



## Evaluation of Alvarado Scoring System in Preoperative Diagnosis of Acute Appendicitis

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### Abstract:

**Background:** Aim of the study was to evaluate Alvarado scoring system in preoperative diagnosis of Acute Appendicitis and to compare clinical diagnosis and Alvarado scoring for early diagnosis and correlate them with histopathological findings in case of acute appendicitis.

**Material and Method:** The present study is carried out in 100 cases of appendicitis admitted in of Index Medical College, Hospital and Research Centre, Indore during the period from January 2015 to June 2016 (18 months). Calculation of Alvarado score done on the basis of signs symptoms and Laboratory findings of patients admitted in IMCHRC during the course of the study. Confirmation of diagnosis by histopathological correlation.

**Result:** We concluded our study in 100 consecutive patients with clinical features of acute appendicitis among them 32 were females and 68 were males. Male to female ratio 2.12:1. Most of the patients belong to younger age group (43% in age group of 21-30 years). Mean scores for the emergency surgery group, and observation group were 7-10 and 5-6 respectively. Negative appendectomy rate in our study was 32.9% out of which among males it is lesser (31.57%) as compared to females who had a higher Negative appendectomy rate of 35.7%. Sensitivity of Alvarado score  $\geq 7$  was 92.9% and specificity was 78.5%. Positive and Negative value of Alvarado score  $\geq 7$  was 89.8% and 84.6% respectively.

**Conclusion:** Acute Appendicitis was definitely absent among 28 operated cases. This rate of 32.9% was by no means high when compared to the reported range of 8- 33% in the literature but certainly not enough to make its adoption recommendable.

**Keywords:** Acute Appendicitis, Alvarado scoring.

### Introduction

Acute appendicitis is one of the most common causes of an abdominal emergency and accounts for approximately 1% of all surgical operations.<sup>1</sup> Approximately 8% of those in Western countries have appendicitis at some time during their life,

the lifetime risk of developing appendicitis is 8.6% for males and 6.7% for female with a peak incidence between 10 and 30 years of age, with the highest incidence in the second and third decades. The risk gradually decreases until age 50, when it stabilizes.<sup>2</sup>

Early diagnosis is a primary goal to prevent morbidity and mortality in acute appendicitis. In acute appendicitis it is not possible to have definitive diagnosis by gold standard test (histopathology) pre-operatively. Delay in diagnosis definitely increases the morbidity, mortality and cost of treatment. The perforation rate is as high as 35% when surgery is delayed.<sup>3</sup>

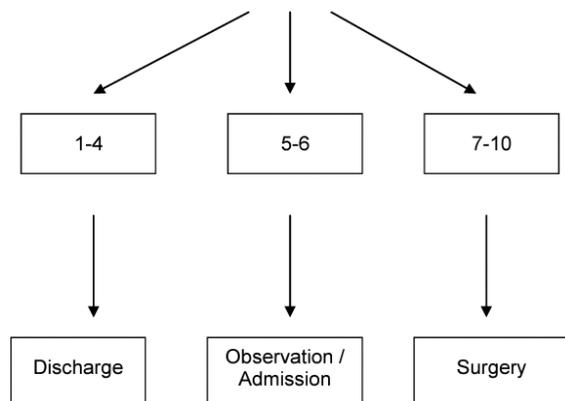
In spite of advancements in medical diagnostics, after elapse of more than a century since its first description, it continues to be a diagnostic problem and diagnostic inaccuracy in acute appendicitis has remained unchanged. The most important diagnostic tool is still physical examination. The accuracy of a clinical examination ranges from 71% to 97%, depending on the experience of the surgeon.<sup>3</sup>

Over the last two decades different protocols have been introduced and tested by different researchers which include Lidverg, Fenyo, Christian, Oh-man and Alvarado scoring system to make an early diagnosis of this sometimes very elusive disease. Alvarado in 1986 introduced a criterion for the diagnosis of acute appendicitis.<sup>4</sup>

**Alvarado score<sup>5</sup>**

Alvarado in 1986 introduced a criterion for the diagnosis of acute appendicitis. He conducted a retrospective study of 305 patients hospitalized with abdominal pain suggestive of acute appendicitis. Signs, symptoms, and laboratory findings were analyzed for specificity, sensitivity, predictive value, and joint probability. The total joint probability, the sum of a true-positive and a true-negative result, was chosen as a diagnostic weight indicative of the accuracy of the test. Eight predictive factors were found to be useful in making the diagnosis of acute appendicitis. Their importance, according to their diagnostic weight, was determined as follows: localized tenderness in the right lower quadrant, leukocytosis, migration of pain, shift to the left, temperature elevation, nausea-vomiting, anorexia, and direct rebound pain. Based on this weight, we devised a practical diagnostic score that may help in interpreting the confusing picture of acute appendicitis.<sup>6</sup>

Alvarado score	
Feature	Score
Migration of pain	1
Anorexia	1
Nausea	1
Tenderness in right lower quadrant	2
Rebound pain	1
Elevated temperature	1
Leucocytosis	2
Shift of white blood cell count to the left	1
<b>Total</b>	<b>10</b>



Till date various diagnostic methods have been devised but none of them have been regarded as the best or foolproof method for diagnosis because of false positive and false negative which lead to unnecessary surgery and undue discharges. Various clinical scoring system, blood test and radiological examination have been used but most of the tests have limitations, including low accuracy rates, high false negative rates and high cost.

This study is a prospective and comparative study which deals with the role of scoring system in the diagnosis of acute appendicitis, evaluates and compares the diagnostic accuracy of Alvarado score as a valuable tool for decision making in case of acute appendicitis.

**Material and Methods**

On approval from ethical committee, in our prospective study, 100 cases were analysed for a period of 18 months from January 2015 to June 2016 in surgery department at Index Medical College, Hospital and Research Centre, Indore. In prospective study, all the new cases admitted in surgery department were studied. The sample

included all the cases of right iliac fossa pain provisionally diagnosed as acute appendicitis. Patients having clinical general peritonitis were excluded from this study. At admission these patients were prospectively evaluated using Alvarado scores. Those patients with equivocal scores and those at lower end of the scoring system were reassessed every 12 hours until the time of operation or discharge. The score were subsequently correlated with clinical, operative and histopathological findings of the removed appendices. Decision of operation was however entirely clinical one. The overall sensitivity,

specificity, positive predictive value, negative predictive value of Alvarado score were detected and compared with that of clinical diagnosis and confirmed by histopathological examination.

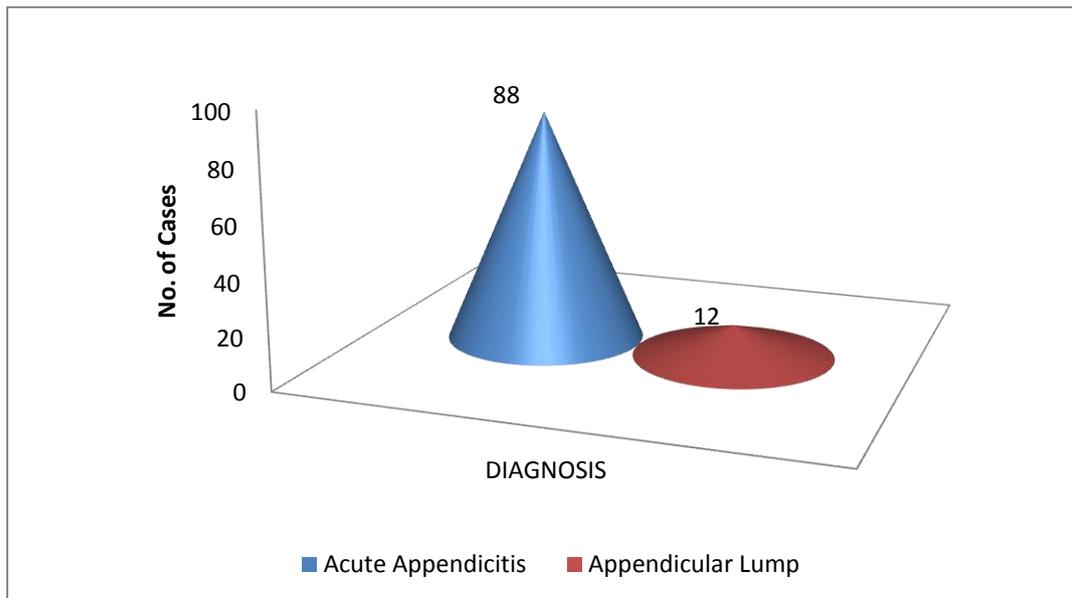
**Result**

**Table No. 01** Presentation of Cases of Pain In Rif

Provisional Clinical Diagnosis	Cases
Acute Appendicitis	88
Appendicular Lump	12

Majority of cases at presentation were diagnosed clinically as appendicitis, only about 12% of cases were appendicular lump.

**Graph No. 01** Presentation of Cases With Pain In Rif



**Table No. 02** Incidence With Age And Sex

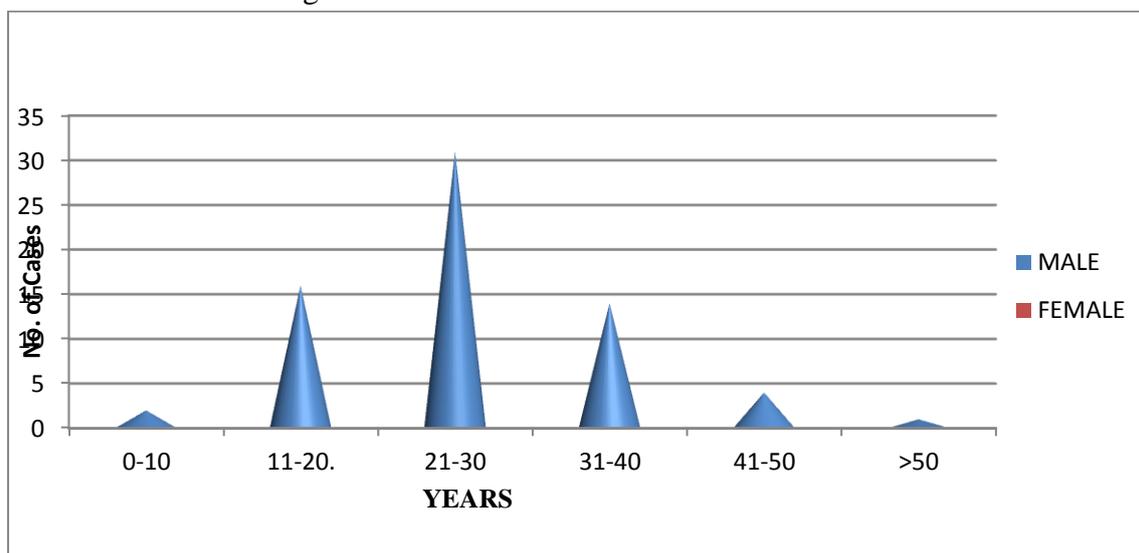
Years	Male	%	Female	%	Total	%
0-10	02	02	02	02	04	04
11-20	16	16	04	04	20	20
21-30	31	31	12	12	43	43
31-40	14	14	12	12	26	26
41-50	04	04	02	02	06	06
>50	01	01	0	0	01	01

Majority of cases of acute appendicitis (43%) belong to younger age group between 21-30 years in both males and females.

Male:Female : : 2.12:1

In children also males have an increased incidence of acute appendicitis.

**Graph No. 02** Incidence With Age And Sex



**Table No. 03** Incidence of Symptoms

	No. of Cases	Pain in RIF	Generalised Pain	Nausea/ Vomiting	Fever	Anorexia	Burning in Micturition	Diarrhoea
Acute Appendicitis	88	85	12	73	56	43	04	08
Appendicular Lump	12	12	00	09	06	04	04	00

Pain in the right iliac fossa with vomiting and fever constitute the major symptoms of acute appendicitis, anorexia which is supposed to be a major symptom is present in only 48.8% of cases.

**Table No. 04** Incidence of Signs

	No. of cases	Tenderness in RIF	Rebound Tenderness	Rigidity	Abdominal Lump	P/R tenderness
Acute Appendicitis	88	85	44	38	00	08
Appendicular Lump	12	11	05	04	12	05

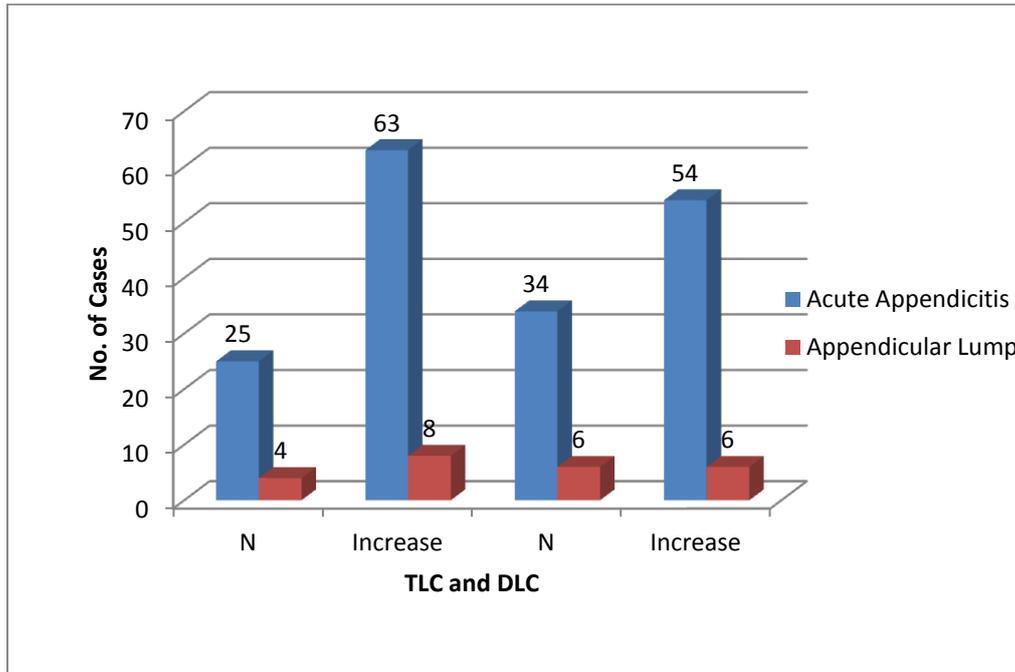
Tenderness in RIF is a major sign of Acute Appendicitis in the present study.

**Table No. 05** Acute Appendicitis And Its Relation with TLC, DLC

	No. of Cases	TLC		DLC	
		N	Increase	N	Increase
Acute Appendicitis	88	25	63	34	54
Appendicular Lump	12	04	08	06	06

Differential WBC count though being more significant for a case of acute appendicitis accounts for only 61.36% of the total thus concluding that this criteria has poor sensitivity and specificity.

**Graph No. 03** Acute Appendicitis and Its Relation With TLC, DLC

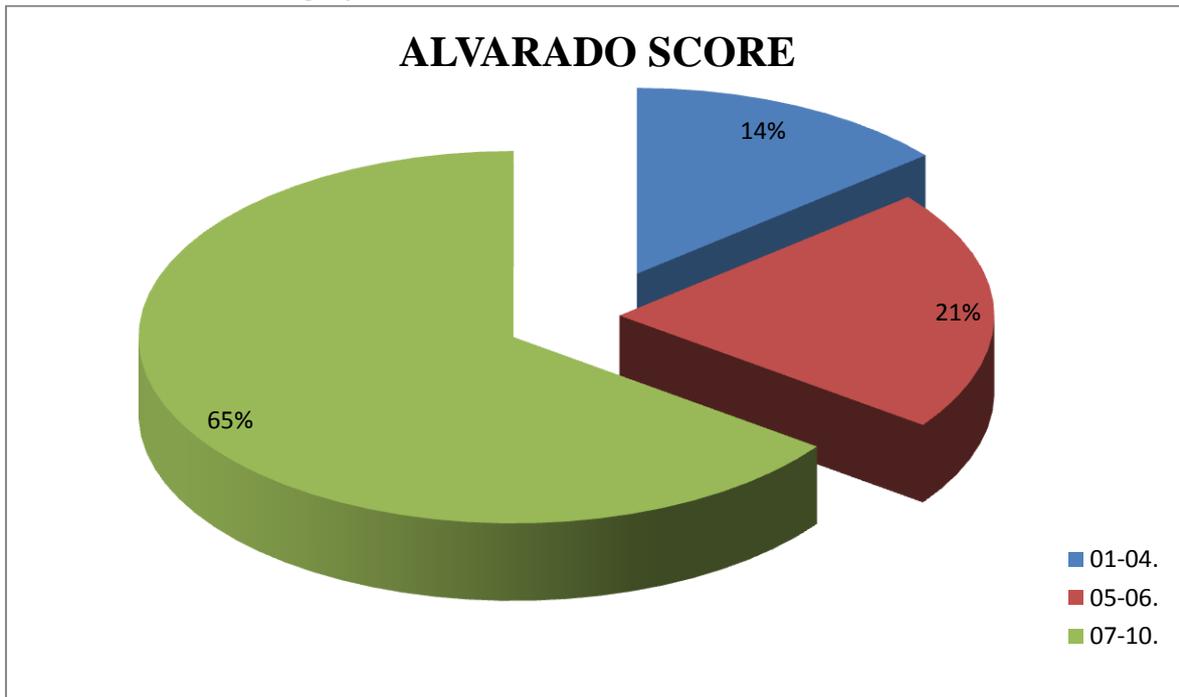


**Table No. 06** Alvarado Scoring System

Alvarado Score	Total No. of Cases	Percentage
1-4	14	14%
5-6	21	21%
7-10	65	65%

Majority of cases(65%) have an Alvarado score of 7-10

**Graph No. 04** Alvarado Scoring System



**Table No. 07** Comparison Between Alvarado Score And Histopathological Findings

Alvarado Score	Total No. of Cases	Total Operations	Histopathological Findings
1-4	14	11	04 Chronic PID 02 Typhlitis 01 Crohn's 01 Caecal Diverticulitis 01 Ruptured ovarian cyst 02 Mesenteric Lymphadenitis. 01 Chronic Appendicitis
5-6	21	15	03 Catarrhal Appendicitis 01 Tubercular appendicitis 01 Chronic PID 01 Obstructed Right Inguinal Hernia 04 Chronic Appendicitis 02 Typhlitis 01 Meckel's Diverticulitis 01 Torsion Meckel's ( Ileomesenteric Band ) 01 Acute Mesenteric Lymphadenitis 01 Terminal Ileitis (tubercular)
≥7	65	59	42 Catarrhal Appendix 10 Gangrenous Appendix 01 Pyelonephritis 01 Chronic Appendicitis 01 Gangrenous Caecum 01 Amyand's hernia 02 Appendicular Abscess 01 Ovarian Torsion

This table suggests that an Alvarado score of 7-10 is more significant for the diagnosis of acute appendicitis.

**Graph No. 05** Comparison Between Alvarado Score And Histopathological Findings

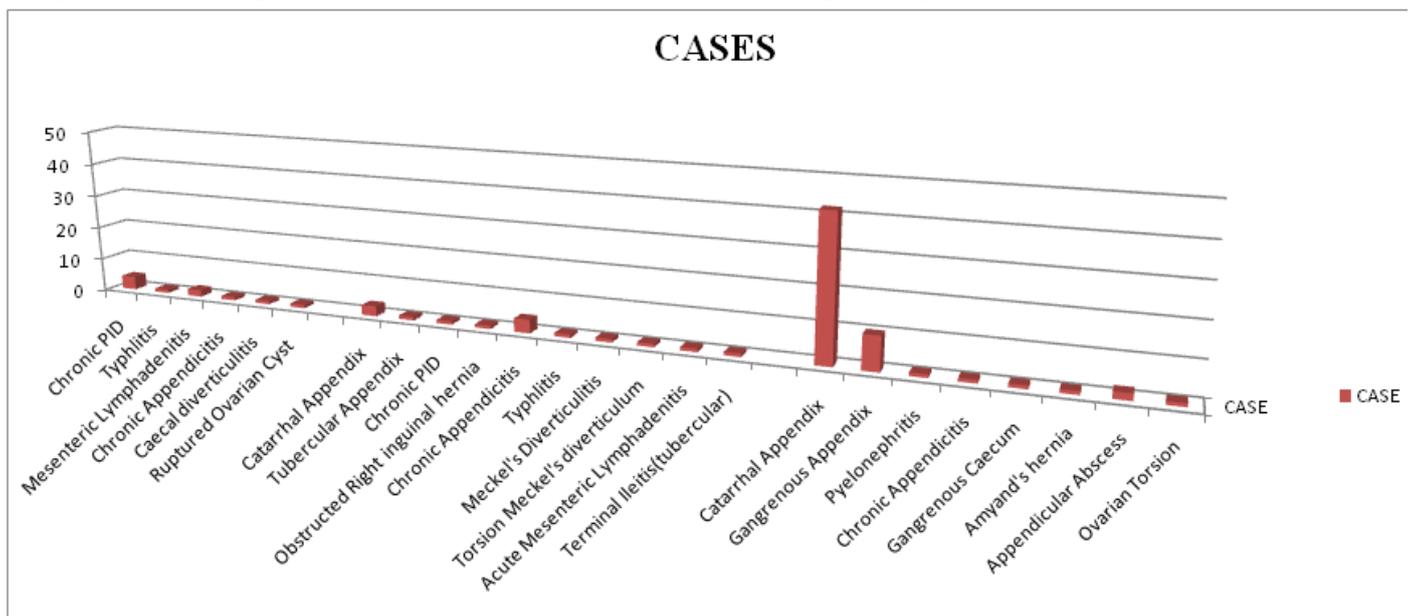


TABLE NO. 08 - FINAL STATISTICAL OUTCOME

TABLE 08 (A) OVERALL (MALES+FEMALES)

Score ( $\geq 7$ )	Final Outcome		Grand Total
	A	P	
-	22(TN)	4(FN)	26
+	6(FP)	53(TP)	59
<b>Grand Total</b>	<b>28</b>	<b>57</b>	<b>85</b>

- ABSENT

+ PRESENT

P= Disease Present Histopathologically

A=Disease Absent Histopathologically

Sensitivity- TP/TP+FN

Overall Sensitivity of score= 0.929= 92.9%

Specificity- TN/TN+FP

Overall Specificity of score: 0.785= 78.5%

Positive Predictive value-TP/TP+FP

PPV = 0.898 = 89.8%

Negative Predictive Value -TN/ TN+FN

NPV= 0.846 =84.6%

Total Negative Appendectomies: 28

Overall Negative Appendectomy Rate(NAR) : 0.329= 32.9%

Table No.08 (B) Statistical Outcome In Males

Score ( $\geq 7$ )	Final Outcome		Grand Total
	A	P	
-	13 (TN)	1(FN)	14
+	5 (FP)	38(TP)	43
<b>Grand Total</b>	<b>18</b>	<b>39</b>	<b>57</b>

- ABSENT

+ PRESENT

P= Disease Present Histopathologically

A=Disease Absent Histopathologically

Sensitivity- TP/TP+FN

Sensitivity in Males: 0.974 = 97.4%

Specificity- TN/TN+FP

Specificity in Males: 0.722 = 72.2%

Positive Predictive value- TP/TP+FP

PPV in Males : 0.883= 88.3%

Negative Predictive Value -TN/ TN+FN

NPV in Males: 0.928 =92.8%

**Total Negative Appendectomies in males: 18****NAR in Males: 31.57%****Table No. 08 (C) Statistical Outcome In Females**

Score ( $\geq 7$ )	Final Outcome		Grand Total
	A	P	
-	09	3	12
+	1	15	16
<b>Grand Total</b>	<b>10</b>	<b>18</b>	<b>28</b>

- ABSENT

+ PRESENT

P= Disease Present Histopathologically

A=Disease Absent Histopathologically

Sensitivity- TP/TP+FN

Sensitivity in Females= 0.833 = 83.3%

Specificity- TN/TN+FP

Specificity in Females= 0.9 = 90%

Positive Predictive value- TP/TP+FP

PPV in Females = 0.937 = 93.7%

Negative Predictive Value -TN/ TN+FN

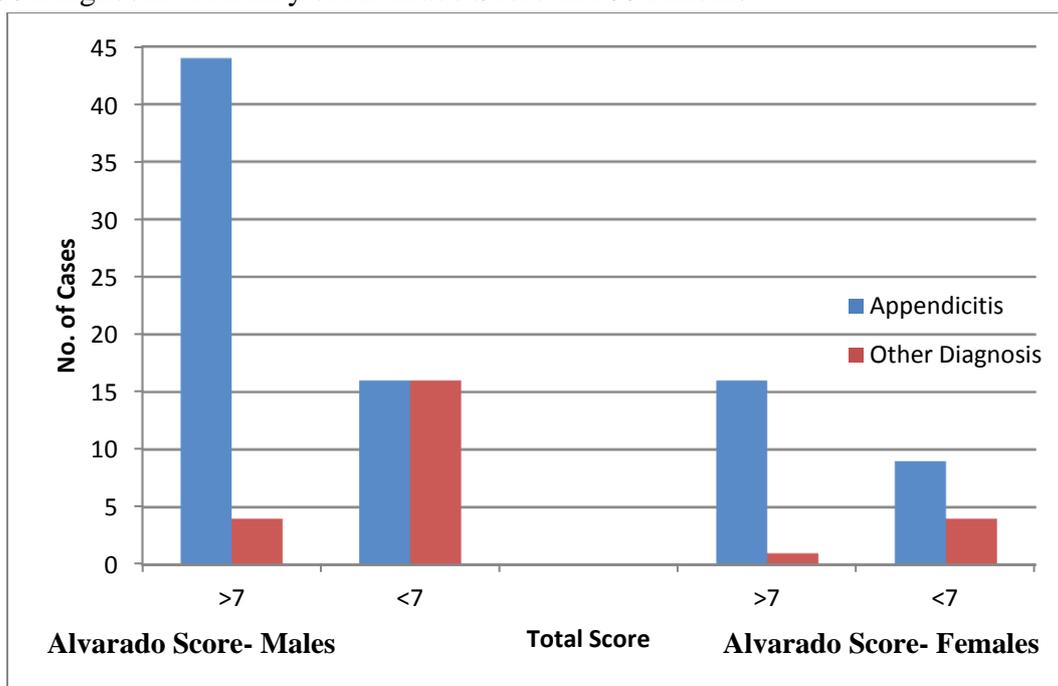
NPV in Females = 0.75 = 75%

**Total Negative Appendectomies in Females:10****NAR in Females : 35.7%**

**Table No. 09** Diagnostic Accuracy Of Alvarado Score In 100 Patients

Total Score	Appendicitis	Other Diagnosis
<b>Alvarado Score</b>		
>7	<b>60</b>	<b>05</b>
<7	<b>15</b>	<b>20</b>
<b>Males:</b>		
<b>Alvarado Score</b>		
>7	<b>44</b>	<b>04</b>
<7	<b>16</b>	<b>16</b>
<b>Female:</b>		
<b>Alvarado Score</b>		
>7	<b>16</b>	<b>01</b>
<7	<b>09</b>	<b>04</b>

**Graph No. 06** Diagnostic Accuracy of Alvarado Score In 100 Patients



**Fig. I.** Conditions Mimicking Appendicitis (Diiferential Diagnosis)



- A. Amyand's Hernia:** a rare form of inguinal hernia in which the vermiform appendix is located within the hernial sac. It is seen in less than 1% of inguinal hernia.
- B. Obstructed Right Inguinal Hernia**
- C. Torsion Meckel's Diverticulum**
- D. Torsion Right Ovary**

**Discussion**

Although acute appendicitis is the commonest abdominal emergency encountered clinically, clinicians now and again experience difficulty in diagnosing it accurately and in timely manner due to varied presentation. Operating early when the

diagnosis is less than certain, risks removal of a normal appendix which is far from harmless to patients but operating late when signs and symptoms are florid – risks rupture which is associated with a manifold increase in morbidity and mortality. To help tackle this determine, numerous types of diagnostic methods have been devised. Classical symptoms in cases of Acute appendicitis are present in only 55% of the subjects and the Negative appendectomy rate according to literature ranges from 8- 33%.

- 1) We concluded our study in 100 consecutive patients with clinical features of acute appendicitis among them 32 were females and 68 were males. Male to female ratio 2.12:1.
- 2) Most of the patients belong to younger age group ( 43% in age group of 21-30 years).
- 3) Mean scores for the emergency surgery group, and observation group were 7-10 and 5-6 respectively.
- 4) We received 14 patients with Alvarado score of 1-4 among them 8 were males and 6 were females.
- 5) Operative finding and histopathological reports showed that 21 of these patients (Alvarado score of 5- 6) were adulated for observation and regular reevaluation.
- 6) This group comprised of 7 females and 14 male patients. 4 patients ended up in decrease in scores from 9-5, 8-5. after 24 hours and were discharged. One patient had a score of 6 which did not change after the observation period. 3 patients had increased severity of symptoms and underwent appendectomy. Operative and histopathological reports showed that 3 patients had acutely inflamed appendix, 4 patients having chronic inflammatory change and one with histopathology showing epithelioid granuloma with langhans giant cells and neutrophilic infiltrate in the wall of appendix. Remaining 7 had normal appendix, out of these one patients had typhlitis, one patient

had obstructed rt. inguinal hernia, one patient with Chronic PID, one patient had Acute mesenteric lymphadenitis, one patient had a tubercular terminal ileitis, one patient had an Ileomesenteric band with gangrenous meckel's and one had a Meckel's Diverticulitis.

- 7) In 65 patients score was found to be  $>7$ . All were admitted and underwent .6 patients had lump and hence managed conservatively, discharged and called 6 weeks for interval appendectomy. Remaining among 59 patients 56 underwent appendectomy, majority had features of acute appendicitis and other s had chronic appendicitis, gangrenous appendix and appendicular abscess. Remaining 3 were found to be having pyeloepritis, gangrene of right ovary due to torsion and Amyand's hernia.
- 8) Negative appendectomy rate in our study was 32.9% out of which among males it is lesser (31.57%) as compared to females who had a higher Negative appendectomy rate of 35.7%.
- 9) Total no. of surgeries performed in our study was 85 (85%). Operative finding and histopathological report showed that 53 (62.35%) had inflamed appendix.
- 10) In our study overall Sensitivity of Alvarado score  $\geq 7$  was 92.9% and specificity was 78.5%.
- 11) In our study, in males sensitivity of Alvarado score  $\geq 7$  was 97.4% and specificity was 72.2%
- 12) Among females sensitivity of Alvarado score  $\geq 7$  was 83.3% and specificity was 90%.
- 13) Overall Positive and Negative value of Alvarado score  $\geq 7$  was 89.8% and 84.6% respectively.
- 14) Among males PPV and NPV were 88.3% and 92.8% respectively.
- 15) In females PPV and NPV were 93.7% and 75% respectively

### Drawbacks of Alvarado scoring system observed from this study:

1. 04 out of 85 patients with pain in RLQ could not be diagnosed by Alvarado score and only clinical suspicion in these cases was of value to establish the diagnosis and take the patients for and elective appendectomy and these were diagnosed as 03 cases of Acute Catarrhal Appendicitis and a case of Acute Tubercular Appendicitis
2. Also 06 cases were falsely positive with negative appendectomies. These were a diagnosed as a case each of Chronic Appendicitis, Pyelonephritis, Gangrenous Caecum, Amyand's Hernia, a right sided ovarian torsion and a case of acute gastroenteritis.

Therefore a score of  $\geq 7$  in our study has a drawback of being less specific (78.5%) than sensitive (92.9%).

### Advantage over clinical diagnosis:

06 patients having Alvarado scores of 1-4 were misdiagnosed as that of acute appendicitis which intraoperatively proved to be 4 cases of PID and a cases of Typhlitis, Crohn's disease; had Alvarado score being followed for surgical decision these patients would have been saved from unnecessary surgery.

*What should now be recommended for the diagnosis and management of acute appendicitis?*

Clinical judgement still has a place. Especially if an experienced clinician is prepared to reevaluate doubtful cases at regular intervals: rapid, unexpected perforation is uncommon, and there is no case for rushing to operate in marginal cases. Scoring systems may help, if only by formalizing assessment and ensuring attention to detail.

Ultrasound has no place as a screening tool but may help in some patients where the diagnosis is doubtful. Plain radiography of the abdomen and white cell count are highly inaccurate and should be discarded. Scoring systems would appear to be ideal as they are accurate, non invasive and require no special equipment. This is the greatest

beneficiaries for junior staff, whose diagnostic accuracy increases from 58-75%.<sup>7</sup>

### Conclusion

Acute Appendicitis was definitely absent among 28 operated cases. This rate of 32.9% was by no means high when compared to the reported range of 8- 33% in the literature but certainly not enough to make its adoption recommendable. In patients having mesenteric adenitis, PID and gastroenteritis the scoring system proved to be better than clinical diagnosis but the overall performance of clinical diagnosis was more accurate than the scoring system.

The scoring system might have directly contributed to the enhanced diagnostic precision since the surgeons were aware that the presence of 4 or 5 positive criteria suggested acute appendicitis while the presence of less made the diagnosis unlikely.

In 28 cases (32.9%) the managing surgeons did choose to contradict score predictions. It can, of course, still be argued that in remaining 57 instances the clinical decision may have been strengthened by a scoring system.

Research concluded in children and adults have already shown that negative appendectomy can be avoided without at the same time increasing rupture rate by intensive, structured, in hospital observation.

Since this common surgical emergency is managed largely or solely by the most junior members in the surgical team, increased involvement by the senior staff with closer supervision of the juniors can improve clinical performance. These strategies have proven efficacy and only few surgical units should find their adoption problematic.

### References

1. Lewis FR, Holcroft JW, Boey J, et al: Appendicitis: A critical review of diagnosis.
2. Mohamed AA and Bhat NA. Acute appendicitis dilemma of diagnosis and

management. The internet journal of surgery 2010; 23(2), DOI: 10.5580/18e0.

3. Fung HS, Lau S, Siu JCW, Chan CM, Chan SCH. Audit of ultrasonography for diagnosis of acute appendicitis: a retrospective study. J HK Coll Radiol. 2008; 11:108-111.
4. Tamanna MZ, Eram U, Hussain AM, Khateeb SU, Buhary BM. Alvarado score in diagnosis of acute appendicitis. International Journal of Basic and Applied Medical Sciences 2012; 2(1):66-70.
5. Alvarado A. A practical score for the early diagnosis of acute appendicitis. Ann Emerg Med.1986;15:557-564.
6. Ohle R, O'Reilly F, O'Brien KK, Fahey T, Dimitrov BD. The Alvarado score for predicting acute appendicitis: a systematic review. *BMC Med.* 2011;9:139
7. Heinrik Jahan, Claus P., Hovendal Department of Surgery, Odense University Hospital, Odense, Denmark : Comparison of clinical judgement and diagnostic USG in the diagnosis of acuteappendicitis experience with a score aided diagnosis.