

## Lintula Scoring System in The Diagnosis of Acute Appendicitis

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**Conflicts of Interest:** Nil

### Abstract

**Background:** Acute appendicitis is a commonly diagnosed cause of the acute abdomen requiring emergency surgical intervention. It is estimated that as much as 6% to 7% of the general population will develop appendicitis during their lifetime, with the incidence peaking in second decade of life. Lintula score was developed by Hannu Lintula and colleagues in Turku, Finland in 2009. The delay in the diagnosis increases morbidity and mortality like perforation, whereas false positive diagnosis leads to unnecessary surgery. Currently, most of the scores for diagnosis use laboratory tests which may be out of reach, especially in resource limited setting. While Alvarado scoring has clinical and laboratory components, Lintula scoring utilizes only clinical findings.

### Objectives of the study

1. To evaluate Lintula scoring system in

patients presenting with signs and symptoms of Acute Appendicitis.

2. To compare Lintula Scoring system with histopathological findings of appendectomy.

**Methods:** Patients aged 18 years or above having signs and symptoms of Acute Appendicitis are chosen for the study. Data was collected among patients having symptoms of Acute Appendicitis after meticulous history taking, performing necessary investigations. Lintula scoring is calculated based on clinical signs and symptoms in all the patients including those who are adjudged not to have acute appendicitis according to radiological findings. For patients undergoing Emergency Appendectomy, specimen is sent for HPE and follow-up is done to confirm the diagnosis. HPE reports suggesting Acute appendicitis and normal appendix are divided into two groups and they are compared with pre-operative findings of ‘Lintula’

scoring system. Using the data collected, the rates of negative appendectomy, Sensitivity, Specificity, PPV and NPV are calculated for Lintula scoring system and evaluated.

**Results:** Among the study population of 154, 110 were diagnosed to have acute appendicitis radiologically and underwent appendectomy. 44 patients were followed up and found to be not having acute appendicitis. Lintula score was applied for all the patients and the results were as follows:

Sensitivity: 92.72%, Specificity: 86.36%, PPV: 94.4 & NPV: 82.6

P-value in the study was <0.001 in 95% CI, which is statistically very significant.

**Interpretation And Conclusion:** Lintula scoring system can be used for the diagnosis of acute appendicitis and can be used especially in the resource limited setting.

**Keywords:** Lintula, appendicitis, sensitivity, specificity.

### Introduction

The abdomen is commonly compared to a Pandora's box, and for good reason. Since the abdomen contains within its innumerable viscera and other anatomical components, the diseases of the abdomen give rise to a lot of clinical curiosity. A meticulous examination of the abdomen and clinical correlation is one of the most important diagnostic tools and becomes cornerstone of management in many conditions presenting with abdominal pain. Despite the vast advances in the medical field in terms of imaging and other investigation modalities, the importance of clinical examination cannot be stressed upon enough.[1] Acute appendicitis is a commonly diagnosed cause of the acute abdomen requiring emergency surgical intervention. [2] Acute appendicitis is one of the commonest causes for acute

abdomen in any general surgical practice. [3] From the time that it was first described by Reginald Heber Fitz in 1886, it has remained a topic of serial research works for various factors ranging from its etiology, to its management options.[4] Acute appendicitis is a menacing condition known to the mankind since time immemorable. Due to the high mortality associated with the condition in pre-modern era; appendicitis used to be performed for any patient who was suspected to have acute appendicitis. The patient was made to undergo emergency open appendectomy, due to the lack of advances in the field of surgery, anesthesia and lack of efficacious antibiotics to fight against the bacteria implicated in the causation of appendicitis; the post operative outcome was not good although better than leaving a patient with a perforated appendix who would later develop generalized peritonitis, sepsis and finally succumb to sepsis related complications. As the patients with non-specific abdominal pain used to be suspected with acute appendicitis (acute appendicitis is known as a "great mimicker" as the clinical presentation of the patient with acute appendicitis is varied and if a patient is not thoroughly examined properly then potentially such a patient was subjected to a morbid procedure like open appendectomy [as per the standards during early modern surgical era]; this clearly indicated that performing an open appendectomy was unethical and it in turn prompted the clinicians to develop various scoring systems to reduced the rate of negative appendectomy. An unwanted appendectomy would unnecessarily post a great trauma to the patient and also the hospital charges in the west are substantial. USG abdomen and pelvis is pretty unreliable and is highly operator dependent and with many inconclusive or false positive reports. [5]

The delay in the diagnosis increases morbidity and mortality like perforation, whereas false positive diagnosis leads to unnecessary surgery.(6) Currently, most of the scores for diagnosis use laboratory tests which may be out of reach, especially in resource limited setting. While Alvarado scoring has clinical and laboratory components, Lintula scoring utilizes only clinical findings.(7)

Having understood the importance for early and right diagnosis, and having understood that clinical evaluation provides the best and most accurate diagnostic modality for appendicitis, many clinical scoring systems have been developed over the years. This has aided the clinician to a large extent in coming to the right diagnosis and providing early management.

A lot of studies have been carried out to validate various scoring systems used in the diagnosis of Acute Appendicitis. Each of these scoring systems, is helpful in different clinical set-ups. The main utility of Alvarado and Modified Alvarado scoring systems are to decrease unnecessary radiological scans on the patients; patient falling in the low risk category need not undergo radiological investigation to rule out Acute Appendicitis. This in turn will significantly lower the healthcare burden.

Many peripheral centers lack necessary laboratory investigations, required for the diagnosis of the condition based on existing scoring systems; hence, a new scoring system entirely relying on the clinical features was important for diagnosis of the condition in the absence of laboratory investigations. Lintula score was developed by Hannu Lintula and colleagues in Turku, Finland in 2009, to accurately diagnose Acute Appendicitis. (8)

### Lintula Scoring System <sup>8</sup>

Diagnostic Criteria	Response	Score
Gender	Male	2
	Female	0
Intensity of pain	Severe	2
	Mild to moderate	0
Relocation of pain	Yes	4
	No	0
Vomiting	Yes	2
	No	0
Pain in RLQ	Yes	4
	No	0
Fever >37.5°C	Yes	3
	No	0
Guarding	Yes	4
	No	0
Bowel sounds	Absent/tinkling/hi	4
	gh pitched	0
	Normal	
Rebound tenderness	Yes	7
	No	0
Total Score		32

Table 1: Lintula Scoring System

#### Interpretation of scores:

≤15 = Low risk for Appendicitis

16-21 = Moderate risk for Appendicitis

≥21 = High risk for Appendicitis

#### Objectives of The Study

1. To evaluate Lintula scoring system in patients presenting with signs and symptoms of Acute Appendicitis.
2. To compare Lintula Scoring system with histopathological findings of appendectomy.

After obtaining approval and clearance from the institutional ethics committee, the patients fulfilling the inclusion criteria were enrolled for the study after obtaining informed consent.

Patients aged 18 years or above having signs and symptoms of Acute Appendicitis were chosen for the study. Data was collected among patients having symptoms of Acute Appendicitis after meticulous history taking, performing hematological investigations like complete blood count, liver function tests, renal function tests, coagulation profile, serum electrolytes and serology.

Ultrasonography of the abdomen and pelvis, Chest X-ray PA view and erect abdomen X ray were done for all the patients included in the study. Lintula scoring was calculated based on clinical signs and symptoms in all the patients.

Lintula score will assess the clinical features in patients presenting with signs and symptoms of acute appendicitis. If score is  $\leq 15$ , the patients are considered not to have acute appendicitis, if 16- 20, then probable diagnosis of acute appendicitis could be made and if  $\geq 21$  then definite acute appendicitis in need for emergency surgery. But in this study, we have considered the score of  $\leq 15$  as negative for Lintula score and if the score is  $\geq 16$ , then it is considered as positive for Lintula score.

Patients who were adjudged not to have acute appendicitis, their telephone numbers were taken to follow up and enquire about the symptoms after 7 days. For patients undergoing Emergency Appendectomy, specimen was sent for HPE and follow-up was done to confirm the diagnosis. HPE reports suggesting Acute appendicitis and normal appendix were divided into two groups and they are compared with pre-operative findings of 'Lintula' scoring system.

Using the data collected, the rates of negative appendectomy, Sensitivity, Specificity, Positive Predictive value and Negative Predictive values were calculated for Lintula scoring system and evaluated.

All the findings were entered in a predesigned proforma and the findings were tabulated in a Microsoft Excel sheet and analyzed.

### Inclusion Criteria

- Patients aged above 18 years.
- Patients willing to sign the informed consent form as per Annexure 1
- Patients having signs and symptoms of Acute appendicitis.
- Patients undergoing Emergency Appendectomy.

### Exclusion Criteria

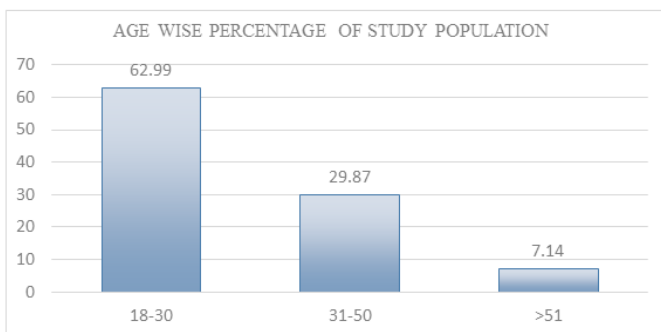
- Patients undergoing interval appendectomy.
- Patients aged below 18 years.
- Patients who are not signing informed consent.
- Patients not fit for surgery because of co-morbidities.
- Patients undergoing conservative management.

### Results

Majority of the patients belonged to the age group between 18 and 30 years. We analyzed that as the age progressed, incidence of acute appendicitis also got reduced. Mean age of the study population was found to be 30.54 years. Standard deviation was 11.49.

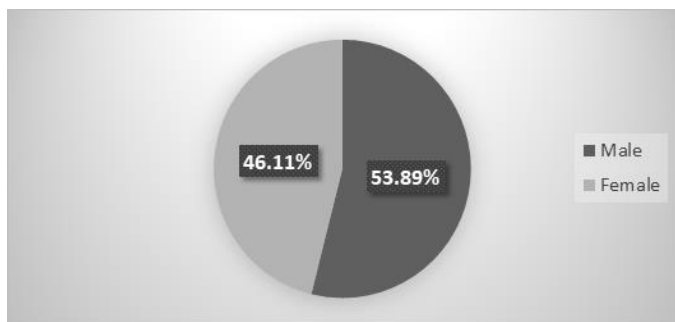
Age (in years)	Number of patients	Percentage of total sample
18-30	97	62.99%
31-50	46	29.87%
>51	11	7.14%

Table 1: AGE based distribution of the patients in the study population



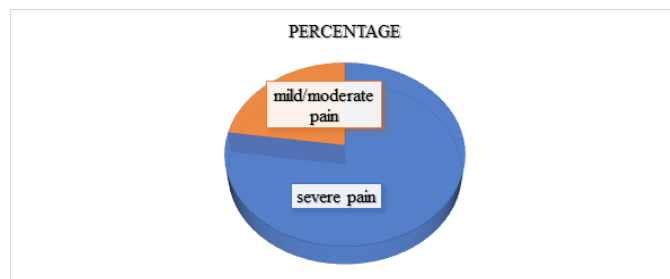
Graph 1: AGE based distribution of the patients in the study population

Further, 83 patients were males and 71 patients were females. Out of 83 males, 64 were diagnosed to have acute appendicitis radiologically who underwent appendicectomy and the rest 19 were followed up on a regular basis. Out of 71 female patients, 46 were diagnosed to have acute appendicitis radiologically and underwent appendicectomy. Lintula score accurately diagnosed appendicitis in 59 male patients and 43 female patients. Lintula score also ruled out appendicitis correctly in 15 of the 19 males, and 23 of the 25 female patients.



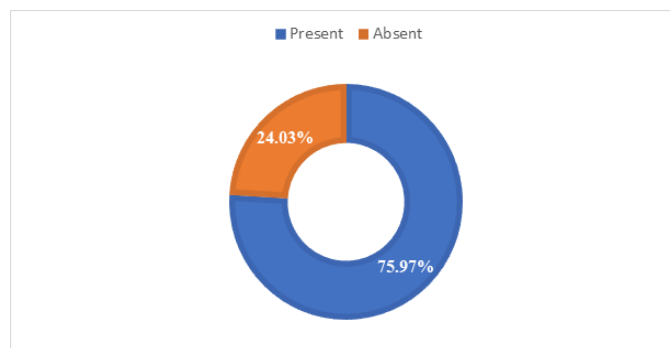
Graph 2: Gender based distribution of the patients in the study population

Out of 154 patients, 120 had severe pain and the rest had either mild or moderate pain.



Graph 3: Pain intensity graph in the study population based on numeric rating pain scale

All 154 patients had presented with the pain in the right iliac fossa. 76 patients had complained of migration of pain, starting at the umbilical region then migrating to RIF. Out of 154 study patients, 117 had come with one or more episodes of vomiting within 48 hours of presentation to the casualty.



Graph 4: PIE/Donut graph detailing percentage of study population, with vomiting as their symptom.

Out of 154 study population, guarding was present in 27 patients and the rest 127 patients did not have guarding. High pitched or absent or tinkled bowel sounds were present only in 16 of 154 study population. 122 patients had come with at least 1 episode of fever in the last 48 hours of 154 patients, 76 presented with rebound tenderness.

- Among the study population of 154, 110 were diagnosed to have acute appendicitis radiologically and underwent appendicectomy. 44 patients who were not having any radiological signs of acute appendicitis were co-related with Lintula score.

- Lintula score was applied for all the patients before conducting radiological examination. Sensitivity: 92.72%, Specificity: 86.36%, PPV: 94.4 & NPV: 82.6.

	lintula score >15 (score positive for acute appendicitis)	lintula score ≤15 (score negative for acute appendicitis)	Total
Appendicitis	102 (true positive)	08 (false negative)	110
No appendicitis	06 (false positive)	38 (true negative)	44
			154

**TABLE 2: Study results tabulation**

The above table was prepared by analyzing the data collected for our study:

$$\text{Sensitivity} = \frac{\text{True Positive}}{(\text{True Positive} + \text{False Negative})}$$

$$\text{Specificity} = \frac{\text{True Negative}}{(\text{True Negative} + \text{False Positive})}$$

$$\text{Positive Predictive Value} = \frac{\text{True Positives}}{(\text{True Positives} + \text{False Positives})}$$

$$\text{Negative Predictive Value} = \frac{\text{True Negative}}{(\text{True Negative} + \text{False Negative})}$$

Chi-Square Tests			
	Value	Degree of freedom	Asymptotic Significance (2-sided)
Pearson Chi-Square	93.851	1	<.001
Continuity Correction	90.113	1	<.001
Likelihood Ratio	95.415	1	
Number of Valid Cases	154		
a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 13.14.			
b. Computed only for a 2x2 table			

Table 3: Chi-Square Tests

In our study we determined the accuracy of Lintula scoring system in correctly predicting the presence of Acute Appendicitis with HPE results as gold standard for co-relation. The results obtained by applying Chi-Square test were checked for statistical significance using the tests mentioned in the above table using SPSS Version 25. All the values were found to be statistically significant (p-value less than 0.001, CI-95%).

The Pearson’s Correlation was calculated with Lintula score and HPE diagnosis of the acute appendicitis and the following results were obtained. The Pearsons coefficient was found to be 0.781 which was statistically significant. The obtained p-value was obtained to be less than 0.001 at 95% confidence interval. From this can we conclude that there is a statistically significant association with positiveness (>16) of Lintula score and HPE-Acute appendicitis.

		Lintula Score	HPE- Acute Appendicitis
Lintula Score	Pearson Correlation	1	.781**
	Sig. (2-tailed)		.000
	N	154	154
HPE- Acute Appendicitis	Pearson Correlation	.781**	1
	Sig. (2-tailed)	.000	
	N	154	154
** Correlation is significant at the 0.01 level (2-tailed).			

Table 4: Correlation of Lintula Test Positivity With The Diagnosis Of Hpe-Acute Appendicitis

**Discussion**

A study population of 154 patients was taken into consideration, who presented with signs and symptoms of acute appendicitis to the casualty of ESIC Medical College & PGIMSR, Rajajinagar, Bangalore. Lintula scoring system was used to check the accuracy of the scoring system in the correct diagnosis of acute appendicitis in all the patients.



Based on our study, we found that majority of the patients in our study belonged to the age group between 18 and 30 years, covering around 63% of the patients. Mean age was found to be 30.54 years.

Out of 154 study patients, 110 were diagnosed to have acute appendicitis radiologically who underwent open or laparoscopic appendicectomy. The rest 44 were regularly followed up, and repeat radiological investigation was performed to conclusively rule out any active episode of acute appendicitis. The patients planned for conservative management were not considered in this study, as HPE co-relations were not possible for them for the positive diagnosis.

This study also provided us with the data suggesting that majority of- the patients who did undergo appendicectomy were belonging to the age group 18-30 years old, almost making up 63%.

Majority of the patients were male, 53.89% being male and the rest being female. This bodes well with the study, as male gender carries 2 points in our Lintula scoring system.

Intensity of pain, which was calculated using numeric rating scale, showed that 120 patients had come with severe intensity of pain. But all the patients did have pain in the right iliac fossa.

Vomiting was also a major complaint among the patients, with almost 76% of the patients presenting with one or more episodes of vomiting.

Fever was also a prominent symptom, which was present in 79.22% of the population. At least 1 episode of fever was present in the above-mentioned population.

76 patients presented with rebound tenderness. As this is the particular sign, which carries highest significance in our scoring system, this data gives us relevant information regarding the diagnosis of the condition. It

carries 7 points out of total 32 points in our scoring system. Although, not a very prominent sign in every patient, its presence significantly points out towards the direction of acute appendicitis.

Guarding and change in bowel sounds, were not a prominent finding as only 27 patients had guarding and 16 had change in bowel sounds. The latter also being a subjective finding, was checked with 2 of our colleagues to confirm the finding before the calculation of the score for the patient.

Since the score was applied in all the patients, clinical diagnosis of whether the patient had acute appendicitis or not was done based on the score. But, since the score has not yet been widely accepted, the management plan was based on radiological finding. Finally, radiologically proven acute appendicitis, and underwent appendicectomy, HPE reports were collected.

A total of 110 patients were found to have acute appendicitis, out of which Lintula scoring system correctly diagnosed the condition in 102 patients. Out of the remaining 44 patients, Lintula scoring system predicted the correct diagnosis in 38 patients. Based on these findings, we calculated Sensitivity, specificity, PPV and NPV.

- Sensitivity: 92.72%
- Specificity: 86.36%
- PPV: 94.4
- NPV: 82.6.

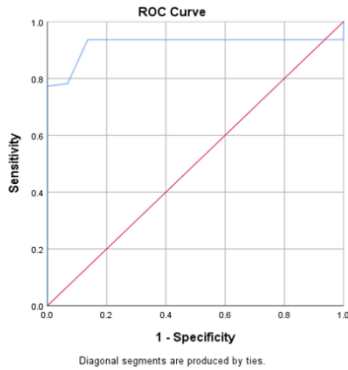
These findings concur with the studies previously conducted by Sana Khan et al(2018) and Omer Yoldas et al(2010).

Parameters	Our Study	Sana Khan Et Al	Omer Yoldas Et Al
Sensitivity	92.72%	71%	88.11%

Specificity	86.36%	87%	91.66%
Ppv	94.4	96	97.8%
Npv	82.6	40	64.7%

Table 5: Comparison of our study with previous studies.

**Receiver Operator Characteristics Curve**



Receiver operator characteristics curve was plotted for the data obtained and then area under the curve (ROC-AUC) was calculated. ROC-AUC was found to be 0.924, suggesting that Lintula score has a very good discriminatory accuracy. For reference any score with an AUC-ROC of greater than 0.9 is considered to be a very good score.

Coordinates plotted on the ROC showed that the sensitivity (true positive rate) and (1-specificity) (false positive rate) for a value of 15.5 was 78.2% and 93.2% respectively. Specificity and sensitivity for a value of 16.5 was 100% and 71.3% respectively. Specificity for a score greater than 16.5% was 100%. This suggests that the apt cut off Lintula score to make a diagnosis of Acute appendicitis is somewhere between 15.5 and 16.5; and a clinician can be sure that the patient has got acute appendicitis if the calculated score is greater than 16.5. This is in concordance with the results published earlier (in fact our study showed better results compared to the earlier studies.)

The test result variable(s): total has at least one tie between the positive actual state group and the negative actual state group.

a. The smallest cutoff value is the minimum observed test value minus 1, and the largest cutoff value is the maximum observed test value plus 1. All the other cutoff values are the averages of two consecutive ordered observed test values.

Positive if Greater Than or Equal To <sup>a</sup>	Sensitivity	1 – Specificity
5.00	1.000	1.000
6.50	.964	1.000
7.50	.936	1.000
8.50	.936	.909
9.50	.936	.795
10.50	.936	.705
11.50	.936	.409
12.50	.936	.227
14.00	.936	.136
15.50	.782	.068
16.50	.773	.000
17.50	.627	.000
19.00	.564	.000
20.50	.336	.000
21.50	.273	.000
22.50	.200	.000
23.50	.182	.000
25.00	.136	.000
27.00	.082	.000
29.00	.045	.000
31.00	.036	.000
33.00	.000	.000

Table 6: Table depicting variables of Lintula scoring system and its sensitivity and specificity based on ROC. The Pearson’s Correlation was calculated with Lintula score and HPE diagnosis of the acute appendicitis and the following results were obtained. The Pearsons coefficient was found to be 0.781 which was statistically significant. The obtained p-value was obtained to be less



than 0.001 at 95% confidence interval. From this can we conclude that there is a statistically significant association with positiveness (>16) of Lintula score and HPE-Acute appendicitis.

### **Conclusion**

Acute appendicitis still remains one of the most common surgical emergencies all over the world. Timely diagnosis and accurate management of the condition plays a vital role in preventing further complications. Currently, there are various scoring systems which help us arrive at the diagnosis, Alvarado and RIPASA scores being prominently used all over the world.

Since, all scoring systems use laboratory investigations, diagnosis is set to be delayed until the arrival of reports. This poses a great deal of problem, especially in places where 24\*7 lab facilities might not be available. Hence, in this study, we have used Lintula scoring system which relies only on clinical signs and symptoms to arrive at the diagnosis. This method of scoring system proves to be of vital importance, as it provides diagnosis within minutes and is particularly helpful in places where laboratory investigations are not readily available.

With the results we acquired from our study, it proved that Lintula scoring system has a high sensitivity and specificity which can be compared with popular scores like Alvarado scoring system. The scoring system also showed an above average NPV and PPV, which is crucial in any scoring system adapted for accurate diagnosis. Correlation co-efficient and p-value found in our study is found to be statistically very significant. Hence, this can be deemed as a reliable method of scoring system to assess acute appendicitis in patients clinically, especially in a laboratory limited setting. This result is of prime importance, as to prevent any

complication due to acute appendicitis as it almost accurately diagnoses the condition.

Our study does not include patients below 18 years of age, which can be considered as a weakness. A study design including pediatric group of population would help us find out the effectiveness of this scoring system in that age group.

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