A PROSPECTIVE EVALUATION OF THE COMBINED USE OF MODIFIED ALVARADO SCORE AND ULTRASONOGRAPHY IN DECREASING NEGATIVE APPENDICECTOMY RATE

Vivek Patel¹, Sunil Agrawal², Mukesh Singh Narwaria³, Achal Gupta⁴

¹Post Graduate Student, Department of Surgery, Gajra Raja Medical College, Gwalior, Madhya Pradesh.

²Associate Professor, Department of Surgery, Gajra Raja Medical College, Gwalior, Madhya Pradesh.

³Assistant Professor, Department of Surgery, Gajra Raja Medical College, Gwalior, Madhya Pradesh.

⁴Professor and HOD, Department of Surgery, Gajra Raja Medical College, Gwalior, Madhya Pradesh.

ABSTRACT

BACKGROUND

Making the diagnosis of acute appendicitis is difficult and is important for preventing perforation of the appendix and negative appendectomy results. Clinical Scoring System like Modified Alvarado Scoring System, Ultrasonography or combined use of both simultaneously are very helpful in making the early and accurate diagnosis and decreasing negative appendectomy.

OBJECTIVES

Aim of this study is to evaluate the sensitivity, specificity and diagnostic accuracy of modified Alvarado scoring system and Ultrasonography in the diagnosis of acute appendicitis and their correlation with histopathology report and to reduce the rate of negative appendectomy by combined use of modified Alvarado scoring system and Ultrasonography in the patients of acute appendicitis.

METHODOLOGY

A total of 97 patients who were diagnosed as having acute appendicitis and subsequently underwent emergency appendectomy after proper explained written consent were included in this study. Data regarding demographic profile, Modified Alvarado Score, Ultrasound abdomen and histopathology report were collected and analysed statistically.

RESULTS

Sensitivity, specificity and Diagnostic Accuracy of Modified Alvarado score using cut-off score of ≥ 7 and Ultrasound Abdomen were 92.39%, 40%, 89.69% and 88.04%, 80%, 87.62% respectively. Sensitivity, Specificity, Negative Predictive Value and Diagnostic Accuracy of our combined diagnostic approach in the diagnosis of acute appendicitis were 99.99%, 40%, 100% and 96.90% respectively. Negative appendectomy rate in the study was 5.15%.

CONCLUSION

In comparison to modified Alvarado scoring system and Ultrasonography alone, combined use of Modified Alvarado Scoring System and Ultrasonography has better sensitivity, positive predictive value, negative predictive value, diagnostic accuracy with lower false positive rate making it more accurate predictor of acute appendicitis, thus helpful in early accurate diagnosis and decrease negative appendectomy rate in the diagnosis of acute appendicitis.

KEYWORDS

Appendicitis, Ultrasonography, Modified Alvarado Scoring System (MASS).

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INTRODUCTION

Acute appendicitis is the most common acute surgical condition of the abdomen in all ages and common disease in surgical practice, which comprises 10% of all surgical cases in emergency department.¹ Approximately, 7% of population will have appendicitis in their lifetime with a peak incidence between 10 and 30 years.²

Even after elapse of more than 120 years since Fitz first described the pathophysiology of appendicitis and McBurney demonstrated how early appendectomy can prevent appendicular perforation. This common surgical disease continues to remain a diagnostic problem and can baffle best of the clinician.^(3,4)

Removing normal appendix is an economical burden both on the patients and the health resources, while on the other hand misdiagnosis and delay in surgery can lead to complications like perforation and finally peritonitis, thus definitely increases the morbidity, mortality and cost of treatment. Many studies found that it is impractical to have a gold standard for definitive preoperative diagnosis, which leads to an appreciable rate of negative appendectomy as reported in the world literature varying from 20–40% with its associated morbidity of around 10%.⁵

In order to make an early and correct diagnosis of this sometimes very elusive disease and decrease unnecessary

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Corresponding Author:

Vivek Patel,

Department of Surgery,

Gajra Raja Medical College,

Gwalior,

Madhya Pradesh.

E-mail: vivekjmrcraipur@gmail.com

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appendicectomies, over the last two decades, different protocols for example Scoring system, Imaging modalities and Laboratory investigations have been introduced and tested by different researchers. Various Scoring system include Lidverg, Fenyo, Christian, Ohmann and Alvarado Scoring Systems. Alvarado in 1986 introduced a criterion for the diagnosis of acute appendicitis. The Alvarado score was modified later by Kalan in 1988, which considered only one laboratory finding and a total score of 9 instead of 10.^(6,7,8,9)

Thus the aim of this study is to evaluate the sensitivity and specificity of Modified Alvarado Scoring System and Ultrasonography in the diagnosis of acute appendicitis, to evaluate diagnostic accuracy of both and their correlation with histopathology report and to reduce the rate of negative appendectomy by combined use of Modified Alvarado Scoring System and Ultrasonography in the patients of acute appendicitis.

METHODS AND MATERIALS

This Prospective Study was conducted at Department of Surgery, Gajra Raja Medical College and J A Group of Hospitals, Gwalior, involving 97 adult patients admitted, suspected to have acute appendicitis, fulfilled the inclusion and exclusion criteria and giving written consent to be undergoing emergency appendectomy during period of September 2014 to August 2015.

Inclusion Criteria

Were age ≥ 15 and ≤ 70 years and acute abdominal pain clinically presumed to be of appendicular origin.

Exclusion Criteria

Were age < 15 years or > 70 years, palpable mass on abdominal examination, signs of generalized peritonitis and patient who were not willing for appendectomy.

All suspected patients had undergone clinical examination with Modified Alvarado Scoring, routine blood investigations and Ultrasound abdomen. As confirmation of diagnosis of acute appendicitis was only possible by histopathological examination of appendix. All suspected cases underwent emergency appendectomy after well-informed written consent.

In this Study Patients were taken for Emergency Appendectomy if

1. Modified Alvarado Score ≥ 7 with or without ultrasound reporting suggestive of acute appendicitis.
2. Modified Alvarado Score < 7 with ultrasound reporting suggestive of acute appendicitis.
3. Modified Alvarado Score < 7 with negative ultrasound report with sign and symptoms suggestive of acute appendicitis, failing to subside with conservative management of 48 hours.

All patients subjected to emergency open appendectomy were adequately prepared preoperatively with nil orally of 6 hours, parenteral fluids, electrolyte supplements and administration of broad-spectrum antibiotics intravenously.

Emergency open appendectomy was done under spinal anaesthesia after well-informed written consent. Grid iron incision was employed in majority of cases. Intra-operative diagnosis was noted and biopsy sent for histopathological

confirmation. Post-operative patients were kept nil orally, till bowel sound returned and patients were kept on parenteral fluids, electrolyte supplements, analgesics and broad-spectrum antibiotics intravenously. Patients were monitored for complications and treated if required. Post-operative sutures were removed on post-operative day 7-9 and patients were discharged after histopathological confirmation. Observations regarding results of Modified Alvarado Scoring System and Ultrasonography were noted and tabulated along with intra-operative and histopathological findings. Then master chart was prepared and various factors were compared to each other using Statistical Analysis Software SPSS version 23. Detailed results and observations were prepared.

OBSERVATIONS AND RESULTS

A total of 97 patients who were diagnosed as having acute appendicitis and subsequently underwent emergency appendectomy in the Department of Surgery, G R Medical College and J A Group of Hospitals, Gwalior, were included in this study and analysed using Statistical Analysis Software SPSS version 23.

In our study, mean age of the sample was 29.3 (± 1.37) years ranging from 15 years to 70 years with maximum number of patients ($n=34$) belonged to 21-30 years age groups. Our series of study also showed that male patients outnumbered female patients with M:F of 1.85:1.

Abdominal tenderness was most consistent component of Modified Alvarado Score, which was present in all the cases of study regardless of cut-off points followed by Migratory Right Iliac Fossa pain, which was present in 89.69% of cases (92.04% in mass ≥ 7 and 55.55% in mass < 7). Other factors were consistent finding when cut-off score was ≥ 7 , while became less consistent or absent when cut-off score was < 7 except Elevated Temperature which was equally consistent regardless of cut-off score.

In this study, Modified Alvarado Score (Using cut-off score ≥ 7) diagnosed 88 patients as case of acute appendicitis. Similarly, using Ultrasound of the abdomen we were able to diagnose 82 patients. Importantly, out of the total 9 patients who were diagnosed as not having acute appendicitis by Modified Alvarado Score, 7 were later diagnosed as having acute appendicitis on Ultrasound, while 2 of them remain negative even on the ultrasound abdomen. Thus, total of 95 were diagnosed as case of acute appendicitis using our combined diagnostic approach of Modified Alvarado Score and Ultrasound of the abdomen. However, out of these 95 only 92 patients had histopathology report suggestive of acute appendicitis. Two patients had neither Modified Alvarado score ≥ 7 nor Ultrasound abdomen positive for acute appendicitis, but both these patients had undergone procedure since both had sustained migratory right iliac fossa pain, abdominal tenderness and elevated temperature even after 2 days of conservative management. Later on histopathological examination, both patients had normal appendix.

In our study Sensitivity, Specificity, Positive Predictive Value, Negative Predictive Value and Diagnostic Accuracy of Modified Alvarado Score using cut-off score of ≥ 7 were 92.39%, 40%, 96.5%, 22%, 89.69% respectively. Similarly, Ultrasound Abdomen documented Sensitivity, Specificity, Positive Predictive Value, Negative Predictive Value and Diagnostic Accuracy of 88.04%, 80%, 98.7%, 26%, 87.62%

respectively. Sensitivity, Specificity, Positive Predictive Value, Negative Predictive Value and Diagnostic Accuracy of our combined diagnostic approach in the diagnosis of acute appendicitis were 99.99%, 40%, 96.84%, 100% and 96.90% respectively. Negative appendectomy rate in the study was 5/97 (5.15%).

DISCUSSION

Acute appendicitis remains a common abdominal emergency throughout the world. Despite the advances in the diagnostic field, the diagnosis of the acute appendicitis remains an enigma for the attendant surgeon.

In this study, it was found that maximum cases presented from 21-30 years (35.1%) followed by 15-20 years (27.8%) with mean age of 29.3 (± 1.37) years and M:F of 1.85:1. Similar results were also obtained in the study done by Kailash Singh et al (2008).¹⁰ Sanjot B Kurane et al (2008).¹¹ Talukder et al (2009).¹² Nautiyal et al (2009).¹³ Kodliwadmth HB et al (2011).¹⁴ Nasiri et al (2012).¹⁵ Swagata Brahmachari et al (2013).¹⁶ Wilasrusmee et al (2014).¹⁷ Satyajeet et al (2014).¹⁸ and Nishikant Gujar et al (2015).¹⁹

In this study, we observed that abdominal tenderness (100%) followed by migratory right iliac fossa pain (89.69%) was the most constant component of Modified Alvarado Score, which were present in patients of acute appendicitis. Similar results were also documented in the study of Kodliwadmth HB et al (2011).¹⁴ Shirzad Nasiri et al (2012).¹⁵ and Nishikant Gujar et al (2015).¹⁹

Overall Sensitivity, Specificity, Positive Predictive Value, Negative Predictive Value and Diagnostic Accuracy of Modified Alvarado Score using cut-off score of ≥ 7 in the diagnosis of acute appendicitis were 92.39%, 40%, 96.5%, 22% and 89.69% respectively ($p < 0.01$), which was similar to study done by Baidya N et al (2007).²⁰ Talukder et al (2009).¹² Alamgir et al (2009).²¹ Thabit et al (2012).²² Nasiri et al (2012).¹⁵ Nishikant Gujar et al (2015).¹⁹ Sensitivity of Modified Alvarado Score in the study of Sanjot B Kurane et al (2008).¹¹ Nautiyal et al (2009).¹³ Satyajeet et al (2014).¹⁸ was quite lower when compared to our study, while study done by Kodliwadmth HB et al (2011).¹⁴ documented sensitivity of 98.8%. Davis et al (1993).²³ and Sanjot B Kurane et al (2008).¹¹ observed Positive Predictive Value of 82.9% and 75% respectively. Nautiyal et al (2009).¹³ documented diagnostic accuracy of 56% while Davis et al (1993).²³ documented diagnostic accuracy of 71.2%.

In our study Sensitivity, Specificity, Positive Predictive Value, Negative Predictive Value and Diagnostic Accuracy of Ultrasound abdomen in the diagnosis of acute appendicitis were 88.04% and 80%, 98.7%, 26% and 87.62% respectively ($p < 0.01$), which was comparable to study done by Puylaert et al (1987).²⁴ Davis et al (1993).²³ Charles D Douglass et al (2000).²⁵ Shinji Himeno et al (2003).²⁶ Sanjot B Kurane et al (2008).¹¹ Nautiyal et al (2009).¹³ Kodliwadmth HB et al (2011).¹⁴ There are few studies whose findings partially or completely contradict findings of our study. Nasiri et al (2012).¹⁵ documented lower sensitivity (71.2%) with similar specificity, Satyajeet et al (2014).¹⁸ observed lower specificity (50%), while Nishikant Gujar et al (2015).¹⁹ found both higher sensitivity and specificity with value of 98.44% and 94.44% respectively. Satyajeet et al (2014).¹³ Sanjot B Kurane et al (2008).¹¹ documented lower Positive Predictive Value of 80.48% and 82.16% respectively. Satyajeet et al (2014).¹³ Nasiri et al (2012).¹⁵ documented lower diagnostic accuracy of 70.9% and 72.4% respectively.

Our combined diagnostic approach in the diagnosis of acute appendicitis has Sensitivity, Specificity, Positive Predictive Value, Negative Predictive Value and Diagnostic Accuracy of 99.99%, 40%, 96.84%, 100% and 96.90% respectively ($p < 0.01$), which were higher than study done by Sanjot et al (2008).¹¹ Nautiyal et al (2010).¹³ Gujar et al (2015).¹⁹ However, specificity of our combined approach was 40% which was significantly lower than previous studies.

ROC curve for the diagnosis of acute appendicitis, area under curve is 0.700 with standard error of 0.150 and confidence interval of 0.406 to 0.994.

In the study, negative appendectomy rate was 5.15% which was similar to the study of Sanjot B Kurane et al (2008).¹¹ and Kodliwadmth HB et al (2011).¹⁴ and significantly lower than other previous studies.

In comparison with Modified Alvarado score alone, our combined approach in the diagnosis of acute appendicitis has better sensitivity, positive predictive value, negative predictive value, diagnostic accuracy with same degree specificity and lower negative appendectomy rate. Similarly, our combined approach has better sensitivity, positive predictive value, negative predictive value, diagnostic accuracy with lower degree of specificity and lower negative appendectomy rate compared to Ultrasound abdomen alone. Various previous studies Sanjot et al (2008).¹¹ Nautiyal et al (2010).¹³ Gujar et al (2015).¹⁹ also documented same results.

Fig. 1: Inflamed Appendix with its Mesentery

Fig. 2: Histological Section of Acute Appendicitis showing Congestion and Inflammation in Muscularis Propria Haematoxylin and Eosin Stain (HE) (x100)

Fig. 3: Histological Section showing Langhans Giant Cells in Lamina Propria Suggestive of Tubercular Appendicitis H.E. (x100)

Modified Alvarado Score System (MASS)	Histopathology Report		Total
	Acute Appendicitis	Other than Acute Appendicitis	
7-9 (≥ 7)	85	03	88
<7	07	02	09
Total	92	05	97

Table 1: Comparison of MASS with Histopathology

Ultrasound Abdomen	Histopathology Report		Total
	Acute Appendicitis	Other than Acute Appendicitis	
Acute Appendicitis	81	01	82
Normal Appendix	11	04	15
Total	92	05	97

Table 2: Comparison of USG Abdomen with Histopathology

Combined Diagnostic Approach	Histopathology Report		Total
	Acute Appendicitis	Other than Acute Appendicitis	
Acute Appendicitis	92	03	95
Normal Appendix	00	02	02
Total	92	05	97

Table 3: Comparison of Our Combined Diagnostic Approach with Histopathology Report

Out of the five patients who had histopathology report other than acute appendicitis, two patients had normal appendix, two patients had tubercular appendicitis, while one patient had carcinoid on histopathology report.

Sl. No.	Name of the Study	Negative Appendicectomy Rate
1.	Kailash Singh et al (2008)	16.21%
2.	Sanjot B Kurane et al (2008)	3.44%
3.	Nautiyal et al (2009)	8.11%
4.	Talukder et al (2009)	16%
5.	Kodliwadmth HB et al (2011)	6.7%
6.	Shirzad Nasiri et al (2012)	10.7%
7.	Thabit et al (2012)	14%
8.	Satyajeet Singh et al (2014)	8.5% (MASS), 19.51% (USG)
9.	Nishikant Gujar et al (2015)	33.71%
10.	Our Study	5.15%

Table 4: Comparison of Negative Appendicectomy Rate with Other Series

Name of the Study		SENS	SPEC	PPV	NPV	DA
Sanjot et al (2008)	MASS	78.26	83.78	75	86.11	81
	USG	82.61	89.19	82.16	89.19	86.67
	Combined	88.8	96.5	94.11	93.33	93.61
Nautiyal et al (2010)	MASS	40	93.33	93.33	40	56
	USG	88.57	86.57	93.94	76.47	88
	Combined	97.14	80	91.89	92.31	92
Gujar et al (2015)	MASS	98.44	94.4	99.13	96.49	96.57
	USG	98.44	94.44	98.01	60.41	77.42
	Combined	99.10	96.3	99.40	96.80	97.45
Our Study	MASS	92.39	40	96.5	22	89.69
	USG	88.04	80	98.7	26	87.62
	Combined	98.99	40	98.01	100	96.90

Table 5: Comparison of Our Combined Approach v/s Modified Alvarado Score v/s Ultrasound Abdomen in Diagnosis of Acute Appendicitis with Other Series (%)

SUMMARY AND CONCLUSION

The present study concludes that Modified Alvarado Scoring System is better diagnostic tool than Ultrasonography alone in diagnosis of acute appendicitis. But still neither Modified Alvarado Scoring System nor Ultrasonography is absolute tool in reducing negative appendectomy rate. When compared to Modified Alvarado Scoring System and Ultrasonography alone, combined use of Modified Alvarado Scoring System and Ultrasonography has better sensitivity, positive predictive value, negative predictive value, diagnostic accuracy with lower false positive rate making it more accurate predictor of acute appendicitis thus helpful in early accurate diagnosis, decrease complications thus decreasing morbidity and mortality and decrease negative appendectomy rate in the diagnosis of acute appendicitis.

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