ORIGINAL RESEARCH

Evaluation of Ohmann Score in the Diagnosis of Acute Appendicitis in Patients Admitted in a Tertiary Care Hospital

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ABSTRACT
Background: To Diagnose Acute Appendicitis based on Ohmann score and correlating it with postoperative histopathological report.
Materials and Methods: This study was undertaken in 80 patients with a provisional diagnosis of acute appendicitis getting operated over a period of 18. months.Ohmann score was applied in the preliminary diagnosis, which was confirmed by intra operative and histopathological findings.
Results: Fifty-eight patients were males and 22 were females. There was no statistical significance in the male to female ratio. The highest incidence was found in the age group of 21-30 and the lowest was seen in the age group of >40. Ohmann score of 13.5 was found in 11 patients and score of 14 was also seen in 11 patients .1.5 was least ohmann score seen who had a normal appendix on histopathology. As ohmann score was categorised into 3 categories,3 patients had Ohmann score of less than 6 out of which 2 had a normal appendix on histopathology and the other patient had appendicitis on histopathology. Depending on the cut-off value taken, sensitivity ranges from 100% to 4.54%, specificity ranges from 14.28% to 100%, positive predictive value ranges from 84.61% to 100% and negative predictive value ranges from 100% to 18.18%.
Conclusion: Ohmann scoring system significantly reduces the number of negative laparotomies without increasing overall rate of appendicular perforation. It can work effectively in routine practice as an adjunct to surgical decision making in questionable acute appendicitis. It is simple to use and easy to apply since it relies only on history, clinical examination and basic lab investigations.
Keywords: Ohmann Score, Appendicitis, Specificity, Histopathology, Perforation, Laprotomy.

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INTRODUCTION
Acute appendicitis is the most common abdominal emergency requiring surgery with an estimated lifetime prevalence of 7%.[1]The classical signs and symptoms of acute appendicitis were first reported by Fitz in 1886.[2]
The effort of early diagnosis and intervention has successfully lowered the mortality rate to less than 0.1% for non-complicated appendicitis, 0.6% where there is gangrene, and 5% for perforated cases.[3] The early and accurate diagnosis of acute appendicitis is still a difficult problem.[4] Despite the introduction of ultrasound and special laboratory investigations (e.g.

C-reactive protein), high diagnostic error rates are observed.[5] As a consequence, perforation rates and rates of appendectomy with normal findings of 15% and more occur.[6]

Equivocal cases usually require inpatient observation. Attempts to increase the diagnostic accuracy in acute appendicitis have included computer aided diagnosis, imaging by ultrasonography, laparoscopy, and even radioactive isotope imaging.[7-10]

In the last few years, several scoring systems have been developed for supporting the diagnosis of acute appendicitis.[11] Initial evaluation studies have reported excellent results, indicating that scoring systems would be ideal as diagnostic aids because they have good performance and require no special equipment, being user- friendlyand comprehensible to the clinician. The Ohmann score includes seven clinical variables and a WBC count.[12] The score was developed in a group of 870 patients at German and Austrian hospitals and was validated four months later in a second group of patients at the same hospitals. In the prospective validation, the Ohmann score successfully identified patients at low, moderate, and high risk of appendicitis.[12]

Aim
To assess Ohmann score in the diagnosis of acute appendicitis.

Objectives
Diagnosing Acute Appendicitis based on Ohmann score and correlating it with postoperative histopathological report.

MATERIALS & METHODS
Place of Study: Osmania General Hospital,Hyderabad.
Period of Study:18 months
Sample Size:80 patients
Study Design: Cross-sectional study

Inclusion Criteria
1. 80 patients admitted with pain in right iliac fossa suspected to have acute appendicitis.
2. Both sexes.
3. Age 12 years and above.

Exclusion Criteria
1. Age less than 12 years.
2. Critically ill patients.
3. Patients diagnosed as appendicular perforation/abscess/mass preoperatively based on ultrasonography.
4. Patients diagnosed to have ureteric colic, pelvic inflammatory disease, torsion ovarian cyst, endometriosis.
5. Patients with history of tuberculosis, amebiasis.

All subjects who were about to undergo surgery on the decision of senior surgeon were included. During examination general data were taken (age, gender), as well as data crucial for the diagnostic scores (intensity, localisation and quantity of pain, presence or absence of other symptoms, existence of nausea or vomiting, existence of anorexia). The main part of physical examination was palpation of abdomen, painful sensitivity of abdomen on palpation, existence of signs of peritonitis on palpation, positive Blumberg test (rebound tenderness). Body temperature was measured with mercury thermometer placed axillary.

Number of leucocytes was determined from full blood samples taken with anticoagulant K3-EDTA in automated hematology counter. The results were stated in number of leucocytes/L.All patients were subjected to ultrasonography.
Ohmann score was calculated for all the patients

Table 1: Ohmann Score

Symptoms/Signs/Investigations	Score
Tenderness In RightLower Quadrant	4.5
ReboundTenderness	2.5
AbsenceOfUrinarySymptoms	2.0
ContinuousPain	2.0
Wbc>10,000	1.5
Age<50Years	1.5
Symptoms/Signs/Investigations	Score
Migration Of Pain To Right Lower Quadrant	1.0
Involuntary Muscular Tension(Defence)	1.0
Total Score	16

<6 - Appendicitis Excluded 6-11.5 - Observation Needed
≥12 - Appendicectomy Needed

Criteria for appendicitis by histopathology:
A histological criterion for the diagnosis of acute appendicitis is polymorphous leucocytic infiltration of the muscularis mucosa
After preoperative processing, the patients underwent surgery and appendix as preparation was submerged into 10% formalin and submitted to the Department of Pathology. Appendix preparation was treated with standardised procedure and stained with hematoxylin and eosin, followed by observation through a microscope for the needs of histopathological diagnostics which excluded or confirmed appendicitis and the degree of inflammation was determined.
Ohmann score was compared to the histopathology report and accuracy of ohmann score was analysed.

Statistics: Data entry and analysis were done using SPSS(Statistical Package for Social Sciences) Version 19.Association between Ohmann score and Histopathology was tested using Chi-square test.p value less than 0.05 was considered as significant.

RESULTS
In the present study, 80 cases were provisionally diagnosed of acute appendicitis and were operated during the study period.

Table 2: Age Distribution

Age	Frequency	Percent
12-20	26	32.5%
21-30	40	50%
31-40	12	15%
>40	2	2.5%
Total	80	100%

From the above table, in the present study, 26 patients were found in the age group of 12-20(32.5%), 40 patients were found in the age group of 21-30(50%), 12 were found in the age

group of 31-40(15%),2 patients were found in the age group above 40(2.5%).Mean age of presentation is 24.6 years.

Table 3: Sex Distribution

Sex	Frequency	Percentage
Male	58	72.5%
Female	22	27.5%

In this study 58 were male (72.5%) and 22 were female(27.5%).

Table 4: Ohmann Score Distribution

Ohmann score	Appendicitis on HPE	Normal on HPE	Total
1.5	0	1	1
3.5	0	1	1
5	1	0	1
6	1	2	3
7	1	2	3
8	3	1	4
9	1	0	1
9.5	1	0	1
10	2	1	3
10.5	2	2	4
11	2	0	2
11.5	2	1	3
12	4	1	5
12.5	4	1	5
13	6	0	6
13.5	11	0	11
14	10	1	11
14.5	2	0	2
15	10	0	10
16	3	0	3
Total	66	14	80

Out of 80 patients, 66 have appendicitis and 14 have normal findings on histopathology.Out of 66 it was observed that highest number of patients (11) were having an ohmann score of 13.5 and least ohmann score of 5 was observed in 1 patient. Two patients one with ohmann score of 12.5 and one with 14 were found to have normal appendix on histopathology.

Table 5: Group-wise distribution of OHMANN score

Ohmann Score Range	Appendicitis On HPE	Normal On HPE	Total
<6	1	2	3
6-11.5	15	9	24
≥12	50	3	53

In 3 patients with Ohmann score <6 ,1 has appendicitis and 2 have normal appendix on HPE.In 24 patients with Ohmann score of 6-11.5 ,15 patients have appendicitis and 9 patients have normal appendix on HPE. In 53 patients with Ohmann score ≥12 ,50 patients have appendicitis and 3 patients have normal appendix on histopathology.

Table 6: Validity of ohmann score for diagnosis of acute appendicitis

Cut-off Value	True Negative	False Negative	True Positive	False Positive	Sensitivity	Specificity	Positivepredictive value	Negativepredictive value	Accuracy
≥5	2	0	66	12	100%	14.28%	84.61%	100%	85%
≥6	2	1	65	12	98.48%	14.28%	84.41%	66.66%	83.75%
≥7	4	2	64	10	96.96%	28.57%	86.48%	66.66%	85%
≥8	6	3	63	8	95.45%	42.85%	88.73%	66.66%	86.25%
≥9	7	6	60	7	90.90%	50%	89.55%	53.84%	83.75%
≥9.5	7	7	59	7	89.39%	50%	89.39%	50%	82.5%
≥10	7	8	58	7	87.87%	50%	89.23%	46.66%	81.25%
≥10.5	8	10	56	6	84.84%	57.14%	90.32%	44.44%	77.5%
≥11	10	12	54	4	81.81%	71.42%	93.10%	45.45%	80%
≥11.5	10	14	52	4	78.78%	71.42%	92.85%	41.66%	77.5%
≥12	11	16	50	3	75.75%	78.57%	94.33%	40.74%	76.25%
≥12.5	12	20	46	2	69.69%	85.71%	95.83%	37.5%	72.5%
≥13	13	24	42	1	63.63%	92.85%	97.67%	35.13%	68.75%
≥13.5	13	30	36	1	54.54%	92.85%	97.29%	30.23%	61.25%
≥14	13	41	25	1	37.87%	92.85%	96.15%	24.07%	47.5%
≥14.5	14	51	15	0	22.72%	100%	100%	21.53%	36.25%
≥15	14	53	13	0	19.69%	100%	100%	20.89%	33.75%
≥16	14	63	3	0	4.54%	100%	100%	18.18%	21.25%

Depending on the cut-off value taken, sensitivity ranges from 100% to 4.54%,specificity ranges from 14.28% to 100%, positive predictive value ranges from 84.61% to 100% and negative predictive value ranges from 100% to 18.18%. If 12 is considered as a cut-off point

then the sensitivity, specificity, positive predictive value, negative predictive value can be calculated.

Table 7:Ohmann Score

Ohmann score	Appendicitis	Normal	Total
≥12	50(True positives)	3(Falsepositives)	53
<12.5	16(False negatives)	11(True negatives)	27

Table 8: Negative Appendicectomies

	Male	Female
Normal on histopathology	9	2

DISCUSSION

Acute appendicitis is a common abdominal emergency throughout the world. The diagnosis of acute appendicitis continues to be difficult due to the variable presentation of the disease and the lack of reliable diagnostic test.

The diagnosis of acute appendicitis is purely based on history, clinical examination and laboratory investigations. Previously, imaging techniques have been shown to aid very little in diagnosing acute appendicitis. Though there are lots of advances in the diagnostic field with the invention of sophisticated investigations, diagnosis of acute appendicitis still remains an enigma for the attendant surgeon.

Radiological methods such as ultrasonography and computed tomography are being used. In an attempt to increase the diagnostic accuracy, several scoring systems have been devised.

A certain diagnosis can only be obtained per operative and after pathological examination of the surgical specimen. A negative appendectomy rate of 20-25% has been reported. Removing normal appendix is an economic burden both on patients and health resources. Misdiagnosis and delay in surgery can lead to complications like appendicular abscess, gangrene, perforation and eventually peritonitis. Difficulty in diagnosis arises in very young, elderly patients and females of reproductive age group because they usually have atypical presentations and other pathological conditions presenting as acute abdomen for example dysentery, mesenteric lymphadenitis and pelvic inflammatory disease and other gynaecological conditions.Time and again, it has proved that some of the investigations already discussed are costly, time consuming, require more sophisticated equipment and expertise, while some are not feasible and not readily available.

There have been many attempts to increase the accuracy of the diagnosis of acute appendicitis. Besides clinical evaluation, with the variety of clinical signs and symptoms, many of the modern diagnostic tools, such as graded compression sonography, CT and diagnostic laparoscopy have proved to be effective in the diagnosis of acute appendicitis.

With this background many eminent surgeons and physicians have been adopting different scoring systems in order to decrease negative appendectomy. Although there has been some improvement in the diagnosis of acute appendicitis over the past several decades, the percentage of normal appendices reported in various series varies from 8 to 33%.

Clinical scoring systems have significantly proved useful in the management of acute appendicitis cases.In the past few years various scores have been developed to aid the diagnosis of acute appendicitis. Although sonography and CT increase the accuracy of the diagnosis of acute appendicitis, they are unfortunately still often unavailable around the clock in some emergency departments, especially in the absence of highly trained, experienced staff.

Several scoring systems that have been devised for the purpose of increasing both the sensitivity and specificity of the diagnosis of acute appendicitis had been repeatedly tested. Scoring systems represent inexpensive, non-invasive and easy to use diagnostic aid.

The simplicity of the score for acute appendicitis is quite appealing.

The idea of improving the diagnostic accuracy simply by assigning numeric values to defined signs and symptoms has been a goal in some of scores described. Parameters comprising the score usually include general signs of abdominal illness (e.g. type, location and migration of pain, body temperature, signs of peritoneal irritation, nausea, vomiting etc) as well as routine laboratory findings (leukocytosis). Such simple scoring systems may work as expected in the original setting, but they do not take into consideration different diagnostic weights of each parameter in different sub- population (e.g. children, women etc). Thus, scores usually did not repeat their good results when applied to different populations, which led to the creation of new scoring systems and their re-evaluation in different settings.

The Ohmann scoring system requires history, clinical examination and basic lab investigations(WBC Count).

The present study was undertaken to evaluate the usefulness of Ohmann scoring system in reducing the number of negative appendectomy and to evaluate the sensitivity, specificity, positive predictive value,negative predictive value by correlating with the histopathology.

Ohmann et al. performed a multivariate analysis, and of initial 15 parameters, 8 were included into regression model, resulting in different values being attributed to each parameter. Originally, it has been pro- posed that patients with scores less that 6 should not be considered to have appendicitis. Patients with scores 6 or more should undergo observation, and those with scores 12 or more should proceed to immediate appendectomy.

Our results and observations were discussed and compared with various other studies. The age group in which acute appendicitis occurred commonly was between 21 and 30 years with a peak incidence in the third decade.It is clear that incidence is less in younger and older age groups who have higher risk of perforation.

In our study the male to female ratio is 2.6:1 which is in accordance to previous studies that acute appendicitis is more common in males.

In our study the male to female ratio is 2.6:1 which is in accordance to previous studies that acute appendicitis is more common in males.

Pain, tenderness were among the most commonest presenting variables and has been observed in almost all the cases in the present study.

Ohmann score of 13.5 was found in 11 patients and score of 14 was also seen in 11 patients.1.5 was least ohmann score seen who had a normal appendix on histopathology. As ohmann score was categorised into 3 categories,3 patients had ohmann score of less than 6 out of which 2 had a normal appendix on histopathology and the other patient had appendicitis on histopathology.

The sensitivity and specificity showed inverse relationship to each other.Positive predictive value was high at all cut-off values.

Kıyak et al,[7] reported in their study that Ohmann scoring system may be more successful at excluding diagnosis of acute appendicitis.In our study only 3 patients had an ohmann score of <6 (which is considered as appendicitis ruled out according to Ohmann score),so negative predictive was calculated as 66.66% but is not of much significance as only 3 patients are in this category which is very low.

The sensitivity in our study(75.75%) is not the best as compared to other studies on Ohmann score as well as modified Alvarado score.The sensitivity was 96% in study by Koppad etal in which ≥9 Ohmann score was considered as appendicitis and <9 Ohmann score was considered.

as 'No appendicitis'. This study by Koppad etal,[13] showed highest sensitivity maybe because of the lower set cut-off value.

The specificity in our study was (78.57%) is comparable to the study by Bhushankumar AThakur (80.95%).[14]

Our study showed a highest Positive predictive value of 94.33% as compared to many studies indicating ohmann score ≥12 has very high possibility of appendicitis.

Negative predictive value was low (40.74%) indicating that even though the score was low (<12) there is chance of acute appendicitis, therefore a range of 6-11.5 is therefore considered as 'observation category'.

Negative appendicectomy rate in our study was 17.5% which is comparable to other studies 30% in Ohmanns study and 15-30% as reported.

CONCLUSION

Ohmann scoring system significantly reduces the number of negative laparotomies without increasing overall rate of appendicular perforation. It can work effectively in routine practice as an adjunct to surgical decision making in questionable acute appendicitis. It is simple to use and easy to apply since it relies only on history, clinical examination and basic lab investigations. It is cost-effective and can be used in all district general hospitals with basic lab facilities. Scoring systems should not be the only parameters on the basis of which a conclusion is made on the existence of acute appendicitis in patients with abdominal pain, a clinical, radiological and comprehensive assessment of each case is necessary, led by contemporary algorithms in which diagnostic scores are also implemented.

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