTRIBUTION IN CASES**

| Age (yrs) | CASE | |
|---|---|---|
| | **N** | **%** |
| ≤20 | 18 | 21.4% |
| 21-30 | 27 | 32.1% |
| 31-40 | 18 | 21.4% |
| 41-50 | 16 | 19.0% |
| >50 | 5 | 6.0% |
| Total | 84 | 100.0% |

**FIGURE 8: BAR GRAPH SHOWING DISTRIBUTION OF CASES ACCORDING TO AGE**



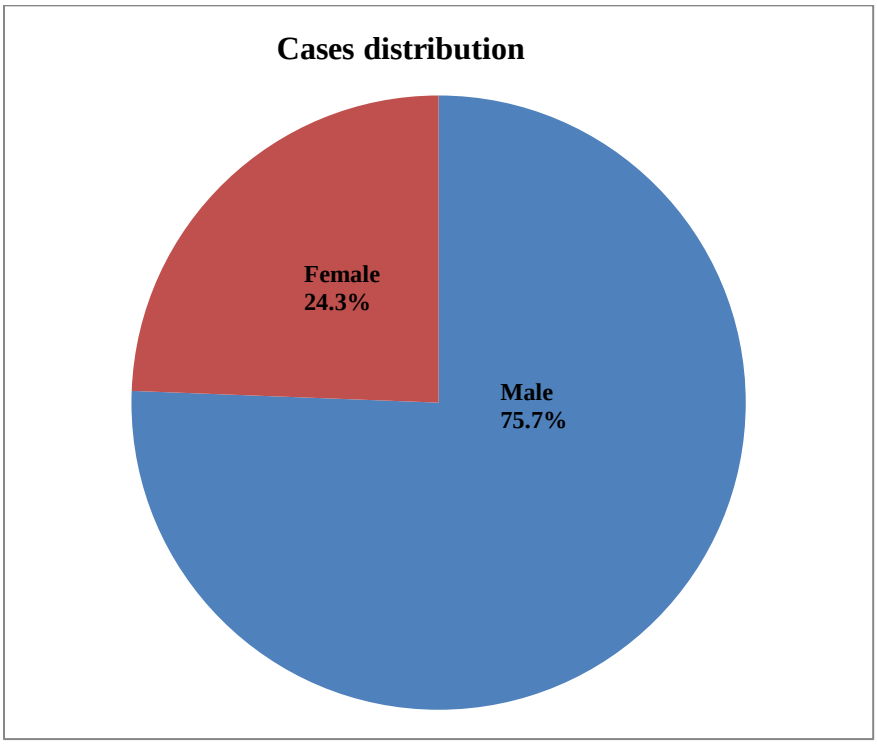

**DISTRIBUTION OF CASES ACCORDING TO GENDER**

The total number of males diagnosed with acute appendicitis among cases was 57 (67.9%) and females cases were 27 (32.1%). The male to female ratio was 3.1:1. (Table 9 & Figure 9)

**TABLE 9 : DISTRIBUTION OF CASES ACCORDING TO GENDER**

| Sex | Number of cases | Percentage (%) |
|---|---|---|
| Male | 57 | 67.9 |
| Female | 27 | 32.1 |
| **Total** | **84** | **100** |

**FIGURE 9: PIE CHART SHOWING DISTRIBUTION OF GENDER AMONG THE ACUTE APPENDICITIS CASES**



## HEMATOLOGICAL PARAMETERS

## DISTRIBUTION OF MEAN OF VARIOUS HEMATOLOGICAL PARAMETERS AMONG ACUTE APPENDICITIS CASES AND HEALTHY CONTROLS

In the current study, the mean values of hematological parameters were evaluated and compared with the control group. These parameters included Total Leucocyte Count(TLC), Neutrophil percentage(N%), Lymphocyte percentage(L%), Platelet count(PLT), Neutrophil-to-Lymphocyte Ratio(NLR) and Platelet-to-Lymphocyte Ratio(PLR). Results were as tabulated in Table 10 below.

Dinc *et al*[79] evaluated PDW in percentage (%) and Boshnak *et al*[80] in femtoliter (fl). In our study, we evaluated the results as follow, TLC in cells/cmm, Platelet count in lakhs/cmm, neutrophils and lymphocytes in percentage. Platelet indices were analyzed as MPV, PDW in femtoliter (fl) and PCT and P-LCR in percentage (%).

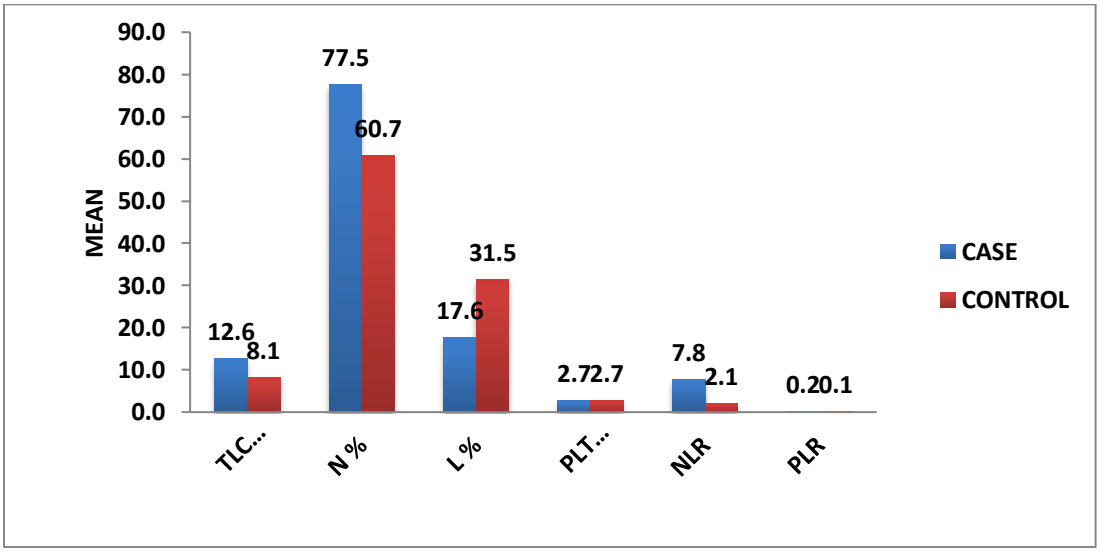
The various hematological parameters' mean values were tabulated in table 16 and figure 17. The TLC mean was 12609.3±4062.8/cmm in cases and 8147.3±1662.1/cmm in controls (p value <0.001), the neutrophil percentage was 77.5±13.1% and lymphocyte percentage was 17.6±11.8% in acute appendicitis cases. Total leucocyte count and the neutrophil percentage were significantly higher in acute appendicitis cases. The mean value of platelet count was 2.7±0.8lakhs/µl (p value 0.864). The NLR and PLR were significantly higher in acute appendicitis cases (p value <0.001).

**TABLE 10: DISTRIBUTION OF MEAN OF VARIOUS HEMATOLOGICAL PARAMETERS BETWEEN THE CASES AND CONTROLS**

| PARAMETERS | CASE | | CONTROL | | p value |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | |
| TLC (cells/cmm) | 12609.3 | 4062.8 | 8147.3 | 1662.1 | <0.001* |
| Neutrophil (%) | 77.5 | 13.1 | 60.7 | 7.2 | <0.001* |
| Lymphocyte (%) | 17.6 | 11.8 | 31.5 | 7.0 | <0.001* |
| Platelet (lakhs/cmm) | 2.7 | 0.8 | 2.7 | 0.6 | 0.864 |
| NLR | 7.8 | 7.0 | 2.1 | 0.7 | <0.001* |
| PLR | 0.2 | 0.2 | 0.1 | 0.0 | <0.001* |

Note: * significant at 5% level of significance (p<0.05)

**FIGURE 10: BAR GRAPH SHOWING DISTRIBUTION OF MEAN OF VARIOUS HEMATOLOGICAL PARAMETERS BETWEEN THE CASES AND CONTROLS**



## PLATELET INDICES

The platelet indices i.e. mean platelet volume (MPV), platelet distribution width (PDW), plateletcrit (PCT) and platelet large cell ratio (P-LCR) was studied among histopathologically confirmed 84 acute appendicitis cases and were compared with age and sex-matched 84 healthy controls.

## PLATELET INDICES DISTRIBUTION IN THE CASES AND CONTROLS

In our study MPV, PDW, PCT and P-LCR were evaluated which were compared with platelet indices of age and sex-matched healthy controls. The mean MPV in acute appendicitis cases was 9.7± 1.2fl with p value 0.914 and the mean PDW was 11.5± 2.2fl in acute appendicitis group compared to the healthy controls where it was 10.6±1.3fl.

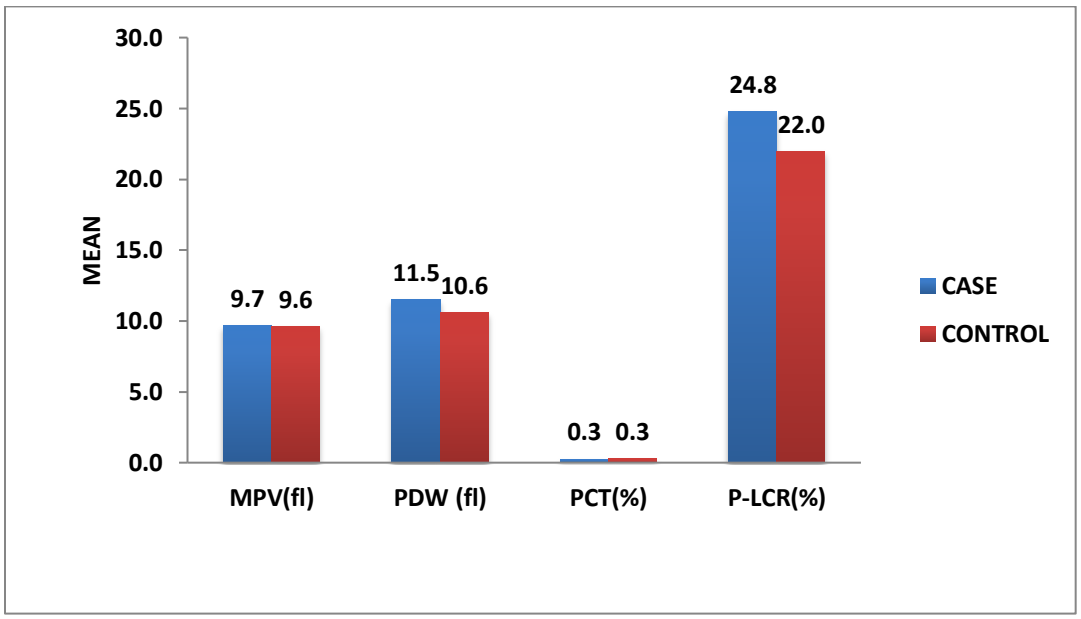
We observed that the mean value of PDW and P-LCR were significantly higher in acute appendicitis patients in comparison to healthy controls.(Table 11 & Figure 11)

**TABLE 11: PLATELET INDICES DISTRIBUTION IN CASES AND CONTROLS**

| PARAMETERS | CASE | | CONTROL | | p value |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | |
| MPV(fl) | 9.7 | 1.2 | 9.6 | 0.7 | 0.914 |
| PDW (fl) | 11.5 | 2.2 | 10.6 | 1.3 | 0.002* |
| PCT(%) | 0.3 | 0.1 | 0.3 | 0.1 | 0.81 |
| P-LCR(%) | 24.8 | 6.6 | 22.0 | 5.2 | 0.003* |

Note: * significant at 5% level of significance ($p<0.05$)

**FIGURE 11: BAR GRAPH SHOWING DISTRIBUTION OF MEAN OF PLATELET INDICES BETWEEN THE CASES AND CONTROLS**



## MEAN OF PLATELET INDICES DISTRIBUTION ACCORDING TO THE ALVARADO SCORE

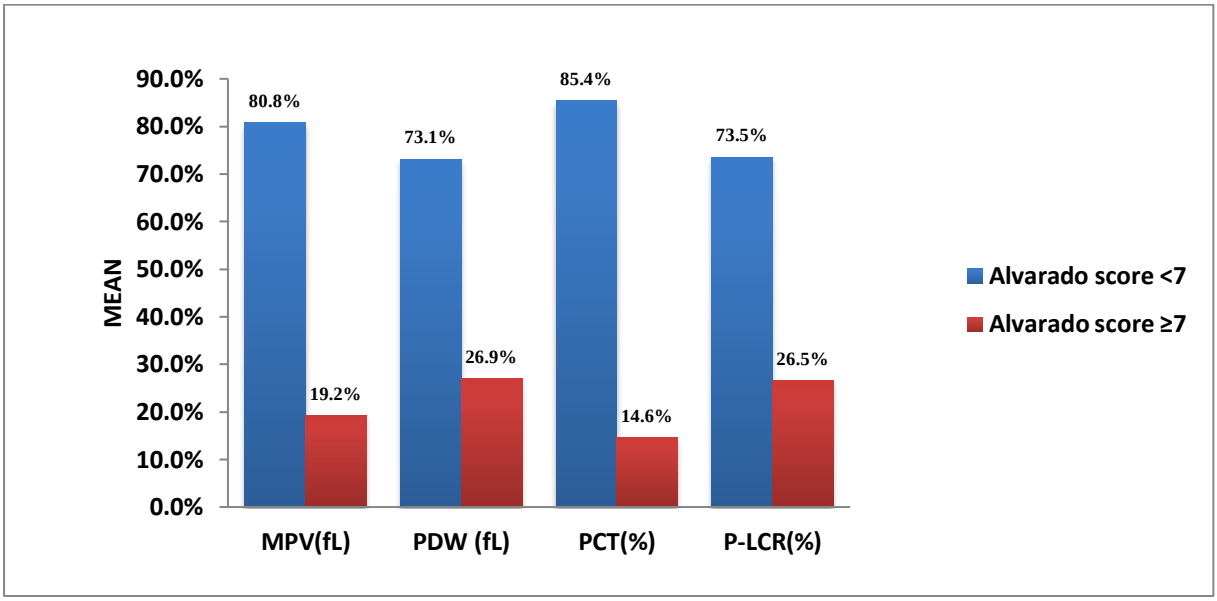
The study groups' mean platelet indices parameters were compared with the Alvarado score but except for PCT value, no other parameter showed significant variation, which was 0.3±0.1% in the cases which had score ≥7 as compared to 0.2±0.1% in cases with score <7 (p value 0.044). Results were as shown below in table no.12 & figure 12.

## TABLE 12: MEAN OF PLATELET INDICES DISTRIBUTION ACCORDING TO THE ALVARADO SCORE

| Parameters | Alvarado score <7 | | Alvarado score ≥7 | | p value |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | |
| MPV(fl) | 10.1 | 1.0 | 10.0 | 1.1 | 0.661 |
| PDW (fl) | 11.7 | 1.9 | 11.4 | 2.3 | 0.593 |
| PCT(%) | 0.2 | 0.1 | 0.3 | 0.1 | 0.044* |
| P-LCR(%) | 25.5 | 4.2 | 24.6 | 7.1 | 0.606 |

Note: * significant at 5% level of significance (p<0.05)

**FIGURE 12: BAR GRAPH SHOWING DISTRIBUTION OF MEAN OF PLATELET INDICES ACCORDING TO THE ALVARADO SCORE**




## ROC CURVE ANALYSIS OF ALL PARAMETERS IN PREDICTING ACUTE APPENDICITIS

In the present study ROC curve analysis was performed to get the best cutoff value, the area under the curve (AUC), sensitivity and specificity for the parameters such as TLC, neutrophil percentage, lymphocyte percentage, platelet count, NLR, PLR, MPV, PDW, PCT and P-LCR. The area under the curve for TLC was 0.854 and neutrophil percentage was 0.836. AUC for PDW and P-LCR was 0.617 and 0.623 respectively.

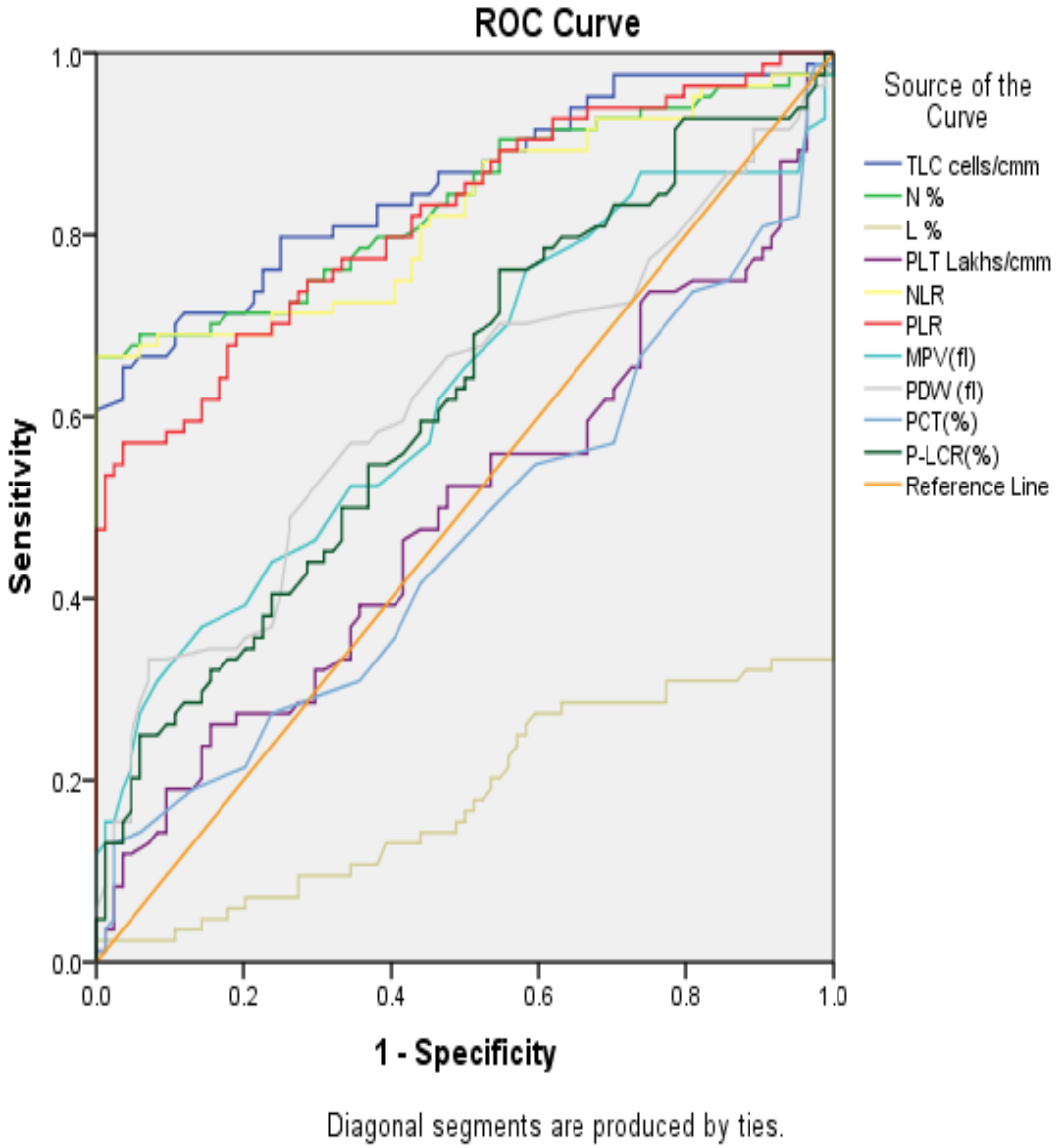
Total leucocyte count showed higher sensitivity and specificity of 77% and 75% respectively, at a cutoff of 9540cells/cmm. Neutrophil percentage, lymphocyte percentage, NLR and PLR had a sensitivity and specificity of 73% and 71%; 71.4% and 72.6%; 71.4% and 70.2%; and 73.8% and 72.6%, respectively. In platelet indices parameters, the PDW cutoff value for clinically predicting acute appendicitis was 10.7fL, which had a sensitivity of 60% and specificity of 58%, which was highest among all other platelet indices. (Table 13 and figure 13)

**TABLE 13: ROC CURVE ANALYSIS OF ALL PARAMETERS IN PREDICTING ACUTE APPENDICITIS**

| Parameters | Area Under the Curve | Std. Error | p value | 95% Confidence Interval | | Cut off | Sensitivity | Specificity |
|---|---|---|---|---|---|---|---|---|
| | | | | Lower Bound | Upper Bound | | | |
| TLC /cmm | 0.854 | 0.03 | <0.001* | 0.796 | 0.913 | 9540.0 | 77% | 75% |
| N % | 0.836 | 0.032 | <0.001* | 0.773 | 0.9 | 65.1 | 73% | 71% |
| L % | 0.818 | 0.034 | <0.001* | 0.751 | 0.885 | 26.7 | 71.4% | 72.6% |
| PLT /cmm | 0.492 | 0.045 | 0.854 | 0.403 | 0.58 | 2.685 | 52.4% | 51.2% |
| NLR | 0.823 | 0.034 | <0.001* | 0.757 | 0.889 | 3.6 | 71.4% | 70.2% |
| PLR | 0.82 | 0.032 | <0.001* | 0.756 | 0.883 | 0.11 | 73.8% | 72.6% |
| MPV(fl) | 0.626 | 0.043 | 0.005* | 0.541 | 0.711 | 9.8 | 57% | 55% |
| PDW (fl) | 0.617 | 0.044 | 0.009* | 0.531 | 0.703 | 10.7 | 60% | 58% |
| PCT(%) | 0.469 | 0.045 | 0.486 | 0.381 | 0.557 | 0.2 | 55% | 41% |
| P-LCR(%) | 0.623 | 0.043 | 0.006* | 0.538 | 0.707 | 22.9 | 58% | 56% |

Note: * significant at 5% level of significance ($p<0.05$)

**FIGURE 13: ROC CURVE ANALYSIS SHOWING ALL PARAMETERS IN PREDICTING ACUTE APPENDICITIS**



# DISCUSSION

Acute appendicitis continues to be a prevalent abdominal emergency worldwide. To decrease the morbidity and mortality associated with delayed diagnosis and its complication, early and precise diagnosis of acute appendicitis is needed. Besides substantial morbidity and mortality, negative appendectomy is also liable for the loss of valuable time of medical staff and economical resources.[1]

Although there are many advances with the invention of advanced investigations available in the diagnostic sector, the diagnosis of acute appendicitis continues to be a diagnostic dilemma for the clinician. Acute appendicitis cannot be diagnosed accurately by investigations like USG and/or CT scan. Due to the variable presentation of acute appendicitis and a lack of reliable diagnostic tests, the clinical diagnosis remains questionable. As discussed earlier, the available investigations like USG and CT scan are expensive, time-consuming and need more advanced equipment and experience. However, some investigations are not feasible and not available easily.[2,3]

A various number of clinical scoring systems are used in the diagnosis of acute appendicitis as complimentary assistance. Using a clinical scoring system, initial evaluation can be enhanced. Out of the many scoring systems available till date, the most commonly used one is the Alvarado scoring system. It is based on historical, physical examination and few laboratory investigations. It is simple, easy to use and low- cost complementary aid to support the clinical diagnosis of acute appendicitis.[4]

The clinical diagnosis however, remains the cornerstone of diagnosis of acute appendicitis, but under routine circumstances, their supposedly excellent outcomes were not

always reproducible. In children, the elderly and females of reproductive age groups, clinical diagnosis is difficult.[6]

The precision of clinical examination ranged from 71 to 97% and varies widely based on the examiner's experience. Since missing a ruptured appendix has immediate and life-threatening complications, surgeons have generally accepted a 20% rate of negative appendectomy.[8]

The present study was undertaken to evaluate the diagnostic utility of platelet indices in correlation with the clinical diagnosis of acute appendicitis, done by using the Alvarado scoring system to get a more accurate clinical diagnosis.

**TABLE 14: COMPARISION OF THE SENSITIVITY, SPECIFICITY, POSITIVE PREDICTIVE VALUE AND NEGATIVE PREDICTIVE VALUE OF THE ALVARADO SCORING SYSTEM WITH OTHER STUDIES**

| **Study** | **Sensitivity (%)** | **Specificity (%)** | **PPV(%)** | **NPV(%)** |
|---|---|---|---|---|
| Jain *et al*[82] | 89.6 | 92.8 | 94.5 | 86.6 |
| Memon *et al*[83] | 93.5 | 80.6 | 92.3 | 83.3 |
| **Present study** | **93.3** | **80** | **88** | **84.21** |

Our study results were comparable to studies conducted by Jain *et al*[82] and Memon *et al*[83] (Table 14). These results showed that the Alvarado scoring system is useful in predicting the diagnosis of acute appendicitis clinically.

**TABLE 15: COMPARISION OF GENDER WISE DISTRIBUTION OF ACUTE APPENDICITIS CASES WITH OTHER STUDIES**

| **Study** | **Number of cases** | **Male:Female ratio** |
|---|---|---|
| D Saxena *et al*[8] | 213 | 2.5:1 |
| Kucuk *et al*[74] | 60 | 1.5:1 |
| **Present study** | **84** | **3.1:1** |

The present study showed more male prevalence with a male to female ratio of 3.1:1 in acute appendicitis cases. Which is similar to other studies which also reported a male predominance in acute appendicitis.[8,74] (Table 15)

**TABLE 16: COMPARISON OF MEAN AGE DISTRIBUTION IN ACUTE APPENDICITIS CASES AND CONTROLS WITH OTHER STUDIES**

| **Study** | **Cases** | **Mean age** | **Controls** | **Mean age** | **p value** |
|---|---|---|---|---|---|
| Narci *et al*[73] | 503 | 34.7±14.1 | 121 | 35.2±8.1 | 0.71 |
| Albayrak *et al*[77] | 226 | 32.5±15.1 | 206 | 35.5±14.7 | 0.36 |
| Dinc *et al*[79] | 295 | 29.9 ± 12.0 | 100 | 30.4 ± 13.0 | 0.930 |
| **Present study** | **84** | **31.2±11.5** | **84** | **31.1±11.5** | **0.957** |

In the present study, the age ranged from 16-55years. The mean age of patients in our study was 31.2±11.5years. Majority of the patients diagnosed with acute appendicitis belonged to 2$^{nd}$-3$^{rd}$ decades of life. This is in accordance with other studies.[73,77,79] There was no significant statistical difference was noted among the cases and the controls groups.(Table 16)

**HEMATOLOGICAL PARAMETERS**

**TABLE 17: COMPARISION OF MEAN VALUE, CUTOFF, SENSITIVITY AND SPECIFICITY OF TOTAL LEUCOCYTE COUNT, NEUTROPHIL PERCENTAGE (N%) AND LYMPHOCYTE PERCENTAGE (L%) WITH OTHER STUDIES**

| **Parameters** | | | **Studies** | | |
|---|---|---|---|---|---|
| | | | Kostakis *et al*[84] | Madani *et al*[85] | **Present study** |
| **TLC /cmm** | **Mean value** | **Cases** | 14186 ± 4034 | 11.3 (8.1-15.0) | **12609.3±4062.8** |
| | | **Controls** | 6855 ± 1438 | 8.3 (6.60-9.88) | **8147.3±1662.1** |
| | | **p value** | ≤ 0.000 | <0.001 | **<0.001** |
| | **Cut off** | | 9000 | 9.865 | **9540** |
| | **AUC (95% CI)** | | 0.96 (0.94-0.99) | 0.811 | **0.854 (0.796-0.913)** |
| | **Sensitivity(%)** | | 91 | 74.7 | **77** |
| | **Specificity (%)** | | 92 | 75.4 | **75** |
| **N %** | **Mean value** | **Cases** | 79.4 ± 9.9 | 70.8 (64.00-79.00) | **77.5±13.1** |
| | | **Controls** | 56.7 ± 8.8 | 61.9 (54.35-71.00) | **60.7±7.2** |
| | | **p value** | ≤ 0.000 | 0.001 | **<0.001** |
| | **Cutoff** | | 70 | 71.9 | **65.1** |
| | **AUC (95% CI)** | | 0.94 (0.91-0.97) | 0.812 | **0.836 (0.773-0.9)** |
| | **Sensitivity(%)** | | 87 | 77.8 | **73** |
| | **Specificity (%)** | | 88 | 76.9 | **71** |
| **L %** | **Mean value** | **Cases** | 13.5 ± 8.3 | 22.0 (15.90-28.00) | **17.6±11.8** |
| | | **Controls** | 33.2 ± 7.5 | 28.3 (19.60-34.37) | **31.5±7.0** |
| | | **P value** | ≤ 0.000 | 0.004 | **<0.001** |
| | **Cutoff** | | 24 | 19.2 | **26.7** |
| | **AUC (95% CI)** | | 0.94 (0.92-0.97) | 0.804 | **0.818 (0.751-0.885)** |
| | **Sensitivity(%)** | | 90 | 76.4 | **71.4** |
| | **Specificity (%)** | | 86 | 73.7 | **72.6** |

During the inflammatory response the ratio of the leucocytes in circulatory system changes which results in an increase in neutrophil count accompanied with relative lymphopenia.[84]

The total leucocyte count in our study was significantly higher in acute appendicitis cases (p value <0.001), which is similar to the literature.[73-80] The sensitivity was 77% and specificity was 75% at a cutoff of 9540 cells/cmm. Our study found a statistical significant difference in mean values of neutrophil and lymphocyte percentages between the both study groups, which was consistent with the findings of studies done by, Kostakis *et al*[84] and Madani *et al*[85].(Table 17)

Only few studies like Kostakis *et al*[84] and Madani *et al*[85] have mentioned lymphocyte values in their studies. Our study results were also comparable to these studies where acute appendicitis cases showed less lymphocyte count as compared to healthy controls.

We observed that leucocytosis remains a consistent finding in majority of acute appendicitis cases along with neutrophilia and lymphocytopenia.

**TABLE 18: COMPARISION OF MEAN OF PLATELET COUNT WITH OTHER STUDIES**

| **Study** | **Cases** | **Platelet count** | **Controls** | **Platelet count** | **p value** |
|---|---|---|---|---|---|
| Erdem *et al*[75] | 100 | 2.3±0.7 | 100 | 2.4±0.6 | 0.320 |
| Albyarak *et al*[77] | 226 | 2.5±0.6 | 206 | 2.5±0.8 | 0.21 |
| Mehmat *et al*[86] | 455 | 2.5 ± 0.6 | 114 | 2.4± 0.6 | 0.057 |
| **Present study** | **84** | **2.7±0.8** | **84** | **2.7±0.6** | **0.864** |

In our study we found that statistically there was no difference between the acute appendicitis cases and controls, which is similar to the results of other studies done by Erdem *et al*[75], Albyarak *et al*[77] and Mehmat *et al*.[86] Thus, our analysis found no association of platelet count variations in acute appendicitis.(Table 18)

**TABLE 19: COMPARISION OF MEAN VALUE, CUTOFF, SENSITIVITY AND SPECIFICITY OF NEUTROPHIL-TO-LYMPHOCYTE RATIO (NLR) WITH OTHER STUDIES**

| **Parameters** | | | **Study** | | |
|---|---|---|---|---|---|
| | | | Ulukent *et al*[87] | Kostakis *et al*[84] | **Present study** |
| **NLR** | **Mean value** | **Cases** | 5.9±4.1 | 8.4 ± 5.6 | **7.8±7.0** |
| | | **Controls** | 1.9±0.8 | 1.9 ± 0.8 | **2.1±0.7** |
| | | **p value** | <0.0001 | ≤ 0.000 | **<0.001** |
| | **Cutoff** | | 3.15 | 3 | **3.6** |
| | **AUC (95% CI)** | | 0.903 (0.85-0.95) | 0.94 (0.92-0.97) | **0.823 (0.757-0.889)** |
| | **Sensitivity(%)** | | 77 | 90 | **71.4** |
| | **Specificity (%)** | | 94 | 88 | **70.2** |

To our knowledge only few studies such as Kostakis *et al*[84], Mehmet *et al*[86] and Ulukent *et al*[87] have evaluated the Neutrophil-to-Lymphocyte Ratio in acute appendicitis along with the platelet indices.

Following stress as a physiological response of leucocytes there will be an increase in neutrophil count which leads to a relative decrease in lymphocyte count. Thus, the ratio of these two parameters can be used as a reagent of inflammatory response.[88]

A study conducted by Kaykisiz *et al*[89] found that NLR value 4.659 in acute appendicitis cases can be used as an useful parameter for the preoperative diagnosis of acute appendicitis. Hence, it can aid in reducing the negative laparotomy rates.

Ulukent *et al*[87] in their study mentioned that NLR on admission to the hospital is an independent predictor of positive appendicitis on histology.

In our study NLR value results were in concordance with the values of the studies as mentioned in table 19. Thus, it was found that NLR was significantly higher in acute appendicitis and it has an association with the clinical prediction of acute appendicitis.

**TABLE 20 : COMPARISION OF MEAN VALUE, CUTOFF, SENSITIVITY AND SPECIFICITY OF PLATELET-TO-LYMPHOCYTE RATIO (PLR) WITH OTHER STUDIES**

| **Parameters** | | **Study** | |
|---|---|---|---|
| | | Ulukent *et al*[87] | **Present study** |
| **Mean value** | **Cases** | 166±97 | **0.2± 0.2** |
| | **Controls** | 107±28 | **0.1± 0.0** |
| | **p value** | <0.0001 | **<0.001** |
| **Cutoff** | | 117 | **0.11** |
| **AUC (95% CI)** | | 0.735 (0.65-0.81) | **0.82 (0.756-0.883)** |
| **Sensitivity(%)** | | 66 | **73.8** |
| **Specificity (%)** | | 70 | **72.6** |

Mehmet *et al*[86] in their study titled "The role of neutrophils/lymphocyte ratio, platelet/lymphocyte ratio and platelet distribution width values in acute appendicitis diseases" mentioned PLR as a new inflammation reagent used for the diagnosis of acute appendicitis and they observed that PLR values were higher in acute appendicitis cases when compared with the controls. Further they emphasized that decreased lymphocyte counts can be added to the Alvarado scoring system as a parameter for clinical evaluation of acute appendicitis.

Our study result also showed significantly higher values, similar to studies done by Mehmet *et al*[86] and Ulukent *et al*[87] where mean values of PLR were 162.6±97.3 and 107±28 respectively. We got a sensitivity of 73.8% when cut off was taken 0.11(Table 20). We found that there was an association between PLR values and acute appendicitis.

**PLATELET INDICES:**

Platelet indices (MPV, PDW, PCT & P-LCR) were analyzed in acute appendicitis cases and compared with age and sex matched healthy controls.

**MEAN PLATELET VOLUME**

The MPV value evaluated in our study was 9.7±1.2 fl in acute appendicitis group and 9.6±0.7fl in the control group. We found that MPV was not significant (p value 0.914) in acute appendicitis patients when compared with age and sex matched healthy controls.

**TABLE 21: COMPARISON OF MPV IN ACUTE APPENDICITIS WITH OTHER STUDIES**

| Study | Cases | MPV (fl) | Controls | MPV(fl) | p value |
|---|---|---|---|---|---|
| Narci *et al*[73] | 503 | 7.92±1.68 | 121 | 7.43±1.34 | <0.001 |
| Erdem *et al*[75] | 100 | 7.4±0.9 | 100 | 9.1±1.6 | <0.001 |
| Aktimur *et al*[78] | 469 | 9.6±1.5 | 61 | 9.1±1.5 | 0.018 |
| Boshnak *et al*[80] | 125 | 11.26±1.00 | 55 | 11.14±0.75 | NS |
| Ulukent *et al*[87] | 97 | 8.2±1.2 | 94 | 8.5±0.8 | 0.168 |
| **Present study** | **84** | **9.7±1.2** | **84** | **9.6±0.7** | **0.914** |

Note: NS- Not significant p value

**TABLE 22: COMPARISION OF CUTOFF, SENSITIVITY AND SPECIFITY OF MPV IN ACUTE APPENDICITIS WITH OTHER STUDIES**

| **Study** | **Cut off (fl)** | **AUC** | **Sensitivity** | **Specificity** |
|---|---|---|---|---|
| Narci *et al*[73] | 7.87 | 0.62 | 66 | 59 |
| Aktimur *et al*[78] | 9.6 | 0.595 | 57.1 | 60.7 |
| **Present study** | **9.8** | **0.626** | **57** | **55** |

It was hypothesized that in inflammation related diseases there is an increase in the MPV resulting from early platelet activation due to inflammation and a late increase in release of young platelets into the circulation from the bone marrow, whereas decrease in MPV occurs due to enhanced sequestration and destruction of activated platelet at the inflammation site.[68,69]

Many studies conducted on the non infectious inflammatory disorders, suggested that variations in MPV may indicate activity in inflammation [64-72] The various studies conducted on acute appendicitis and role of MPV in its diagnosis suggested that variation in the MPV values is acceptable, such as increased or decreased levels or no significant difference as found in our study also, depending on which of the two mechanisms mentioned above dominates.[73-80]

Although, in our study an increase in MPV was found but it was not statistically significant when compared with the healthy control group (p value 0.914) which was in concordance with studies conducted by Boshnak *et al*[80] and Ulukent *et al*[87], thus ruling out MPV association in predicting acute appendicitis.

We got a cut off of 9.8fl (p value 0.005*) for which sensitivity was 57% and specificity was 55% the results were comparable to Aktimur *et al*[78] study results as mentioned in the above table (Table 22).

**PLATELET DISTRIBUTION WIDTH:**

To our knowledge only few studies have investigated the changes in PDW values in acute appendicitis.

**TABLE 23: COMPARISON OF PLATELET DISTRIBUTION WIDTH (PDW) IN ACUTE APPENDICITIS WITH OTHER STUDIES**

| **Publication** | **Cases** | **PDW (fl)** | **Controls** | **PDW (fl)** | ***p* value** |
|---|---|---|---|---|---|
| Dinc *et al*[79] | 295 | 49.0 (10.6-86.5) | 100 | 18.4 (10.3-62.5) | <0.001 |
| Boshnak N *et al*[80] | 125 | 14.25±2.10 | 55 | 12.85±0.96 | <0.001 |
| Madani *et al*[85] | 39 | 11.9 (11.2-13.6) | 200 | 11.8 (10.7-13.47) | NS |
| Mehmet *et al*[86] | 455 | 19.01±1.68 | 114 | 16.77±1.81 | <0.001 |
| Ulukent *et al*[87] | 97 | 15±2 | 94 | 13±2 | <0.0001 |
| **Present study** | **84** | **11.5±2.2** | **84** | **10.6±1.3** | **0.002** |

Note: NS- p value not significant

**TABLE 24: COMPARISION OF CUTOFF, SENSITIVITY AND SPECIFITY OF PDW IN ACUTE APPENDICITIS WITH OTHER STUDIES**

| **Study** | **Cut off (fl)** | **AUC (95% CI)** | **Sensitivity** | **Specificity** |
|---|---|---|---|---|
| Dinc *et al*[79] | 32.15 | 0.95 (0.92-0.98) | 97.1 | 93 |
| Boshnak *et al*[80] | 14.2 | 0.646 ( 0.575–0.712) | 48.28 | 90.91 |
| Ulukent *et al*[87] | 14.5 | 0.706 (0.61-0.79) | 64 | 73 |
| **Present study** | **10.7** | **0.617 (0.531-0.703)** | **60** | **58** |

During an acute inflammatory process the change in the quantity of platelets results in larger platelets entering the circulation and as result there will be rise in consequent PDW values as well.[9] Both MPV and PDW are platelet immaturity markers, and an increase in both as compared to controls indicates that young platelets are entering into the peripheral circulation.[76]

Our evaluation showed that PDW was significantly increased, with p value= 0.002 in the patients of acute appendicitis (11.5±2.2 fl) as compared to the control group (10.6±1.3 fl). Similar results were noted in other studies done by Dinc *et al*[79], Boshna *et al*[80], Mehmet *et al*[86] and Ulukent *et al*[87]. Hence, it was evaluated that increased PDW can be used as a prognostic indicator of disease activity in acute appendicitis.(Table 23)

In our study, we got a cut off of 10.7fl for PDW, for which sensitivity was 60% and specificity was 73%. This was comparable with the other studies mentioned in the table number 24. However, specificity was found to be less in our study.

## PLATELETCRIT

In our study p value for plateletcrit showed significant difference 0.2±0.1% in cases and 0.3±0.1% in control group (p value 0.044).

**TABLE 25: COMPARISION OF PLATELETCRIT IN ACUTE APPENDICITIS WITH OTHER STUDIES**

| Author | Cases | Controls | p value |
|---|---|---|---|
| **Kostakis *et al*[84]** | 0.2±0.1 | 0.3±0.1 | 0.003 |
| **Present study** | **0.2±0.1** | **0.3±0.1** | **0.044** |

Our study results were was in concordance with study done by Kostakis *et al*[84] (Table 25). Although the statistical significant change in PCT value may indicate the involvment of platelets in pathophysiology of acute appendicitis. However, its role in diagnosis of acute appendicitis is not clear yet.

## PLATELET LARGE CELL RATIO

The P-LCR parameter is generated by only a few analysers, with the Sysmex analyser being one of them. It is not often quoted in literature, probably because it is relatively a new Platelet Volume Indices (PVI) parameter. The value of P-LCR observed in our study in acute appendicitis group was 24.8±6.6% compared to healthy controls group where it was 22.0±5.2% (p value 0.0003).

**TABLE 26: COMPARISION OF P-LCR IN ACUTE APPENDICITIS WITH OTHER STUDIES**

| Study | Cases | Controls | p value |
|---|---|---|---|
| Madani *et al*[85] | 24.7 (18.60-28.10) | 23.55 (18.55-28.57) | NS |
| **Present study** | **24.8±6.6** | **22.0±5.2** | **0.0003** |

However, reverse to our study a study done by Madani *et al*[85] "Role of platelet parameters as a biomarker in diagnosis of acute appendicitis: A retrospective case-controlled study" evaluated P-LCR value in cases was 24.7% and 23.55% in controls group there was an increase in P-LCR values in their study but it was not statistically significant. but in our study we got a significantly higher P-LCR value (p value 0.0003) in acute appendicitis cases when compared with the healthy controls.(Table 26) Thus we concluded that further research is needed in this regard to confirm the variations in P-LCR values in acute appendicitis.

**COMPARISION OF PLATELET INDICES ACCORDING TO THE ALVARADO SCORE**

To our knowledge, only one study in literature has evaluated the role of platelet indices in acute appendicitis with correlation the Alvarado score however they have only mentioned PDW and its relation with the Alvarado score.

**TABLE 27: COMPARISON OF PDW ACCORDING TO THE ALVARADO SCORE WITH OTHER STUDIES**

| Parameter | Mehmet *et al*[86] | | | Present study | | |
|---|---|---|---|---|---|---|
| | **Alvarado score <7** | **Alvarado score ≥7** | **P value** | **Alvarado score <7** | **Alvarado score ≥7** | **P value** |
| **PDW** | 19.00 ± 1.71 | 19.03 ± 1.64 | 0.806 | 11.7±1.9 | 11.4±2.3 | 0.593 |

Mehmet *et al*[86] found that PDW was not significant when it was compared with the Alvarado score. Our study also got similar results (Table 27). Thus it showed that there is no association between the Alvarado score and platelet indices.

## SUMMARY

- The study titled 'Study of platelet indices in clinically diagnosed acute appendicitis using the Alvarado score' was undertaken in B.L.D.E. (Deemed to be University) Shri B. M. Patil Medical College, Hospital and Research center, Vijayapura, Karnataka to study the utility of platelet indices in the diagnosis of acute appendicitis.
- A total of 102 cases were included in the study out of which 84 histopathologically confirmed acute appendicitis cases were evaluated for platelet indices and its utilization in clinical diagnosis of acute appendicitis with age and sex-matched 84 healthy controls
- For assessment of results of the Alvarado scoring system with histopathological results and platelet indices association the 84 cases acute appendicitis cases were divided into two groups. The cases with score >7 clinically highly predictive acute appendicitis and cases with score ≤7 were considered as the cases with an equivocal probability of acute appendicitis.
- In our study, the Alvarado scoring system showed sensitivity, specificity, PPV and NPV of 93.33%, 80%, 88% and 84.21% respectively.
- Majority of the patients diagnosed with acute appendicitis belonged to the $2^{nd}$ to $3^{rd}$ decades of life. Male to female ratio was 3.1:1.
- No statistical difference was found for platelet count between the cases and controls. Total leucocyte count, neutrophil percentage (N%), lymphocyte percentage (L%), NLR and PLR showed significant statistical difference when compared with the healthy controls (p value <0.001).

- The mean MPV and PCT showed no statistical difference. Mean MPV in acute appendicitis cases was 9.7± 1.2fl and in controls it was 9.6±0.7fl (*p* value 0.914) and the PCT recorded in our study for cases and controls were 0.3± 0.1% and 0.3± 0.1% (p value 0.81) respectively. P-LCR was found to be significantly higher in cases 24.8±6.6% (p value 0.003).
- The PDW was significantly higher in acute appendicitis cases which was 11.5±2.2fl and 10.6±1.3fl in the healthy controls. Among all the platelet indices PDW showed higher sensitivity of 60% and specificity of 58% at cutoff of 10.7fl.
- In terms of higher sensitivity and specificity WBC count and neutrophil percentage proved to be better biomarkers with sensitivity of 77% and 73% and specificity of 75% and 71%, respectively.
- In the present study, no significant variation was noted when comparison was done between the Alvarado score >7 and ≤7 cases and mean values of platelet indices except for the platetecrit values (p value 0.044). Thus, no association was found between the Alvarado scoring system and platelet indices parameters.

## CONCLUSION

- Platelet indices play an important role in the diagnosis of acute appendicitis and can be used in predicting it preoperatively. Leucocytosis with neutrophilia and lymphopenia are also a consistent finding in acute appendicitis.
- We found that Neutophil-to-Lymphocyte Ratio and Platelet-to-Lymphocyte Ratio are also seems to be better inflammatory markers in acute appendicitis clinical predictivity.
- Since there is no definitive and cost effective method is available for the clinical diagnosis of acute appendicitis, utilizing these predictive parameters may be helpful in reducing the unnecessary surgery, complications and mortality in high risk cases.
- Out of the four platelet indices parameters (MPV, PDW, PCT and P-LCR), PDW showed increased values with highest sensitivity, followed by P-LCR. Thus, we conclude that these parameters can be used as supportive aid in the clinical diagnosis of acute appendicitis. However, further studies are needed in this regard.

## BIBLIOGRAPHY


1) Humes DJ, Simpson J. Acute appendicitis. BMJ. 2006 Sep 7;333(7567):530-4.
2) Hoffmann J, Rasmussen OØ. Aids in the diagnosis of acute appendicitis. British Journal of Surgery. 1989 Aug;76(8):774-9.
3) Jones PF. Suspected acute appendicitis: trends in management over 30 years. British journal of surgery. 2001 Dec;88(12):1570-7.
4) Dey S, Mohanta PK, Baruah AK, Kharga B, Bhutia KL, Singh VK. Alvarado scoring in acute appendicitis—a clinicopathological correlation. Indian journal of surgery. 2010 Aug 1;72(4):290-3.
5) O'Connell PR. The vermiform appendix. In: Williams NS, Bulstrode C J.K., O,Connell PR. Bailey & Love's short practice of surgery.26th Ed International student's edition. CRC press;2013.p 1206-7.
6) Budak YU, Polat M, Huysal K. The use of platelet indices, plateletcrit, mean platelet volume and platelet distribution width in emergency non-traumatic abdominal surgery: a systematic review. Biochemia medica: Biochemia medica. 2016 Jun 15;26(2):178-93.
7) Andersson RE. Meta-analysis of the clinical and laboratory diagnosis of appendicitis. British journal of surgery. 2004 Jan;91(1):28-37.
8) Saxena D. Role of mean platelet volume in diagnosis of acute appendicitis. IJBR. 2015;6:235-7.
9) Ceylan B, Aslan T, Çınar A, Kurt AR, Akkoyunlu Y. Can platelet indices be used as predictors of complication in subjects with appendicitis? Wiener klinische Wochenschrift. 2016 Dec 1;128(8):620-5.

10) Williams GR. Presidential Address: a history of appendicitis. With anecdotes illustrating its importance. Annals of surgery. 1983 May;197(5):495-8.

11) Fitz RH. Perforating inflammation of the vermiform appendix: with special reference to its early diagnosis and treatment. Dornan; 1886.p100-7.

12) Mc Burney C. The incision made in the abdominal wall in cases of appendicitis, with a description of a new method of operating. Annals of surgery. 1894 Jul;20(1):38-43.

13) Langman J, Sadler TW. Langman's Medical Embryology 14th revised ed. UK: Lippincott williams and Wilkins, 2003.p.224-5.

14) Peter J Lunniss. Large intestine. Gray's Anatomy: The Anatomical Basis of Clinical Practice; 41st Ed. Elsevier; 2016: p.1142-5.

15) Pawlina W, Ross MH. Digestive system II: Esophagus and gastrointestinal tract. In:Ross MH, Pawlina W. Histology: a text and atlas: with correlated cell and molecular biology. 7th Ed. Lippincott Williams & Wilkins; 2016. p 598-9.

16) Randal Bollinger R, Everett ML, Palestrant D, Love SD, Lin SS, Parker W. Human secretory immunoglobulin A may contribute to biofilm formation in the gut. Immunology. 2003 Aug;109(4):580-7.

17) Madenci AL, Peranteau WH, Smink DS. Appendix and small bowel diverticula. In: Zinner MJ, Ashley SW, Joe Hines O. Maingot's abdominal operations. 13th Ed. McGraw-hill Education ; 2019: p.1814-40.

18) Primatesta P, Goldacre MJ. Appendicectomy for acute appendicitis and for other conditions: an epidemiological study. International journal of epidemiology. 1994 Feb 1;23(1):155-60.

19) Naveen K, Sareesh NN, Satheesha BN, Murlimanju BV, Suhani S, Mamatha H, Sampath PK. Appendicitis and Appendectomy: A Retrospective Survey in South Indian Population. Journal of Surgical Academia. 2013;3(2):10-3.

20) Ferris M, Quan S, Kaplan BS, Molodecky N, Ball CG, Chernoff GW, Bhala N, Ghosh S, Dixon E, Ng S, Kaplan GG. The global incidence of appendicitis: a systematic review of population-based studies. Annals of surgery. 2017 Aug 1;266(2):237-41.

21) Lee JH, Park YS, Choi JS. The epidemiology of appendicitis and appendectomy in South Korea: national registry data. Journal of epidemiology. 2010 Mar 5;20(2):97-105.

22) Addiss DG, Shaffer N, Fowler BS, Tauxe RV. The epidemiology of appendicitis and appendectomy in the United States. American journal of epidemiology. 1990 Nov 1;132(5):910-25.

23) Singh JP, Mariadason JG. Role of the faecolith in modern-day appendicitis. The Annals of The Royal College of Surgeons of England. 2013 Jan;95(1):48-51.

24) Burkitt DP. The aetiology of appendicitis. British Journal of Surgery. 1971 Sep;58(9):695-9.

25) Carr NJ. The pathology of acute appendicitis. Annals of diagnostic pathology. 2000 Feb 1;4(1):46-58.

26) Richardsen I, Schöb DS, Ulmer TF, Steinau G, Neumann UP, Klink CD, Lambertz A. Etiology of appendicitis in children: the role of bacterial and viral pathogens. Journal of Investigative Surgery. 2016 Mar 3;29(2):74-9.

27) Maa J , Kirkwood KS. The appendix. In:Beauchamp, Evers, Mattox. Sabiston Text book of Surgery: The biological basis of modern surgical practice.19th Ed; Elsevier; Saunders; 2012. p 1279-90.

28) Nwose E, Nga P. Appendicitis: A critical reappraisal of symptoms and signs. International Journal of Medicine and Health Development. 2001;6(2).p 81.

29) Wagner JM, McKinney WP, Carpenter JL. Does this patient have appendicitis?. Jama. 1996 Nov 20;276(19):1589-94.

30) Lee SL, Ho HS. Acute appendicitis: is there a difference between children and adults?. The American Surgeon. 2006 May 1;72(5):409-13.

31) Sasso RD, Hanna EA, Moore DL. Leukocytic and neutrophilic counts in acute appendicitis. The American Journal of Surgery. 1970 Nov 1;120(5):563-6.

32) Kamran H, Naveed D, Nazir A, Hameed M, Ahmed M, Khan U. Role of total leukocyte count in diagnosis of acute appendicitis. J Ayub Med Coll Abbottabad. 2008;20(3):70-1.

33) Lewis FR, Holcroft JW, Boey J, Dunphy JE. Appendicitis: a critical review of diagnosis and treatment in 1,000 cases. Archives of Surgery. 1975 May 1;110(5):677-84.

34) Thompson MM, Underwood MJ, Dookeran KA, Lloyd DM, Bell PR. Role of sequential leucocyte counts and C-reactive protein measurements in acute appendicitis. British journal of surgery. 1992 Aug;79(8):822-4.

35) Hallan S, Åsberg A. The accuracy of C-reactive protein in diagnosing acute appendicitis—a meta-analysis. Scandinavian journal of clinical and laboratory investigation. 1997 Jan 1;57(5):373-80.

36) Sengupta A, Bax G, Paterson-Brown S. White cell count and C-reactive protein measurement in patients with possible appendicitis. The Annals of The Royal College of Surgeons of England. 2009 Mar;91(2):113-5.

37) Birchley D. Patients with clinical acute appendicitis should have pre-operative full blood count and C-reactive protein assays. The Annals of The Royal College of Surgeons of England. 2006 Jan;88(1):27-32.

38) Bhat S. SRB's Manual of Surgery.5th ed.New Dehli: JP Medical Ltd; 2016: p 942-3.

39) Alvarado A. A practical score for the early diagnosis of acute appendicitis. Annals of emergency medicine. 1986 May 1;15(5):557-64.

40) Brooks DW, Killen DA. Roentgenographic findings in acute appendicitis. Surgery. 1965 Mar 1;57(3):377-84.

41) Rao PM, Rhea JT, Rao JA, Conn AK. Plain abdominal radiography in clinically suspected appendicitis: diagnostic yield, resource use, and comparison with CT. The American journal of emergency medicine. 1999 Jul 1;17(4):325-8.

42) Mostbeck G, Adam EJ, Nielsen MB, Claudon M, Clevert D, Nicolau C, Nyhsen C, Owens CM. How to diagnose acute appendicitis: ultrasound first. Insights into imaging. 2016 Apr 1;7(2):255-63.

43) Pinto F, Pinto A, Russo A, Coppolino F, Bracale R, Fonio P, Macarini L, Giganti M. Accuracy of ultrasonography in the diagnosis of acute appendicitis in adult patients: review of the literature. Critical ultrasound journal. 2013 Dec;5(1):S2.p 1-2.

44) Lane MJ, Liu DM, Huynh MD, Jeffrey Jr RB, Mindelzun RE, Katz DS. Suspected acute appendicitis: nonenhanced helical CT in 300 consecutive patients. Radiology. 1999 Nov;213(2):341-6.

45) Spirtos NM, Eisenkop SM, Spirtos TW, Poliakin RI, Hibbard LT. Laparoscopy—a diagnostic aid in cases of suspected appendicitis: its use in women of reproductive age. American journal of obstetrics and gynecology. 1987 Jan 1;156(1):90-4.

46) Sung T, Callahan MJ, Taylor GA. Clinical and imaging mimickers of acute appendicitis in the pediatric population. American Journal of Roentgenology. 2006 Jan;186(1):67-74.

47) Martin RF. Acute appendicitis in adults: Clinical manifestations and differential diagnosis. Editado por Martin Weiser. Up to date. 2014 Jul 12: 6-8.

48) Flum DR, Morris A, Koepsell T, Dellinger EP. Has misdiagnosis of appendicitis decreased over time?: a population-based analysis. Jama. 2001 Oct 10;286(14):1748-53.

49) Lamps LW.Appendix. In: Goldblum JR, Lamps LW, McKenney JK, Myers JL. Rosai and Ackerman's Surgical Pathology. 11th Ed. Elsevier; 2018: p.617-23.

50) Butler C. Surgical pathology of acute appendicitis. Human pathology. 1981 Oct 1;12(10):870-8.

51) Pinto Leite N, Pereira JM, Cunha R, Pinto P, Sirlin C. CT evaluation of appendicitis and its complications: imaging techniques and key diagnostic findings. American Journal of Roentgenology. 2005 Aug;185(2):406-17.

52) Arshad M, Aziz LA, Qasim M, Talpur KA. Early appendicectomy in appendicular mass–a Liaquat University Hospital experience. J Ayub Med Coll Abbottabad. 2008;20(1):70-2.

53) Tocantins LM. Historical notes on blood platelets. Blood. 1948 Oct 1;3(10):1073-82.

54) Italiano J, Gresele P, Fuster V, Lopez JA. The structure and production of blood platelets. Platelets in Hematolojic and Cardiovasculer Disorders. eBook. Chambridge University. 2008;1:1-21.

55) Spencer FA, Becker RC. Platelets: structure, function, and their fundamental contribution to hemostasis and pathologic thrombosis. InTextbook of coronary thrombosis and thrombolysis. Springer, Boston, MA: 1997. p. 31-49.

56) Gresele P, Page CP, Fuster V, Vermylen J. Platelets in Thrombotic and Non-Thrombotic Disorders: pathophysiology, pharmacology and therapeutics. Journal of Thrombosis and Haemostasis. 2003 Mar;1(3):613-4.

57) Singh T. Text book of hematology.4th edition. Delhi: Avichal publishing company: 2018. P 22-73.

58) Weis HJ.Platelet physiology and abnormalities of platelet function.N Engl J Med 1975;293:531-539.

59) Mekaj YH. The roles of platelets in inflammation, immunity, wound healing and malignancy. Int J Clin Exp Med. 2016 Jan 1;9(3):5347-58.

60) Fujimoto K. Principles of measurement in hematology analyzers manufactured by Sysmex Corporation. Sysmex Journal International. 1999;9(1; SEAS SUM):31-44.

61) Kaito K, Otsubo H, Usui N, Yoshida M, Tanno J, Kurihara E, Matsumoto K, Hirata R, Domitsu K, Kobayashi M. Platelet size deviation width, platelet large cell ratio, and mean platelet volume have sufficient sensitivity and specificity in the diagnosis of immune thrombocytopenia. British journal of haematology. 2005 Mar;128(5):698-702.

62) Corash L, Chen HY, Levin J, Baker G, Lu H, Mok Y. Regulation of thrombopoiesis: effects of the degree of thrombocytopenia on megakaryocyte ploidy and platelet volume. Blood. 1987 Jul 1;70(1):177-85.

63) Osselaer JC, Jamart J, Scheiff JM. Platelet distribution width for differential diagnosis of thrombocytosis. Clinical Chemistry. 1997 Jun 1;43(6):1072-6.

64) Kim KY, Kim KE, Kim KH. Mean platelet volume in the normal state and in various clinical disorders. Yonsei medical journal. 1986 Sep 1;27(3):219-26.

65) Manchanda J, Potekar RM, Badiger S, Tiwari A. The study of platelet indices in acute coronary syndromes. Annals of pathology and laboratory medicine. 2015 Jan 30;2(1): p 30-5.

66) Shilpi K, Potekar RM. A study of platelet indices in type 2 diabetes mellitus patients. Indian Journal of Hematology and Blood Transfusion. 2018 Jan 1;34(1):115-20.

67) Shuba N, Praba V, Prithiviraaj P. Association of platelet indices with disease activity in rheumatoid arthritis. Journal of Evolution of Medical and Dental Sciences. 2018 Sep 3;7(36):3940-6

68) Gasparyan AY, Ayvazyan L, Mikhailidis DP, et al. Mean platelet volume: a link between thrombosis and inflammation?Curr Pharm Des. 2011;17(1):47–58.

69) Danese S, Motte Cd Cde L, Fiocchi C. Platelets in inflammatory bowel disease: clinical, pathogenic, and therapeutic implications. *Am J Gastroenterol*. 2004; 99:938–45.

70) Öztürk ZA, Dag MS, Kuyumcu ME, Cam H, Yesil Y, Yilmaz N, Aydinli M, Kadayifci A, Kepekci Y. Could platelet indices be new biomarkers for inflammatory bowel diseases. Eur Rev Med Pharmacol Sci. 2013 Feb 1;17(3):334-41.

71) Zhang X, Niu Y, Wang X, Liu ZP, Liu T, Wang RT. Mean platelet volume and platelet distribution width are associated with gallbladder cancer. Asian Pacific journal of cancer prevention: APJCP. 2018;19(2):351.

72) Aksoy S, Kilickap S, Hayran M, Harputluoglu H, Koca E, Dede DS, Erman M, Turker A. Platelet size has diagnostic predictive value for bone marrow metastasis in patients with solid tumors. International journal of laboratory hematology. 2008 Jun;30(3):214-9.

73) Narci H, Turk E, Karagulle E, Togan T, Karabulut K. The role of mean platelet volume in the diagnosis of acute appendicitis: a retrospective case-controlled study. Iranian Red Crescent Medical Journal. 2013 Dec;15(12):1-4.

74) Kucuk E, Kucuk I. Mean platelet volume is reduced in acute appendicitis. Turkish journal of emergency medicine. 2015 Mar 1;15(1):23-7.

75) Erdem H, Aktimur R, Cetinkunar S, Reyhan E, Gokler C, Irkorucu O, Sozen S. Evaluation of mean platelet volume as a diagnostic biomarker in acute appendicitis. International journal of clinical and experimental medicine. 2015;8(1):1291.

76) Aydogan A, Akkucuk S, Arica S, Motor S, Karakus A, Ozkan OV, Yetim I, Temiz M. The analysis of mean platelet volume and platelet distribution width levels in appendicitis. Indian Journal of Surgery. 2015 Dec 1;77(2):495-500.

77) Albayrak Y, Albayrak A, Albayrak F, Yildirim R, Aylu B, Uyanik A, Kabalar E, Güzel IC. Mean platelet volume: a new predictor in confirming acute appendicitis diagnosis. Clinical and Applied Thrombosis/Hemostasis. 2011 Aug;17(4):362-6.

78) Aktimur R, Cetinkunar S, Yildirim K, Ozdas S, Aktimur SH, Gokakin AK. Mean platelet volume is a significant biomarker in the differential diagnosis of acute appendicitis. Inflammation and Cell Signaling. 2015 Aug 11;2(2):1-4.

79) Dinc B, Oskay A, Dinc SE, Bas B, Tekin S. New parameter in diagnosis of acute appendicitis: platelet distribution width. World Journal of Gastroenterology: WJG. 2015 Feb 14;21(6):1821.

80) Boshnak N, Boshnaq M, Elgohary H. Evaluation of platelet indices and red cell distribution width as new biomarkers for the diagnosis of acute appendicitis. Journal of Investigative Surgery. 2018 Mar 4;31(2):121-9.

81) Vagdatli E, Gounari E, Lazaridou E, Katsibourlia E, Tsikopoulou F, Labrianou I. Platelet distribution width: a simple, practical and specific marker of activation of coagulation. Hippokratia. 2010 Jan;14(1):28-9.

82) Jain R, Jain V, Jolly S. Alvarado Score: still relevant in diagnosis of acute appendicitis: a prospective study with histopathological correlation. International Surgery Journal. 2017 Jun 22;4(7):2123-30.

83) Memon ZA, Irfan S, Fatima K, Iqbal MS, Sami W. Acute appendicitis: diagnostic accuracy of Alvarado scoring system. Asian journal of surgery. 2013 Oct 1;36(4):144-9.

84) Kostakis ID, Machairas N, Damaskos C, Doula C, Tsaparas P, Charalampoudis P, Spartalis E, Sotiropoulos GC, Kouraklis G. Platelet indices and neutrophil to lymphocyte ratio in adults with acute appendicitis. South African Journal of Surgery. 2016;54(1):29-4.

85) Madani SH, Tarlan M, Mozafari H, Khazaei S, Shaveisi-Zadeh F, Mozafari S. Role of platelet parameters as a biomarker in diagnosis of acute appendicitis: A retrospective case–controlled study. Journal of Acute Disease. 2019 Jul 1;8(4):153-9.

86) Mehmet Ü, Ertuğrul K, Murat O, Veysi BM, Cahfer G. The role of neutrophils/lymphocyte ratio, platelet/lymphocyte ratio and platelet distribution width values in acute appendicitis diseases. Biomedical Research. 2017 Jan 1;28(17):7514-8.

87) Ulukent SC, Sarici IS, Ulutas KT. All CBC parameters in diagnosis of acute appendicitis. International journal of clinical and experimental medicine. 2016 Jan 1;9(6):11871-6.

88) Zahorec R. Ratio of neutrophil to lymphocyte counts-rapid and simple parameter of systemic inflammation and stress in critically ill. Bratislavske lekarske listy. 2001 Feb;102(1):5-14.

89) Kaykisiz EK, Akyol PY, Karakaya Z, Payza U, Topal FE. Neutrophil/lymphocyte ratio is a valuable data to reduce negative laporotomy rates in emergency department. Biomedical Research. 2017;28(19):8438-2.

# ANNEXURES

## ANNEXURES-I

**B.L.D.E. (Deemed to be University) SHRI B.M.PATIL MEDICAL COLLEGE HOSPITAL AND RESEARCH CENTER, BIJAPUR-586103**

### RESEARCH INFORMED CONSENT FORM

**TITLE OF THE PROJECT:** STUDY OF PLATELET INDICES IN CLINICALLY DIAGNOSED ACUTE APPENDICITIS USING THE ALVARADO SCORE.

**PRINCIPAL INVESTIGATOR:**

**P.G.GUIDE**

**P.G.CO-GUIDE:**

**RISK AND DISCOMFORTS:**

I understand that, there are risks involved in the procedures performed like continued pain at the procedure site, infection.

**BENEFITS:**

I understand that my participation in the study will help to know the diagnosis of acute appendicitis.

**CONFIDENTIALITY:**

I understand that the medical information produced by the study will become a part of hospital record and will be subjected to confidentiality and privacy regulations of the hospital. If the data is used for publications the identity of patient will not be revealed.

**REQUEST FOR MORE INFORMATION:**

I understand that I may ask more questions about the study at any time **_____,**The Department of Pathology is available to answer my questions or concerns.

**REFUSAL FOR WITHDRAWAL OF PARTICIPATION:**

I understand that my participation is voluntary and that I may refuse to participate or may withdraw from the study at any time. I also understand that **_____**may terminate my participation in the study after she has explained the reason for doing so.

**INJURY STATEMENT:**

I understand that in the unlikely event of injury to me during the study I will get medical treatment but no further compensations.

After understanding the nature of dissertation or research, diagnosis made, mode of treatment, I the undersigned Shri/Smt _____ under my full conscious state of mind agree to participate in the said research/dissertation.

Signature of patient:

Signature of doctor:

Witness: 1.

2.

Date:

Place:

## ANNEXURES-II

## PROFORMA FOR THE STUDY

NAME**:** OP/IP No. **:**

AGE**:**

SEX **:** D.O.A **:**

OCCUPATION**:** D.O.D **:**

RESIDENCE**:**

**Presenting complaints :**

**Past history:**

**Family history :**

**Treatment history :**

**General physical examination:**

Built:WELL/MODERATE/POOR Nourishment: WELL/MODERATE/POOR

Cyanosis-Present/Absent Lymphadenopathy-Present/Absent

Pallor-Present/Absent Clubbing-Present/Absent

Icterus-Present/Absent Edema-Present/Absent

**VITALS:** PR: RR:

BP: TEMPERATURE: WEIGHT:

**SYSTEMIC EXAMINATION:**

Cardiovascular system

Respiratory system:

Central nervous system:

Per Abdomen:

**Clinical Diagnosis:**

**ALVARADO'S SCORE:**

**Total Score=**

| **Symptoms** | **Score** | **Signs** | **Score** | **Laboratory** | **Score** |
|---|---|---|---|---|---|
| **M**igratory RIF pain (1) | | **T**endernessin RIF (2) | | **L**eukocytosis (2) | |
| **A**norexia(1) | | **R**ebound tenderness(1) | | **S**hift to left(1) | |
| **N**ausea and vomiting(1) | | **E**levated temperature(1) | | | |

**Haematological investigations:**

| **Parameters** | |
|---|---|
| Total leucocyte count (cells/cmm) | |
| Neutrophil(%) | |
| Lymphocyte(%) | |
| Platelet count (lakh/cmm) | |
| MPV (fl) | |
| PDW (fl) | |
| PCT (%) | |
| P-LCR(%) | |

**HISTOPATHOLOGICAL DIAGNOSIS-**

## KEY TO MASTER CHART

| | |
|---|---|
| **M** | **Male** |
| **F** | **Female** |
| **TLC** | **Total Leucocyte Count** |
| **N%** | **Neutrophil Percentage** |
| **L%** | **Lymphocyte Percentage** |
| **PLT** | **Platelet Count** |
| **MPV** | **Mean Platelet Volume** |
| **PDW** | **Platelet Distribution width** |
| **PCT** | **Plateletcrit** |
| **P-LCR** | **Platelet Large Cell Ratio** |
| **AS** | **The Alvarado Score** |
| **HPR** | **Histopathology report** |
| **AA** | **Acute Appendicitis** |
| **CA** | **Chronic Appendicitis** |

## MASTERCHART

## CASES

| Sl.no | IP no | Name | Age (yrs) | Sex | TLC /cmm | N% | L% | MPV (fl) | PDW (fl) | PCT (%) | P-LCR (%) | PLT /cmm | AS | HPR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 42999/17 | Hiragappa | 25 | M | 11000 | 63.9 | 29.6 | 10.1 | 12.5 | 0.17 | 26.9 | 1.66 | 7 | AA |
| 2 | 43281/17 | Sandeep | 28 | M | 14570 | 91.9 | 4.3 | 10.6 | 12.6 | 0.25 | 30.2 | 2.38 | 8 | AA |
| 3 | 44546/17 | Archana | 19 | F | 15680 | 88.3 | 9.4 | 11.8 | 14.9 | 0.39 | 39.5 | 3.3 | 8 | AA |
| 4 | 1212/18 | Laxmi | 35 | F | 18750 | 96.1 | 1.9 | 11 | 14.2 | 0.26 | 33.3 | 2.34 | 7 | AA |
| 5 | 1416/18 | Siddalingayya | 42 | M | 10900 | 80 | 17 | 5.4 | 17.8 | 0.1 | 33.4 | 1.85 | 6 | AA |
| 6 | 2739/18 | Sampat kumar | 22 | M | 5520 | 56 | 35 | 8.7 | 8.7 | 0.2 | 14.1 | 2.29 | 7 | AA |
| 7 | 3347/18 | Lalitha | 28 | F | 13090 | 80.4 | 16.4 | 9.7 | 10.5 | 0.2 | 22.2 | 2.04 | 8 | AA |
| 8 | 4520/18 | Ujawala | 22 | F | 17580 | 90.7 | 7.5 | 10 | 11.3 | 0.36 | 25.3 | 3.56 | 9 | AA |
| 9 | 5187/18 | Yamanappa | 45 | M | 19010 | 90.3 | 4.7 | 10 | 11.4 | 0.3 | 26.1 | 2.99 | 8 | AA |
| 10 | 5431/18 | Arun | 24 | M | 21920 | 86.5 | 6.1 | 10.7 | 12.9 | 0.32 | 31.3 | 2.95 | 8 | AA |
| 11 | 6160/18 | Lakan | 23 | M | 12030 | 88.7 | 5.9 | 9.8 | 10.7 | 0.34 | 23.1 | 3.45 | 7 | AA |
| 12 | 6220/18 | Annapurna | 50 | F | 16670 | 82.4 | 9.2 | 9.1 | 9 | 0.38 | 17.5 | 4.12 | 9 | AA |
| 13 | 6932/18 | Ashok | 21 | M | 19020 | 82.5 | 13.7 | 9.4 | 9.9 | 0.36 | 19.3 | 3.77 | 8 | AA |
| 14 | 7867/18 | Rishi | 19 | M | 12360 | 88.8 | 9.6 | 9.2 | 10.3 | 0.23 | 18.9 | 2.5 | 9 | AA |
| 15 | 9960/18 | Manjunath | 16 | M | 6910 | 79.9 | 15.1 | 9.5 | 8.6 | 0.18 | 17.9 | 1.83 | 7 | AA |
| 16 | 10290/18 | Mohan | 27 | M | 9700 | 55 | 40 | 7.9 | 12.5 | 0.26 | 21.3 | 3.31 | 7 | AA |
| 17 | 10509/18 | Mallapppa | 26 | M | 10740 | 82.7 | 13.5 | 8.7 | 8.6 | 0.24 | 14 | 2.77 | 7 | AA |
| 18 | 10732/18 | Jakirhuseni | 22 | M | 16540 | 87.8 | 9 | 9.1 | 9 | 0.28 | 16.9 | 3.06 | 7 | AA |
| 19 | 10803/18 | Ankita | 16 | F | 14990 | 74.2 | 21.3 | 9.3 | 9.6 | 0.26 | 18.3 | 2.82 | 9 | AA |
| 20 | 11190/18 | Anand | 16 | M | 11310 | 77.9 | 17.2 | 9.5 | 9.7 | 0.22 | 20.2 | 2.31 | 7 | AA |
| 21 | 12224/18 | Revansidda | 21 | M | 16070 | 86.6 | 10.1 | 8.5 | 8 | 0.23 | 11.6 | 2.7 | 8 | AA |
| 22 | 13770/18 | Bhimanna | 45 | M | 18160 | 85.3 | 11.9 | 11 | 16.3 | 0.26 | 35.6 | 2.41 | 9 | AA |
| 23 | 14211/18 | Aspaq | 35 | M | 7860 | 58.9 | 30.8 | 10.2 | 11 | 0.18 | 24.7 | 1.76 | 6 | AA |
| 24 | 14614/18 | Malappa | 28 | M | 7560 | 82.4 | 11.6 | 9.6 | 9.5 | 0.17 | 19.8 | 1.74 | 7 | AA |
| 25 | 14629/18 | Pomu | 45 | M | 19328 | 82.2 | 9.1 | 8.7 | 8.2 | 0.2 | 13 | 2.33 | 8 | AA |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 26 | 16749/18 | Arvind | 15 | M | 15470 | 87.7 | 8.1 | 10.3 | 10.5 | 0.29 | 25.8 | 2.81 | 7 | AA |
| 27 | 19668/18 | Saipansab | 18 | M | 22810 | 86.3 | 8.8 | 8.6 | 8.6 | 0.25 | 14.2 | 2.92 | 8 | AA |
| 28 | 21576/18 | Dilip | 20 | M | 9880 | 60.4 | 32.9 | 9.7 | 11.1 | 0.23 | 23.3 | 2.38 | 6 | AA |
| 29 | 21748/18 | Sangamma | 50 | F | 12320 | 87.9 | 8 | 10.2 | 11.5 | 0.23 | 25.8 | 2.28 | 8 | AA |
| 30 | 22451/18 | Devendra | 37 | M | 8880 | 68.1 | 26 | 11.3 | 13.9 | 0.22 | 34.4 | 1.94 | 7 | AA |
| 31 | 23302/18 | Madiwalawwa | 50 | F | 9580 | 51.1 | 40.9 | 10.4 | 11.7 | 0.32 | 27.9 | 3.06 | 6 | AA |
| 32 | 23729/18 | Guruprasad | 25 | M | 9500 | 61 | 34 | 7.7 | 12.8 | 0.25 | 26.3 | 3.26 | 6 | AA |
| 33 | 26250/18 | Vidhya | 18 | F | 15520 | 85.1 | 10.7 | 9.8 | 9.4 | 0.34 | 21.5 | 3.51 | 9 | AA |
| 34 | 26842/18 | Shrikant | 39 | M | 8500 | 62 | 34 | 8.4 | 11.9 | 0.22 | 23.6 | 2.61 | 6 | AA |
| 35 | 27249/18 | Vikas | 17 | M | 11940 | 90.6 | 6.9 | 9.5 | 9.9 | 0.28 | 20.2 | 2.96 | 8 | AA |
| 36 | 27292/18 | Gayatri | 19 | F | 14290 | 89.5 | 7.9 | 8.7 | 10.3 | 0.29 | 17.3 | 3.32 | 9 | AA |
| 37 | 27919/18 | Nagesh | 30 | M | 14060 | 77.6 | 18.6 | 10.5 | 10 | 0.18 | 26.6 | 1.71 | 7 | AA |
| 38 | 28147/18 | Deepak | 16 | M | 11040 | 83.9 | 10.5 | 10.5 | 12.6 | 0.18 | 30 | 1.71 | 8 | AA |
| 39 | 29328/18 | Vijayalaxmi | 38 | F | 11440 | 63.3 | 30.6 | 10.1 | 11.2 | 0.37 | 24.9 | 3.69 | 7 | AA |
| 40 | 29623/18 | Priyanka | 25 | F | 9450 | 90.4 | 6.2 | 9.8 | 10.8 | 0.2 | 23.1 | 2.07 | 6 | AA |
| 41 | 29883/18 | Suvarna | 17 | F | 14140 | 79.7 | 15 | 9.2 | 9.7 | 0.27 | 18.6 | 2.95 | 8 | AA |
| 42 | 30461/18 | Mahboobi | 38 | F | 6970 | 62.1 | 32.1 | 10.2 | 11.5 | 0.32 | 26.3 | 3.14 | 6 | AA |
| 43 | 28714/18 | Andenappa | 42 | M | 14890 | 93.4 | 5.8 | 10.6 | 18.2 | 0.18 | 29.7 | 1.7 | 8 | AA |
| 44 | 30621/18 | Suresh | 25 | M | 9790 | 65.5 | 28.1 | 9.2 | 9.6 | 0.3 | 17.3 | 3.26 | 7 | AA |
| 45 | 31414/18 | Anita | 19 | F | 12000 | 84.7 | 11 | 9.4 | 9 | 0.29 | 17.8 | 3.09 | 8 | AA |
| 46 | 32756/18 | Mahadev | 50 | M | 15900 | 84.5 | 13 | 10.8 | 12.1 | 0.22 | 23.5 | 5.53 | 8 | AA |
| 47 | 33111/18 | Siddu | 35 | M | 11920 | 81.3 | 15.2 | 8.5 | 7.7 | 0.16 | 14.7 | 1.88 | 8 | AA |
| 48 | 34012/18 | Shreepada | 28 | M | 12700 | 65 | 30 | 7.1 | 12.9 | 0.26 | 28.3 | 3.67 | 9 | AA |
| 49 | 34177/18 | Divya | 33 | F | 10200 | 65 | 31 | 8.7 | 10.6 | 0.23 | 27.2 | 2.63 | 6 | AA |
| 50 | 34300/18 | Arvind | 25 | M | 13000 | 81.9 | 11.5 | 6.5 | 14.9 | 0.31 | 39.4 | 4.74 | 9 | AA |
| 51 | 34416/18 | Amasidda | 45 | M | 11900 | 90 | 6.8 | 10.4 | 11.5 | 0.25 | 27.4 | 2.3 | 8 | AA |
| 52 | 35935/18 | Girijamma | 40 | F | 7840 | 92.8 | 5.7 | 10 | 11.5 | 0.18 | 26 | 1.81 | 7 | AA |
| 53 | 38916/18 | Vinod | 25 | M | 9700 | 64.3 | 31.6 | 7.4 | 12.4 | 0.26 | 28.5 | 3.48 | 7 | AA |
| 54 | 38997/18 | Roopa | 33 | F | 11200 | 68.6 | 25.8 | 8.5 | 10.4 | 0.23 | 21.2 | 2.7 | 7 | AA |
| 55 | 39258/18 | Sangeeta | 27 | F | 10360 | 76.9 | 17.8 | 10.2 | 11.5 | 0.27 | 25.7 | 2.62 | 7 | AA |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 56 | 39381/18 | Kavita | 35 | F | 19130 | 89.5 | 8.6 | 11 | 13.1 | 0.31 | 32.2 | 2.8 | 8 | AA |
| 57 | 39375/18 | Bharat | 42 | M | 10220 | 90.1 | 7.1 | 11.9 | 17.2 | 0.22 | 39.8 | 1.82 | 7 | AA |
| 58 | 39691/18 | Savilsab | 16 | M | 11800 | 46.9 | 45.7 | 10.3 | 11.7 | 0.43 | 29.2 | 4.17 | 7 | AA |
| 59 | 39883/18 | Devamma | 46 | F | 11400 | 52.7 | 38.3 | 7.3 | 12.7 | 0.18 | 17.2 | 2.45 | 8 | AA |
| 60 | 39936/18 | Annamma | 37 | F | 8080 | 60.3 | 30.2 | 10.9 | 12.7 | 0.19 | 31.2 | 1.78 | 6 | AA |
| 61 | 39992/18 | Raut jogi | 21 | M | 17440 | 85.4 | 9.3 | 10 | 11 | 0.28 | 23.8 | 2.82 | 8 | AA |
| 62 | 40264/18 | Rajak | 34 | M | 12390 | 73 | 22.1 | 9.8 | 10.5 | 0.23 | 22.7 | 2.34 | 9 | AA |
| 63 | 40675/18 | Praveen | 40 | M | 8700 | 61.8 | 30.4 | 9.3 | 12.6 | 0.25 | 24.6 | 2.48 | 6 | AA |
| 64 | 40791/18 | Shivleela | 24 | F | 10960 | 81.7 | 12.7 | 10.7 | 13.3 | 0.27 | 31.1 | 2.48 | 6 | AA |
| 65 | 40862/18 | Shantabai | 52 | F | 17190 | 82.5 | 14.2 | 12.5 | 15.9 | 0.52 | 41.1 | 4.18 | 8 | AA |
| 66 | 41997/18 | Kavita | 45 | F | 12910 | 92.5 | 5.3 | 9.6 | 11.5 | 0.28 | 23.8 | 2.94 | 8 | AA |
| 67 | 42450/18 | Bhimashankar | 23 | M | 13620 | 89.3 | 8.4 | 11.5 | 14.3 | 0.22 | 36.1 | 1.87 | 9 | AA |
| 68 | 42661/18 | Shankarramma | 42 | F | 16320 | 58.9 | 36.4 | 10.4 | 11.2 | 0.3 | 27.7 | 2.84 | 9 | AA |
| 69 | 42822/18 | Sahil | 17 | M | 7300 | 63.8 | 31.4 | 6.3 | 10.5 | 0.18 | 21.2 | 2.84 | 6 | AA |
| 70 | 43601/18 | Shailesh | 22 | M | 11400 | 58.7 | 36.3 | 9.2 | 12.8 | 0.23 | 21.2 | 4.4 | 7 | AA |
| 71 | 44072/18 | Basavraj | 23 | M | 10130 | 46.6 | 45.7 | 10.7 | 12.7 | 0.3 | 31.4 | 4.61 | 6 | AA |
| 72 | 3702/19 | Sanjivayya | 42 | M | 18500 | 89.7 | 6.1 | 10 | 11.7 | 0.24 | 25.1 | 2.39 | 8 | AA |
| 73 | 7160/19 | Mahantesh | 19 | M | 7580 | 77.9 | 16.2 | 9.4 | 9.2 | 0.21 | 19.7 | 2.2 | 6 | AA |
| 74 | 8147/19 | Sahebgouda | 19 | M | 8820 | 53 | 39.2 | 10.9 | 11.8 | 0.37 | 31.7 | 3.41 | 7 | AA |
| 75 | 8520/19 | Somavva | 35 | F | 8180 | 82.5 | 13.4 | 9.7 | 11.1 | 0.17 | 22.4 | 1.75 | 6 | AA |
| 76 | 8773/19 | Ramaling | 55 | M | 13320 | 86 | 7.7 | 10.7 | 13.3 | 0.16 | 30.4 | 1.5 | 8 | AA |
| 77 | 10895/19 | Adiraj | 54 | M | 8550 | 91.2 | 5.4 | 9.4 | 10.1 | 0.18 | 20.8 | 1.85 | 6 | AA |
| 78 | 12109/19 | Ramesh | 35 | M | 11600 | 86.1 | 10.8 | 9.4 | 10.6 | 0.27 | 20.2 | 2.86 | 8 | AA |
| 79 | 13687/19 | Shankar | 43 | M | 20870 | 81.3 | 13 | 9.3 | 9.9 | 0.3 | 18.6 | 3.2 | 9 | AA |
| 80 | 13774/19 | Shashappa | 54 | M | 22710 | 88.3 | 7.7 | 9.5 | 9.8 | 0.33 | 20.3 | 3.47 | 9 | AA |
| 81 | 16769/19 | Basavraj | 52 | M | 11070 | 57.2 | 29.2 | 9.7 | 9.8 | 0.27 | 21.9 | 2.78 | 7 | AA |
| 82 | 17585/19 | Gurusiddappa | 27 | M | 10880 | 85 | 10.5 | 9.6 | 9.9 | 0.32 | 20.5 | 3.3 | 6 | AA |
| 83 | 19491/19 | Vinod | 31 | M | 9090 | 90.6 | 5.6 | 10.6 | 12.4 | 0.2 | 29.9 | 1.91 | 7 | AA |
| 84 | 15657/19 | Muregeshi | 35 | M | 4560 | 87 | 5.3 | 11.4 | 14.8 | 0.34 | 34 | 1.22 | 8 | AA |
| 85 | 632/18 | Praveen | 25 | M | 11390 | 79.9 | 14.2 | 9.7 | 10 | 0.3 | 22.3 | 3.05 | 7 | CA |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 86 | 2509/18 | Mahadevi | 34 | F | 10820 | 85.1 | 28.8 | 9.3 | 9.9 | 0.3 | 19.6 | 3.22 | 7 | CA |
| 87 | 4864/18 | Mutappa | 18 | M | 8140 | 49 | 36.7 | 9.4 | 9.7 | 0.22 | 20.3 | 2.35 | 6 | CA |
| 88 | 6503/18 | Mallikarjun | 20 | M | 8750 | 50.9 | 38.7 | 9.7 | 10.6 | 0.25 | 22.2 | 2.53 | 6 | CA |
| 89 | 8444/18 | Pooja godse | 16 | F | 14740 | 67.9 | 28 | 9.3 | 9.8 | 0.3 | 18.6 | 3.2 | 8 | CA |
| 90 | 14789/18 | Maharay | 24 | M | 8000 | 53 | 37.8 | 8.9 | 8.8 | 0.29 | 15.9 | 3.2 | 6 | CA |
| 91 | 15702/18 | Sadashiv | 19 | M | 17560 | 65 | 25.7 | 9 | 9.9 | 0.4 | 17.6 | 4.46 | 7 | CA |
| 92 | 15705/18 | Bhagirathi | 20 | F | 11870 | 81.2 | 11.3 | 8.3 | 8 | 0.25 | 11.8 | 2.96 | 8 | CA |
| 93 | 24778/18 | Sidramappa | 58 | M | 10320 | 67 | 18.6 | 11.4 | 13.8 | 0.22 | 35.9 | 1.9 | 5 | CA |
| 94 | 27086/18 | Moonesh | 43 | M | 8100 | 55.2 | 40 | 8.2 | 10.4 | 0.19 | 14.6 | 2.23 | 6 | CA |
| 95 | 28115/18 | Shivaji | 30 | M | 9820 | 47.6 | 23 | 9.9 | 11.5 | 0.25 | 24.1 | 2.52 | 6 | CA |
| 96 | 30375/18 | Najmeen | 16 | F | 9010 | 51.5 | 41.2 | 10.2 | 11.4 | 0.4 | 26.1 | 3.92 | 7 | CA |
| 97 | 41225/18 | Veeresh | 36 | M | 9800 | 61.8 | 35.2 | 9.3 | 12.8 | 0.25 | 25.3 | 3.25 | 6 | CA |
| 98 | 41317/18 | Manjula | 30 | F | 8100 | 68.6 | 25.8 | 8.8 | 13.7 | 0.29 | 13.2 | 2.95 | 6 | CA |
| 99 | 42285/18 | Pratap | 25 | M | 9700 | 71.6 | 26.4 | 9.3 | 12.8 | 0.23 | 25.6 | 3.48 | 7 | CA |
| 100 | 42103/18 | Manohar | 41 | M | 6800 | 58.7 | 37.3 | 10 | 10.5 | 0.29 | 21.3 | 2.89 | 6 | CA |
| 101 | 43650/18 | Chandsab | 68 | M | 6400 | 53.2 | 39.8 | 7.8 | 10.6 | 0.23 | 21.2 | 2.23 | 7 | CA |
| 102 | 12028/19 | Basu | 26 | M | 6800 | 55.2 | 40.8 | 8.9 | 12.7 | 0.23 | 17.2 | 2.3 | 7 | CA |

## CONTROLS

| Sl.No | OP no | Name | Age (yrs) | Sex | TLC /cmm | N% | L% | PLT /cmm | MPV (fl) | PDW (fl) | PCT (%) | P-LCR (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 17923/19 | Khandu | 25 | M | 11000 | 67.2 | 23.2 | 3.16 | 9.8 | 10.4 | 0.31 | 23.3 |
| 2 | 16956/19 | Carlos | 28 | M | 5490 | 55.2 | 37.2 | 2.04 | 10.3 | 12.6 | 0.21 | 28.2 |
| 3 | 110858//18 | Gurubai | 19 | F | 6090 | 64.2 | 20.2 | 1.88 | 9.5 | 9.7 | 0.18 | 21.4 |
| 4 | 43886/18 | D M Rajput | 35 | F | 8630 | 60.8 | 30.7 | 2.99 | 10.3 | 12.3 | 0.31 | 26.9 |
| 5 | 47380/18 | Gurulingappa | 42 | M | 10070 | 56.7 | 33.5 | 2.54 | 9 | 10 | 0.23 | 19.1 |
| 6 | 110705/18 | Mohsin | 22 | M | 9280 | 63.3 | 29.1 | 3.14 | 10.1 | 10.9 | 0.32 | 25.2 |
| 7 | 152120/19 | Chanchaladevi | 28 | F | 9910 | 58.5 | 32.8 | 3.15 | 10.1 | 11.7 | 0.32 | 25.8 |
| 8 | 110260/18 | Sushmita | 22 | F | 8120 | 62.7 | 31.9 | 2.8 | 8.6 | 8.5 | 0.24 | 13.4 |
| 9 | 45861/18 | Babu | 45 | M | 5840 | 51.6 | 38.7 | 2.2 | 10 | 10 | 0.22 | 23.1 |
| 10 | 16953/19 | Alexandre Rey | 24 | M | 7750 | 61.8 | 31.1 | 1.93 | 10 | 12.1 | 0.19 | 25.9 |
| 11 | 44825/18 | Abuzar | 23 | M | 10360 | 65.4 | 26.6 | 3.22 | 9 | 10.1 | 0.29 | 26.2 |
| 12 | 45452/18 | Bebibai | 50 | F | 5980 | 59.1 | 34.6 | 2.38 | 10.1 | 11.1 | 0.24 | 25.6 |
| 13 | 30065/19 | Parashuram | 21 | M | 6450 | 55.6 | 37.4 | 2.1 | 10 | 11.8 | 0.21 | 25.8 |
| 14 | 44624/18 | Basavraj | 19 | M | 7430 | 54.2 | 40.4 | 2.41 | 10.3 | 12 | 0.25 | 27.3 |
| 15 | 20004/19 | Abajit | 16 | M | 9130 | 63.8 | 26.3 | 2.38 | 10.6 | 12.1 | 0.25 | 29.1 |
| 16 | 110813/18 | F J Sabaragi | 27 | M | 6510 | 55.5 | 36.1 | 2.66 | 9.6 | 10.4 | 0.26 | 22.5 |
| 17 | 120269/18 | Yakub | 26 | M | 6900 | 64 | 29.1 | 2.2 | 9 | 10 | 0.2 | 18.4 |
| 18 | 150943/19 | Mohsin | 21 | M | 5670 | 52.4 | 39.5 | 2.13 | 9.9 | 10.7 | 0.21 | 22.1 |
| 19 | 237019/18 | Kaveri | 16 | F | 7170 | 63.1 | 31 | 2.59 | 10.9 | 12.1 | 0.28 | 31.9 |
| 20 | 41349/18 | Kiran | 16 | M | 10130 | 59.2 | 35.1 | 3.56 | 9.3 | 10.2 | 0.33 | 19.4 |
| 21 | 46095/18 | Sachin | 21 | M | 8550 | 70.8 | 20 | 2.45 | 9 | 9.3 | 0.22 | 16.9 |
| 22 | 24870/18 | Peerappa | 45 | M | 9050 | 63.5 | 28 | 2.51 | 9.3 | 9.1 | 0.23 | 18.5 |
| 23 | 39420/18 | S S Metri | 35 | M | 6210 | 67.8 | 23.2 | 2.57 | 10.3 | 11.8 | 0.26 | 27.2 |
| 24 | 43164/18 | Vinod | 28 | M | 9990 | 54.7 | 34.9 | 2.97 | 9.7 | 10.5 | 0.29 | 22.2 |
| 25 | 112654/18 | Jayasing | 45 | M | 9630 | 68.3 | 21.9 | 2.59 | 9.3 | 10.8 | 0.24 | 20 |
| 26 | 243351/18 | Malingraya | 16 | M | 11000 | 75 | 19.9 | 2.68 | 8.9 | 8.8 | 0.24 | 15.3 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 27 | 26085/19 | Babu Byakod | 18 | M | 11000 | 71.1 | 23.1 | 2.94 | 8.8 | 9.6 | 0.26 | 15.3 |
| 28 | 115014/18 | Shivanand | 20 | M | 8910 | 62.1 | 26.8 | 2.69 | 9 | 10.1 | 0.24 | 16.7 |
| 29 | 110242/18 | Amrumma | 50 | F | 8780 | 54.4 | 34.6 | 1.51 | 9.9 | 10.5 | 0.15 | 23.3 |
| 30 | 16955/19 | Jose Alberto | 34 | M | 9910 | 48.7 | 45 | 2.79 | 10.5 | 13.6 | 0.29 | 30.3 |
| 31 | 40180/18 | Bouramma | 50 | F | 8070 | 64.6 | 27.8 | 1.8 | 10.5 | 11.9 | 0.19 | 27.7 |
| 32 | 17707/19 | Sanganbasu | 25 | M | 8720 | 54 | 40.6 | 2.1 | 10.6 | 12.1 | 0.22 | 29.4 |
| 33 | 46109/18 | Asara | 18 | F | 8740 | 74.6 | 20.1 | 4.45 | 8.8 | 10.2 | 0.32 | 15.5 |
| 34 | 45981/18 | Dadapeer | 39 | M | 10760 | 70.1 | 24.3 | 3.36 | 9.6 | 9.6 | 0.32 | 20 |
| 35 | 29982/19 | Rahutaraya | 17 | M | 10570 | 74.5 | 20.4 | 3.24 | 8.9 | 10.4 | 0.29 | 16.5 |
| 36 | 144655/19 | Lavanya | 19 | F | 9300 | 74.2 | 20.2 | 2.4 | 9.2 | 9.9 | 0.22 | 18.4 |
| 37 | 41939/18 | R S Maled | 30 | M | 6050 | 51.9 | 42.5 | 2.88 | 9.4 | 10 | 0.27 | 19.8 |
| 38 | 29876/19 | Chetan | 16 | M | 9880 | 58.2 | 35.1 | 4.75 | 9.6 | 10.7 | 0.45 | 21.6 |
| 39 | 45227/18 | M M Zingade | 38 | F | 5840 | 54.7 | 37 | 2.54 | 11.5 | 14.9 | 0.29 | 36.5 |
| 40 | 116142/18 | Alekhiya | 25 | F | 6160 | 66.7 | 26.6 | 2.22 | 9 | 8.5 | 0.2 | 16.6 |
| 41 | 15534/19 | Madhu | 17 | F | 9140 | 65.1 | 27.1 | 2.64 | 9.9 | 11.2 | 0.26 | 24.2 |
| 42 | 110205/18 | Jyoti | 38 | F | 8980 | 67.5 | 27.1 | 1.6 | 9.8 | 10.1 | 0.16 | 22.5 |
| 43 | 43910/18 | Jose Javier | 42 | M | 5690 | 60 | 30.6 | 1.77 | 10.7 | 12.5 | 0.19 | 29.5 |
| 44 | 44529/18 | Girish | 25 | M | 7870 | 62 | 27.8 | 3.61 | 8.8 | 9.3 | 0.32 | 15.8 |
| 45 | 241989/18 | Kavita | 19 | F | 9890 | 73.5 | 21.8 | 3.17 | 9.3 | 9.8 | 0.3 | 18.6 |
| 46 | 41444/18 | Ashok | 50 | M | 7850 | 66.3 | 21.7 | 2.6 | 10 | 11 | 0.26 | 24.2 |
| 47 | 110816/18 | S E Jumnal | 35 | M | 9770 | 52.6 | 39.3 | 2.37 | 10.4 | 13.2 | 0.25 | 29.2 |
| 48 | 39387/18 | D Y Walikar | 28 | M | 5690 | 52.3 | 43.1 | 2.8 | 9 | 10 | 0.25 | 18 |
| 49 | 40117/18 | Laxmi | 33 | F | 10040 | 69.7 | 26.2 | 3.49 | 9.4 | 10.1 | 0.33 | 19.8 |
| 50 | 29109/19 | Sanjit | 25 | M | 7710 | 53 | 41.1 | 3.19 | 9.3 | 10.1 | 0.29 | 19.1 |
| 51 | 109584/18 | Rajendra Jain | 45 | M | 10370 | 62.1 | 29.2 | 3.05 | 10.1 | 10.9 | 0.31 | 25.1 |
| 52 | 152136/19 | Neelamma | 40 | F | 9130 | 70.5 | 22.3 | 3.27 | 8.9 | 8.8 | 0.29 | 15.1 |
| 53 | 41936/18 | S H Gunadal | 26 | M | 7770 | 56.3 | 33.8 | 2.52 | 9.5 | 10.3 | 0.24 | 20.8 |
| 54 | 44410/18 | Mahadevi | 33 | F | 8380 | 66.7 | 26.7 | 3.21 | 8.9 | 10 | 0.29 | 15.9 |
| 55 | 120272/18 | Bhuvaneshwari | 27 | F | 9640 | 64.6 | 27.7 | 3.12 | 10.2 | 11.1 | 0.32 | 25.6 |
| 56 | 111467/18 | Shivamma | 35 | F | 7710 | 63 | 28.4 | 2.87 | 9.8 | 10.7 | 0.28 | 23.4 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 57 | 110815/18 | S K Galave | 42 | M | 5500 | 54.2 | 38.5 | 2.26 | 11 | 13.2 | 0.25 | 31.3 |
| 58 | 29250/19 | Vinod | 16 | M | 10740 | 49.2 | 43.3 | 4.09 | 9.5 | 10.5 | 0.38 | 20 |
| 59 | 248006/18 | Prabha | 46 | F | 6560 | 64 | 30.2 | 2.87 | 10.4 | 12 | 0.3 | 28.3 |
| 60 | 45759/18 | Vidya | 37 | F | 7350 | 56.2 | 32.4 | 2.66 | 8.6 | 8.6 | 0.23 | 14.6 |
| 61 | 15413/19 | Santosh | 21 | M | 10390 | 72.4 | 22.1 | 2.15 | 9 | 9.5 | 0.19 | 16.7 |
| 62 | 114168/18 | B R Bajantri | 34 | M | 6410 | 52.7 | 37.9 | 3.4 | 8.8 | 9.4 | 0.3 | 15.8 |
| 63 | 43162/18 | S H Mujawar | 40 | M | 6610 | 51 | 40.7 | 2.02 | 10.2 | 12.1 | 0.21 | 26.7 |
| 64 | 110950/18 | Boramma | 24 | F | 9040 | 71.4 | 21.1 | 3.56 | 8.7 | 8.7 | 0.31 | 14.1 |
| 65 | 109585/18 | Surekha | 52 | F | 5530 | 57.9 | 32.2 | 2.28 | 10.4 | 11.5 | 0.24 | 28.1 |
| 66 | 45732/18 | Shantabai | 45 | F | 6790 | 52.9 | 41.1 | 3.1 | 9.8 | 10.6 | 0.31 | 23.1 |
| 67 | 116086/18 | Gulappa | 23 | M | 5850 | 60.5 | 31.5 | 2.16 | 10.2 | 12 | 0.22 | 26.5 |
| 68 | 40338/18 | Sarojini | 42 | F | 7040 | 58.5 | 35.2 | 2.86 | 8.8 | 8.8 | 0.25 | 14.7 |
| 69 | 117355/18 | Akshy | 17 | M | 8610 | 55.2 | 39.7 | 2.73 | 9.8 | 11.2 | 0.27 | 23.4 |
| 70 | 114991/18 | Dattu | 22 | M | 6030 | 70.1 | 22.3 | 1.65 | 9.2 | 10.5 | 0.15 | 19.3 |
| 71 | 28931/19 | Siddanna | 23 | M | 8450 | 58.4 | 32.2 | 3.38 | 9.2 | 9.8 | 0.31 | 18.9 |
| 72 | 114160/18 | P S Bajantri | 42 | M | 8800 | 57.7 | 33.3 | 2.56 | 10.1 | 11.8 | 0.26 | 25.9 |
| 73 | 44718/18 | Mahesh | 19 | M | 8460 | 67.7 | 24.3 | 3.51 | 9.3 | 10 | 0.33 | 17.9 |
| 74 | 42169/18 | Ningappa | 19 | M | 8220 | 60.5 | 29.9 | 2.89 | 9.8 | 11.3 | 0.28 | 23.9 |
| 75 | 149462/19 | Pallavi | 30 | F | 9920 | 61.7 | 33.6 | 2.99 | 9.2 | 9.8 | 0.28 | 18.4 |
| 76 | 110436/18 | Raghavendra | 55 | M | 4750 | 52.4 | 37.1 | 1.79 | 11.2 | 12.3 | 0.2 | 31.8 |
| 77 | 111451/18 | Shivshankar | 54 | M | 9080 | 68.1 | 25 | 3.32 | 8.2 | 8 | 0.27 | 10.2 |
| 78 | 110828/18 | Suresh | 36 | M | 6990 | 56.8 | 34 | 2.55 | 9.5 | 10.3 | 0.24 | 20.8 |
| 79 | 15936/19 | Pramod | 43 | M | 9250 | 51.8 | 42.4 | 3.16 | 9.2 | 9.9 | 0.29 | 18.8 |
| 80 | 114156/18 | K I Badiger | 54 | M | 7970 | 55.7 | 35.3 | 2.23 | 8.8 | 8.9 | 0.2 | 16.1 |
| 81 | 110817/18 | I S Hirolli | 52 | M | 6650 | 51.3 | 37.7 | 2.56 | 9.5 | 10.4 | 0.24 | 20.5 |
| 82 | 110820/18 | B S Sangapur | 27 | M | 8110 | 49.4 | 41.4 | 2.79 | 9.3 | 9.7 | 0.26 | 18.9 |
| 83 | 41940/18 | Y V Aski | 31 | M | 8420 | 48.6 | 44 | 3.17 | 9.1 | 10.2 | 0.29 | 18.3 |
| 84 | 248669/18 | Sunil | 35 | M | 6190 | 56.8 | 35.4 | 2.16 | 10.3 | 11 | 0.22 | 27 |