

## Evaluation of the Modified Alvarado Score in the Diagnosis of Acute Appendicitis: A Prospective Study

Sudhir Singh<sup>1</sup>, Mohammad Farooque Dudhwala<sup>2</sup>, Honeyal Sinh H Maharaul<sup>3</sup>

**Author's Affiliation:** <sup>1</sup>Resident, <sup>2</sup>Senior Resident, <sup>3</sup>Associate Professor, Department of Surgery, Smt B K Shah Medical Institute and Research Centre, Vadodara, Gujarat 391760, India.

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### Abstract

**Introduction:** The most frequently encountered complaint, for a surgeon, which is an emergency also, is pain in abdomen. One of the commonest cause, among the various causes of abdominal pain, is acute appendicitis, and it is also the commonest cause of acute surgical abdomen. The Modified Alvarado Scoring System (MASS) which uses some clinical signs and symptoms is simple and easy way to diagnose acute appendicitis.

**Methodology:** Fifty patients of either gender and age  $\geq 18$  years that showed up with pain that was located in the area of right lower quadrant of the abdomen and provided written informed consent, over a period of one year and half year from January 2018 to June 2019 were enrolled. Modified Alvarado score was calculated for each of the patient and the score was correlated with histopathological findings.

**Results:** In the present study 50 patients that had presented to the general surgery department of Dhiraj Hospital with right iliac fossa pain were enrolled. 66% (n=33) were males while 34% (n=17) were females.

**Conclusion:** It can be concluded that Modified Alvarado score aides' surgeons in diagnosis of acute appendicitis and this helps in reducing the incidence of negative appendicectomies. Scores at both the extremes of scales has high sensitivity, also the sensitivity of high scores for males is high.

**Keywords:** Alvarado score; Appendix; Appendicitis; Abdominal Lump.

### Introduction

The most frequently encountered complaint, for a surgeon, which is an emergency also, is pain in abdomen. One of the commonest cause, among the various causes of abdominal pain, is acute appendicitis, and it is also the commonest cause of acute surgical abdomen.<sup>1</sup>

The syndrome of acute appendicitis was described by Reginald Heber Fitz, in 1886, as a diagnostic and clinical entity, which required urgent surgical treatment.<sup>2</sup> He considered acute appendicitis to be an ailment. He also enlightened with certain signs and symptoms that are a trademark of appendicitis. Since those days, appendicitis is a frequent surgical practice ailment. It can affect people of any age group. It is easily correctible surgically. It is one of the major causes for abdominal pain.

**Epidemiology:** It rare in infants. It increases with age. Being common in early adulthood, its incidence reaches its peak in the teenagers and early 20s. The risk is small in middle age group.<sup>2</sup> The rate for men and women are 12% and 25% respectively.<sup>3</sup> Average of 6-7% of the population can develop appendicitis in lifetime.<sup>4</sup>

Clinical diagnosis is done for it with presence of variety of acute medical and surgical abdominothoracic conditions. Although it was discovered 120 years back, its diagnosis is dilemmatic.<sup>5</sup> It is impossible without patients'

**Corresponding Author:** Mohammad Farooque Dudhwala, Senior Resident, Department of Surgery, Smt B K Shah Medical Institute and Research Centre, Vadodara, Gujarat 391760, India.

**E-mail:** mfarooque6@gmail.com

history and physical examination.<sup>6</sup> Decision making may be difficult especially for junior doctors who can get confused by a long list of conditions mimicking this clinical scenario. The diagnosis becomes all the more difficult when not all the signs and symptoms are easily elucidated. It may sometimes present with atypical presentations and the diagnosis becomes more challenging when the symptom overlap with some other disease conditions.<sup>7</sup> These variable clinical presentations make diagnosis either straightforward or tricky. This is more so correct when the disease is in its early stages. Equivocal cases usually require in-patient observation and multiple laboratory and imaging investigations. Any delay in the management or inability to diagnose this disease early can increase the severity of disease and may ultimately lead to increase the morbidity, cost and occasional mortality.

Despite the availability of modern diagnostic aids diagnosis of acute appendicitis is mostly clinical. Surgeon takes the call based on his experience in cases of emergency appendectomy. The basic fundamental question while diagnosing a suspected case of acute appendicitis is whether or not to operate, if diagnosed, without increasing the rate of unnecessary negative surgical interventions.<sup>8</sup> Diagnostic difficulties in cases with atypical clinical finding have resulted in high rate of negative appendectomy, which literature reveals to be anywhere between 20-44%. Many surgeons would accept a negative appendectomy rate of up to 30% as inevitable and this results in morbidity of around 10%; these rates of negative appendectomy are even higher in women of child-bearing age.<sup>9</sup> There are various diagnostic tools available but the same may not be available always and in cases of emergencies.

Immediate appendectomy is the recommended treatment for acute appendicitis because of the presumed risk of progression to rupture. The overall rate of perforated appendicitis is 25.8% of all cases of acute appendicitis. Children below 5 years of age and patients above 65 years of age have the highest rates of perforation (45 and 51%, respectively).<sup>4</sup> Removing inflamed appendix before perforation or any other complications is the ultimate goal of surgeon along with minimal negative appendectomies.<sup>10</sup> This requires correct diagnosis as a wrongly made diagnosis is responsible for significant mortality and morbidity. Literature shows that aggressive surgical approach as "when in doubt take it out", in equivocal cases, has resulted in increased white appendectomies.<sup>11</sup>

The goal today is early diagnosis, primarily to prevent morbidity and mortality and also to decrease the incidence of white appendectomies.<sup>12</sup> Since, the premise that it is better to remove a normal appendix than to delay diagnosis doesn't stand up to close scrutiny, particularly in the elderly.

Final diagnosis can be done once the surgery is over. Then a histopathological examination of the specimen taken is done to confirm the diagnosis. Thus it is impractical to have a definitive preoperative diagnosis, since the only confirmation of diagnosis is by histopathology examination. Prompt and accurate diagnosis of appendicitis is crucial in lowering the incidence of complications caused by appendiceal rupture as there is no accurate way of determining when an appendix will rupture before resolution of the inflammatory process. Thus, to avoid complications related to delayed diagnosis or treatment, for example, appendicular rupture, appendicular abscess, or portal pyemia, there is a tendency of over diagnosis of the condition. However, with all operations, postoperative complications can exist, including wound infections, intra-abdominal abscesses, ileus, and in the longer term, adhesions. The diagnosis is important since the management for diverticulitis which is another condition responsible for acute abdomen is initially conservative with antibiotics. Efforts are being made to come to an early diagnosis when interventions are required.<sup>3</sup> Failure to make early diagnosis may lead to high morbidity.<sup>4</sup> Thus, arises a need for a method, which can complement clinical diagnosis and make clinical decision more precise and consistent. To assist in making the correct diagnosis of appendicitis various clinical and laboratory dependent scoring systems have been developed. Some of the scoring systems also combine ultrasound parameters to increase the accuracy of diagnosis. In daily clinical practice, the use of a scoring system has been found to be associated with a reduced rate of non-indicated appendectomies.<sup>13</sup> These scoring systems help surgeons in making decision as to operate or not. The different scoring systems that are there in use to diagnose appendicitis are: Alvarado scoring system, Modified Alvarado scoring system, Tzanakis scoring system, RIPASA scoring system, and Anderson scoring system. Available diagnostic scoring systems can act as an aide to improve the diagnosis.<sup>14</sup>

In 1986, Alvarado<sup>15</sup> described a scoring system, which has been validated in adult surgical practice. Alvarado score consists of 10 points and it includes six clinical parameters and 2 laboratory parameters.

In this scoring system there are three symptoms (migrating pain from the umbilicus to the right iliac fossa, anorexia, and vomiting), three signs (tenderness, rebound tenderness, and pyrexia) and two laboratory data (leukocytosis and shifting to the left of neutrophil maturation).<sup>16</sup>

For total 1 points, 2 points are attributed to tenderness in the right iliac fossa and leukocytosis. There are six other factors that are assigned one point each.

Understanding of Alvarado score - Appendicitis is very unlikely if the score is 1-4, appendicitis is probable if the score is 5-7 and it is highly probable if the score is 8-10.<sup>8</sup>

Mnemonic MANTRELS helps in the ease of remembering all the parameters involved in calculating Alvarado score- where in M - Migration to right iliac fossa, A stands for Anorexia, N is for Nausea/Vomiting, T stands for Tenderness in right iliac fossa, R for Rebound tenderness, E for Elevated temperature (fever), L for Leukocytosis and S points towards Shift of neutrophils to left.

Various studies have established high diagnostic value of Alvarado score. Surgeons believe that Alvarado score being noninvasive and safe diagnostic method and being simple, reusable and repeatable can act as a guide for diagnosis of acute appendicitis.<sup>9-11</sup>

However, in 1994, Kalan devised a modified Alvarado score. In this score he omitted only one parameter which is left shift of neutrophil maturation. The reason for omitting this score was that this test is not routinely in majority of the laboratories.<sup>8</sup> The Modified Alvarado Scoring System (MASS) which uses some clinical signs and symptoms was found to be simple and easy to use scoring system for the diagnosis of acute appendicitis and can be used by junior surgeons in the emergency setting.<sup>6,7</sup> There are mixed results regarding the efficacy of modified Alvarado score.<sup>9-13</sup>

With the aim of evaluating the accuracy of Modified Alvarado scoring system to effectively diagnose acute appendicitis by correlating the score obtained with the use of this score against operative and histopathological findings, this study was conducted.

#### *Aim of the study*

Evaluation of accuracy of Modified Alvarado Score in diagnosis of Acute Appendicitis

#### *Objectives:*

To evaluate the utility and reliability in diagnosing acute appendicitis by use of Modified Alvarado score.

Comparison of the Modified Alvarado Score of patients with the histopathological findings to ascertain its sensitivity.

#### **Materials and Methods**

This prospective, interventional study was conducted in a tertiary health care centre, Dhiraj General Hospital, Piparia, Vadodara. Fifty patients that showed up with pain that was located in the area of right lower quadrant of the abdomen over a period of one year and half year from January 2018 to June 2019 were enrolled. The study was conducted without any ethical violation and maintaining confidentiality of the patients.

#### *Inclusion criteria:*

Patients of either gender and age  $\geq 18$  years.

Patient with complaints of pain in right lower abdomen with features suggestive of acute appendicitis.

Patient providing written informed consent.

#### *Exclusion criteria:*

Patient not agreeing to give consent for participation in the study.

Patients less than 18 years age.

#### *Sample Size:*

Design prevalence (proportion or units): 0.10; Unit (test or cluster) sensitivity: 0.9; Required population sensitivity: 0.9. With these values the calculated sample size as EPITOOL calculator was 25. Accounting for drop outs, the sample size was inflated to 50.

The patients willing to participate in the study were explained about the purpose and method of the study in the language they understood. They were explained that participation in the study will not lead to any financial expenditure on their side; the cost of any investigations performed as a part of the study were borne by the researcher conducting the study. The patients were also given a printed enclosed Participant Information Sheet in the language understood by them, containing necessary information about the project. They were

given opportunity to clarify any issue related to the study and were encouraged to ask questions. Those patients who gave written consent in informed consent form were included in the study. No extra expenditure was imposed on the participating patients for the purpose of study. Confidentiality of participating patients was maintained at all levels.

For each of the patient following information were recorded in case report form: Parameters like name, age, address, occupation, date of admission, height, weight and general parameters, vitals namely pulse rate, blood pressure, respiratory rate and temperature. Systemic examination of respiratory system, cardiovascular system, gastrointestinal system and central nervous system was done; associated disease/ co- morbid condition/ past history, family history, personal history and details of investigations performed. The patient were investigated for: complete blood count, urine routine and microscopy, random blood sugar, liver function test, renal function test, ECG, chest x-ray PA view and other special investigations like CT scan, if required.

Modified Alvarado score was calculated for each of the patient: As we mentioned earlier apart from the 2 points to Tenderness in the right iliac fossa and leukocytosis, other factors that is pain migrating to right iliac fossa, anorexia, nausea or vomiting, rebound tenderness and fever were given 1 point each.<sup>37</sup> Celsius or more were assigned one point. This results in score of 9 points. Here,

1-4 indicates very unlikely appendicitis

5 - 6 Appendicitis possible

7 - 8 Appendicitis probable

9 - Appendicitis definitive.

Those patients that had a 7 and more were operated. Those with a score of 5-6 were advised CT scan of abdomen, if the CT scan suggested appendicitis then the patients were taken for surgery. If the CT scan did not reveal appendicitis, the patients were observed a period of 24 hours, if there was worsening of pain, then the surgery was performed, otherwise the patients were managed conservatively. Those patients who had a score of 1-4 were only observed for 24 hours, surgery was performed if the score worsened in 24 hours. All the removed appendices were sent for histopathological evaluation. Findings of histopathology were correlated with MAS score and age and gender wise sensitivity and specificity was calculated. For analysis purpose patients with score 1-4 were grouped as Group 1, those with score 5-6 were grouped as group 2 and group 3 was

those with score 7-9.

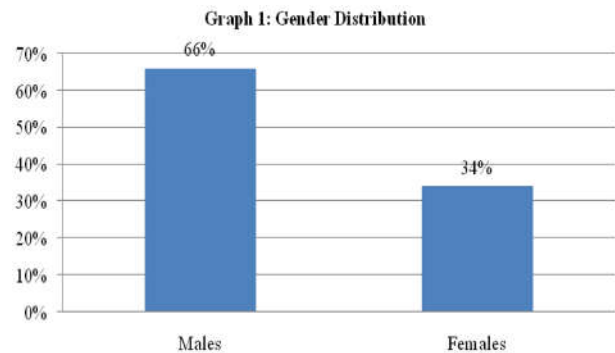
### Results and Discussion

In the present study 50 patients that had presented to the general surgery department with right iliac fossa pain were enrolled.

**Table 1:** Gender distribution.

Gender distribution	N	%
Males	33	66%
Females	17	34%

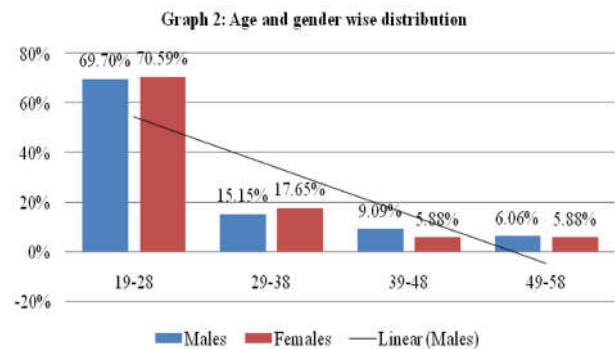
of the 50 patients enrolled, 66% (n=33) were males while 34% (n=17) were females. (Table 1, graph 1)



**Graph 1:** Gender distribution

**Table 2:** Age and gender wise distribution

Age distribution	Males		Females	
	n	%	N	%
19-28	23	69.70%	12	70.59%
29-38	5	15.15%	3	17.65%
39-48	3	9.09%	1	5.88%
49-58	2	6.06%	1	5.88%



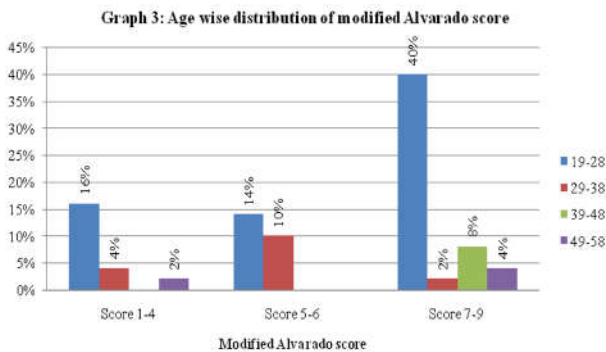
**Graph 2:** Age and gender wise distribution

Patients that were enrolled were in the age range of 19 to 54 years. The age and gender wise distribution of patients was as show in the table 2 and graph 2.



**Table 3:** Age wise distribution of modified Alvarado score

Age distribution	Score 1-4		Score 5-6		Score 7-9		Total	
	n	%	n	%	n	%	n	%
19-28	8	16.00%	7	14.00%	20	40.00%	35	70%
29-38	2	4.00%	5	10.00%	1	2.00%	8	16%
39-48	0	0.00%	0	0.00%	4	8.00%	4	8%
49-58	1	2.00%	0	0.00%	2	4.00%	3	6%
Total	11	22%	12	24%	27	54%	50	100%



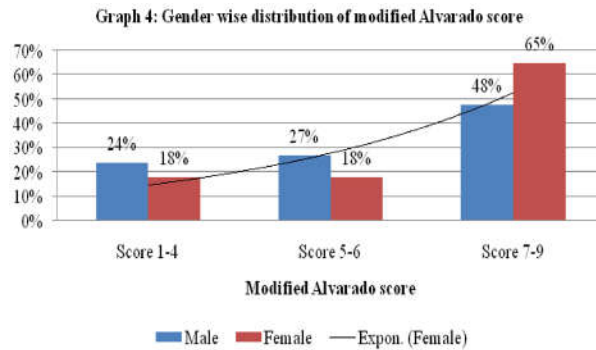
**Graph 3:** Age wise distribution of modified Alvarado score

Age wise distribution of modified Alvarado score was as shown in table 3 and graph 3.

The 19-28 years age group showed highest occurrence which was around 70.59%. The next age group affected (17.65%) was 29-38 years

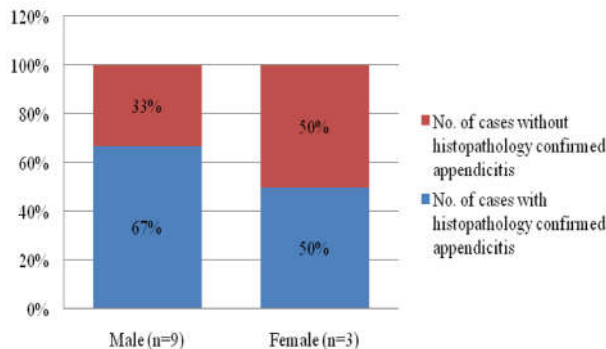
**Table 4:** Gender wise distribution of modified Alvarado score.

Gender distribution	Score 1-4		Score 5-6		Score 7-9		Total	
	n	%	n	%	n	%	n	%
Male	8	24%	9	27%	16	48%	33	100%
Female	3	18%	3	18%	11	65%	17	100%
Total	11	22%	12	24%	27	54%	50	100%

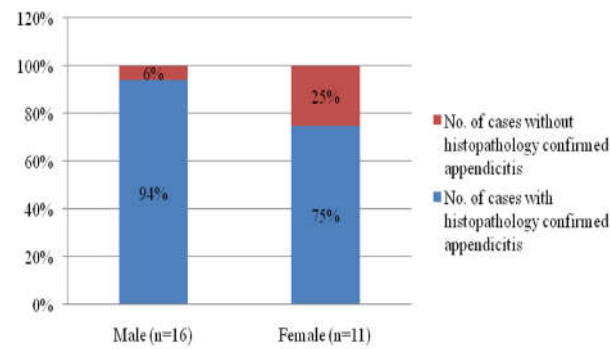


**Graph 4:** Gender wise distribution of modified Alvarado score.

Gender	No. of cases operated		No. of cases with histopathology confirmed appendicitis		No. of cases without histopathology confirmed appendicitis		Proportion of true positive / Sensitivity
	n	%	n	%	N	%	
Male (n=9)	3	33%	2	67%	1	33%	67%
Female (n=3)	2	67%	1	50%	1	50%	50%
Total (n=12)	5	42%	3	60%	2	40%	60%



**Graph 5:** Distribution of patients with Modified Alvarado Score 5-6.



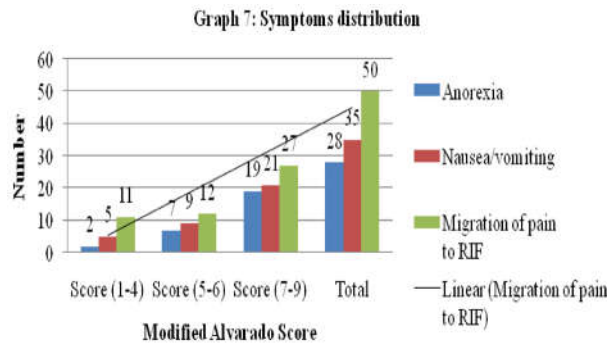
**Graph 6:** Distribution with MAS between seven to nine

**Table 6:** Distribution with MAS between seven and nine.

Gender	No. of cases operated		No. of cases with histopathology confirmed appendicitis		No. of cases without histopathology confirmed appendicitis		Proportion of true positive
	n	%	n	%	n	%	
Male (n=16)	16	100%	15	94%	1	6%	94%
Female (n=11)	8	73%	6	75%	2	25%	54.55%
Total (n=27)	24	96%	21	88%	3	12%	77.78%

Table 7: Symptoms distribution.

Symptoms	Score between 1 and 4	Score between 5 and 6	Score between 7 and 9	Total	
				N	%
Migration of pain to RIF	11	12	27	50	100%
Nausea/vomiting	5	9	21	35	70%
Anorexia	2	7	19	28	56%



Graph 7: Symptoms distribution.

Table 8: Sign distribution.

Symptoms	Score between 1 and 4	Score between 5 and 6	Score between 7 and 9	Total	
				N	%
Tenderness over RIF	2	6	27	35	70%
Elevated temperature >37.3°C	6	7	21	34	68%
Rebound tenderness over RIF	0	8	21	29	58%

Graph 8: Sign distribution

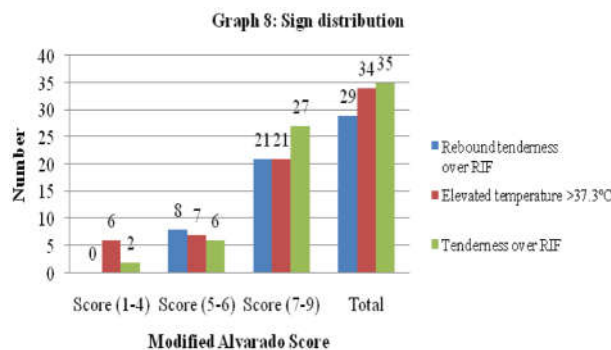
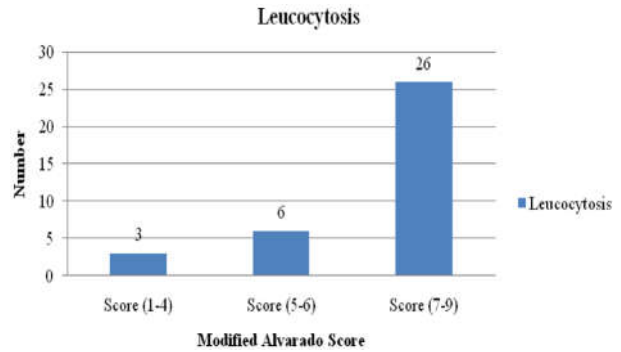


Table 9: Leucocytosis

Lab Parameter	Score between 1 and 4	Score between 5 and 6	Score between 7 and 9	Total	
				N	%
Leucocytosis	3	6	26	35	70%



Graph 9: Leucocytosis

Group - I; 11 patients were in the first group (1-4), these patients had less likely hood of having appendicitis. These patients were kept under observation and were treated conservatively. Discharged after 2-3 days and were followed up every month for one year and none of them required surgery.

Group - II; 12 patients were in the second group (5-6), 5 were operated on CT scan findings or clinical suspicion of high probability of acute appendicitis Table 5. Rest of the cases (7) were treated conservatively, observed and discharged after 3-4 days of stay in hospital and followed up every month for one year and none of them required surgery during the period of observation.

Of the five patients with score of 5-6 who were operated, 3 were males and 2 were females. One out of three males and one out of two females, did not have histologically confirmed appendicitis. 40% negative appendectomy rate was seen in patients that had a score 6 or less.

Group - III; Out of 27 patients in the third group 24 patients underwent appendectomy Table 5. Three female patients on subjecting for Ultrasonography of abdomen had other pathology mimicking acute appendicitis and they didn't undergo appendectomy.

One patient had pelvic inflammatory diseases while other had twisted ovarian cyst and the third one patient had ruptured ectopic pregnancy. Acute appendicitis was observed in the present study in 21 out of 24 cases. When the modified Alvarado score was 7 or more, the sensitivity that is proportion of true positive was 88%. In males the sensitivity of 94% was highest as compared to females in whom it was 54.55%. A negative appendectomy rate was highest among females (25%), where in case of males it was 6%. One male patient that had

normal appendix was diagnosed to have Meckel's diverticulitis.

Migrating pain to right iliac fossa was the most predominant symptom and it was seen in 100% patients in the present study was, this was followed by nausea/ vomiting (70%) and anorexia (56%) as seen in Table 7 and graph 7.

Of 50 patients in present study, 35 had leucocytosis of which 3 were in group - I, 6 in group - II and 26 in group - III. The leucocytosis seen in present study was 70%. (Table 9, Graph 9)

The predominant sign seen in the present study was tenderness over RIF (70%). The next common sign was elevated temperature  $>37.3^{\circ}\text{C}$  (68%) and rebound tenderness over RIF (58%) as shown in Table 8 and graph 8.

## Conclusion

It can be concluded that Modified Alvarado score aides' surgeons in diagnosis of acute appendicitis and this helps in reducing the incidence of negative appendicectomies. Scores at both the extremes of scales has high sensitivity, also the sensitivity of high scores for males is high.

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