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RESEARCH ARTICLE

CLINICAL STUDY ON ACUTE APPENDICITIS INCORPORATING MODIFIED ALVARADO SCORE AND ABDOMINAL ULTRASOUND

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Abstract

Acute appendicitis is one of the most common acute abdominal surgical emergencies; the diagnosis of which is often challenging. If there is a delay in the diagnosis and prompt action is not taken, it may lead to perforation and other complication. Many scoring systems have been devised for the diagnosis of appendicitis, among which Modified Alvarado score is being used widely. Ultrasound also has gained importance in recent years. Our study aims in combining the use of Modified Alvarado score and USG in the diagnosis to bring down the rate of negative appendicectomies.

Aimof The Study

1. To evaluate the sensitivity of the use of modified Alvarado scoring system and ultrasound in the diagnosis of acute appendicitis
2. To reduce the rate of negative appendicectomy.

Materials & Methods: This study was done in 100 patients admitted in Navodaya Medical College Hospital from November 2019 to May 2021. All patients chosen on purposive sampling basis who present with right lower quadrant pain. Preoperatively, modified Alvarado score and abdominal ultrasound are assigned to those included in the study. Intraoperative findings and histo-pathological reports are followed up and the results are compared with modified Alvarado score and abdominal ultrasound.

Results

1. In our study, the sensitivity of Modified Alvarado score in diagnosing Acute Appendicitis in the score range of 1-4 is 60%, so 6 out of 10 patients were confirmed with Acute Appendicitis.
2. In the score range of 5-7, out of 26 patients, 24 patients were confirmed with Acute Appendicitis using HPE having 92.3% sensitivity.
3. In the score >7, out of 64 patients , 63 patients had Acute Appendicitis confirmed with HPE and the sensitivity of HPE was the highest among this score range and its found to be 98.43%.The remaining 7 patients had normal appendix.
4. In our study, the sensitivity of USG Abdomen in diagnosing Acute Appendicitis was 95.83% in the score range of 5-7, 71.42% in score range of >7 and 66.6% in score range of 1-4.Out of 100

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patients, USG abdomen showed positive result for Acute Appendicitis in only 72 patients when compared to HPE which showed 93 patients with Acute Appendicitis.

Interpretation & Conclusion: Modified Alvarado scoring system is the better indicator for confirmation of diagnosis of Acute Appendicitis in the clinical setting rather than relying on USG abdomen imaging modality of investigation for diagnosing and treating the patient with Acute Appendicitis. When we incorporate both Modified Alvarado Scoring system and USG abdomen then we can diagnose Acute Appendicitis with accuracy close to HPE diagnosis of Acute Appendictis.

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Introduction:-

- Acute appendicitis is essentially a clinical diagnosis. About 7% of the population is expected to have appendicitis in their lifetime. Routine history and physical examination still remain the most practical diagnostic modalities. Absolute diagnosis of course is only possible at operation and histopathologic examination of the specimen.

  Removing normal appendix is an economic burden both on patients and health resources. Misdiagnosis and delay in surgery can lead to complications like perforation and finally peritonitis.
- Even with these diagnostic aids the rate of negative appendicectomy of 15 – 25% has been accepted. However the complication of unnecessary operation is 13 %, close to that of a genuinely inflamed appendix. Removing a normal appendix carries a mortality rate of 0.65 for every 100 operations. Prolonged clinical observation in an attempt to minimise unnecessary operations may mean a delayed operation in 28% of cases and an unnecessary risk of perforation.
- Several scoring systems have been introduced to increase the diagnostic accuracy of appendicitis with the Alvarado scoring system being the most popular.
- Graded compression ultrasonography is the least expensive and least invasive of these and has been reported to have an accuracy of 71% to 95%7, but doubts have been raised about the influence of ultrasonography on patient outcomes8 . Furthermore, it has been argued that findings at sonography should not supercede clinical judgment in patients with a high probability of appendicitis9. This raises questions about whether sonography should be performed at all in patients at high risk and whether there is some reliable means of selecting those who can benefit from imaging.
- We designed a diagnostic protocol incorporating graded compression ultrasonography and the Modified Alvarado score on the basis of work in our own institution. We then undertook a randomized controlled trial to assess whether the information provided by the protocol improved clinical outcomes. We tested the hypotheses that compared with standard treatment patients assigned to the diagnostic protocol would have a lower rate of negative appendicectomy.

Materials & Methods:-

Source of data

This is a study of 100 patients with provisional diagnosis of acute appendicitis getting admitted and operated in the surgical department of Navodaya Medical College and Hospital from November 2019 to May 2021. Modified Alvarado score was applied and ultra sound abdomen was done using Siemens G-50, linear transducer 5-10 MHz, pre operatively. The decision for surgery was made independent of the score and ultra sound finding. Diagnosis of patients who underwent appendicectomy was confirmed by both operative finding and histopathology.

Criteria for acute appendicitis by Modified Alvarado score;

	Clinical feature	**Score**
Symptoms	Migratory RIF pain	1
	Anorexia	1
	Nausea/ vomiting	1
Signs	Tender RIF	2

	Rebound tenderness	1
	Elevated temperature	1
	Leucocytosis	2
	Total	9

Score of 7 to 9- Probable acute appendicitis
Score of 5 to 6- Possible diagnosis of acute appendicitis
Score of 1 to 4-Unlikely to have appendicitis

Criteria for acute appendicitis by ultra sound
Sonographically, appendicitis is suggested by the presence of pain on graded compression of the area in which abnormal appendix was seen as a tubular, blind ending, aperistalitic bowel loop which is non compressible with a diameter of 7 mm or greater in antero posterior direction. The presence of a fecolith or prominence of peri appendicular fat was an indirect sign. Ultra sonography was considered negative when the appendix could not be found or was normal, or if non appendicular pathology was discovered.

Criteria for appendicitis by histopathology:
A histological criterion for the diagnosis of acute appendicitis is polymorphous leucocytic infiltration of the muscularis mucosa.

Inclusion criteria
1. Those admitted in Navodaya Hospital having acute lower right sided abdominal pain after other causes of right lower quadrant pain are ruled out.
2. All patients who are willing to participate in the study.

Exclusion criteria
1. Patients who have diagnosed to have other causes of right lower quadrant.
2. Age less than 14 years.
3. Pregnant females.
4.Patients who were managed conservatively
5. patients who not are willing to participate in the study.

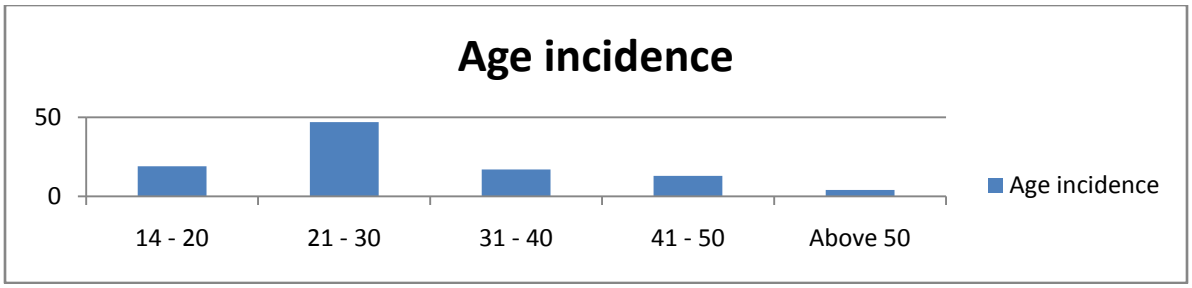
Statistics:
The results of Modified Alvarado score and ultra sound were correlated with the operative and histopathological examination using chi-square test.

Observation And Results:-

In the present study, 100 cases were provisionally diagnosed of acute appendicitis and were operated during the study period.

Table 1:- Age incidence.

Age	Frequency	Percentage (%)
14 - 20	19	19.0
21 - 30	47	47.0
31 - 40	17	17.0
41 - 50	13	13.0
Above 50	4	4.0
Total	100	100.0

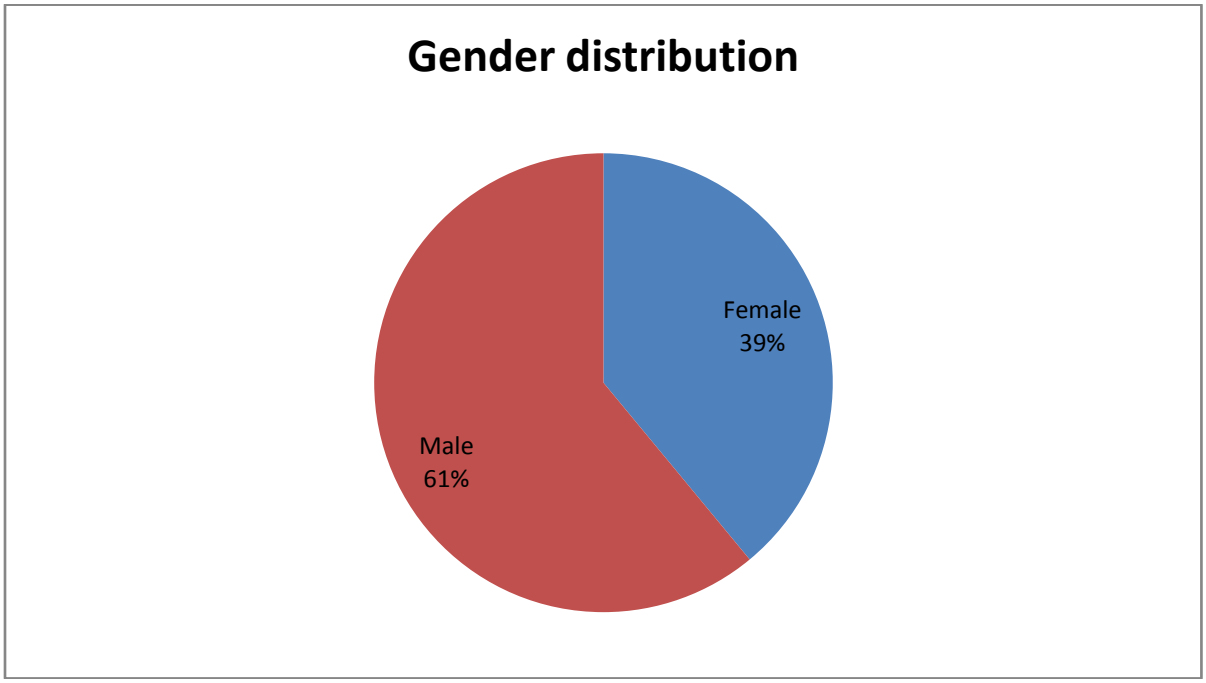


Graph 1:- Age incidence.

From the above table, in the present study, 47 patients were found in the agegroup of 21-30(40%), 19patients were found in the age group of 14-20(24%), 17 were found in the age group of 31-40(19%), 13 patients were found in the age group of 41-50(11%), and 4were found in the age group of above 50(6%).

Table 2:- Gender distribution of patients studied.

Gender	No. of patients	Percentage (%)
Female	39	39.0
Male	61	61.0
Total	100	100.0

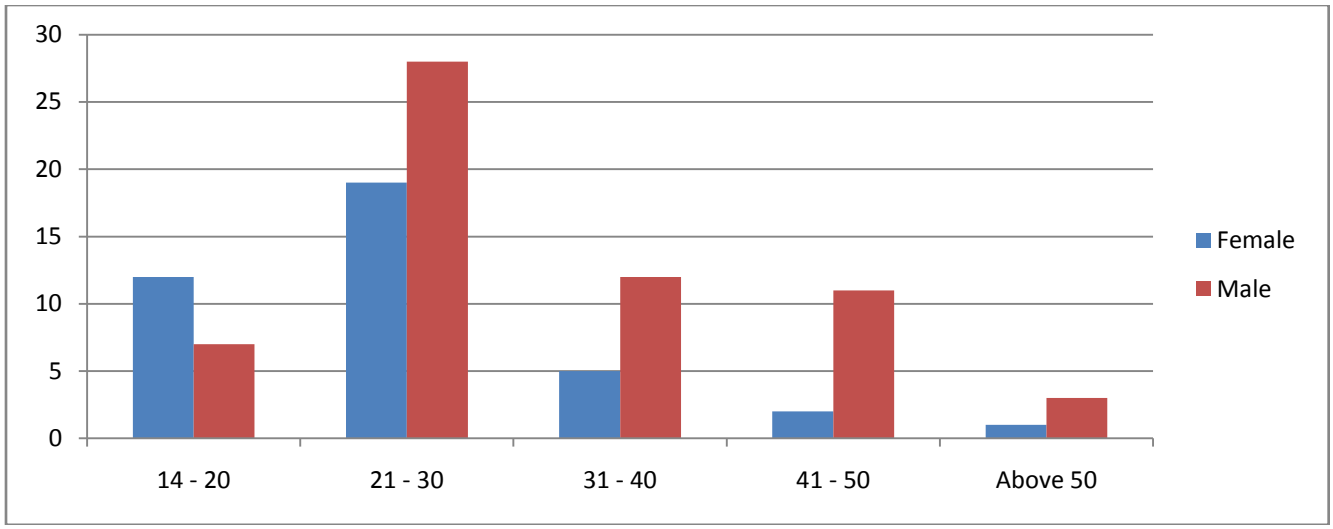


Pie chart 1:- Gender distribution among study subjects.

According to this study 39 patients were female and 61 patients were male.

Table 3:- Age distribution of patients studied according to gender.

Age	Gender		Total
	Female	Male	
14 - 20	12	7	19
21 - 30	19	28	47
31 - 40	5	12	17
41 - 50	2	11	13
Above 50	1	3	4
Total	39	61	100



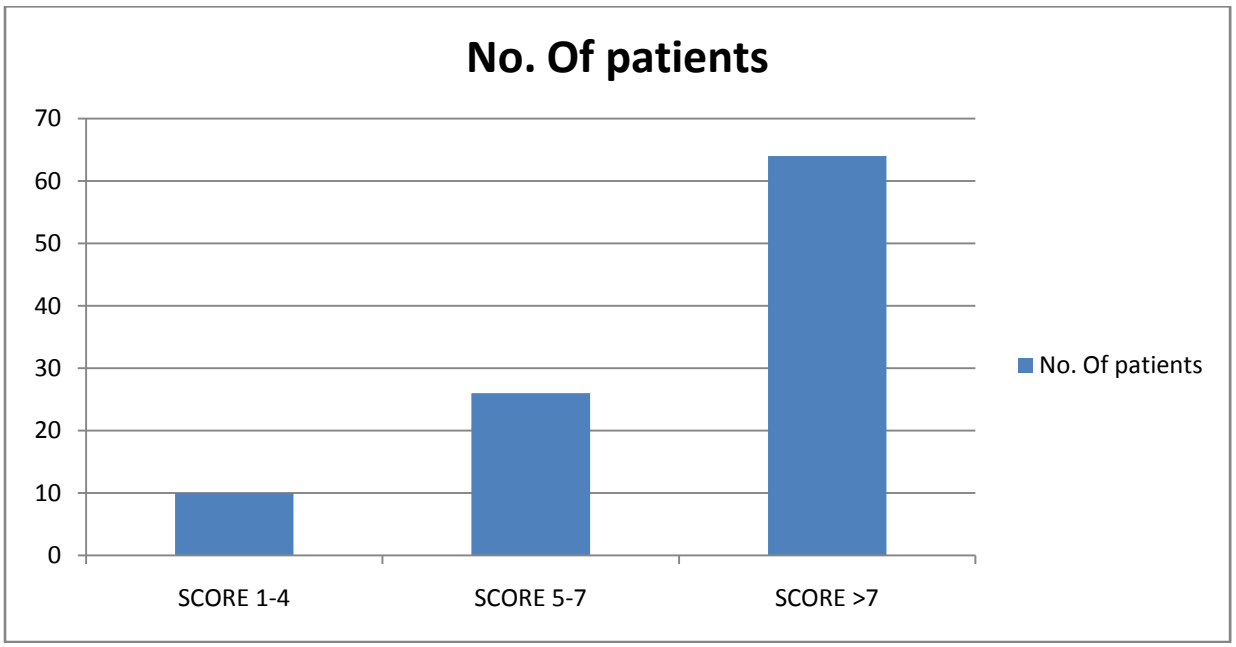
Graph 2:- Age distribution of patients according to gender.

In our study, out of 100 patients, maximum number of patients were in the age group 21-30 years with 19 females and 28 males, with a total of 47 patients.

Age group of 14-20 years had a total of 19 patients with 12 patients in females and 7 males, in the age group of 31-40 years had a total of 17 patients with 12 males and 5 females, in the age group of 41-50 years had total of 13 patients with 11 males and 2 were females, and 3 out of 4 patients were males and 1 patient was female, in the age group above 50.

Table 4:- Modified Alvarado score of patients studied.

Alvarado score	No. of patients	Percentage (%)
1-4	10	10.0
5-7	26	26.0
>7	64	64.0
Total	100	100.0

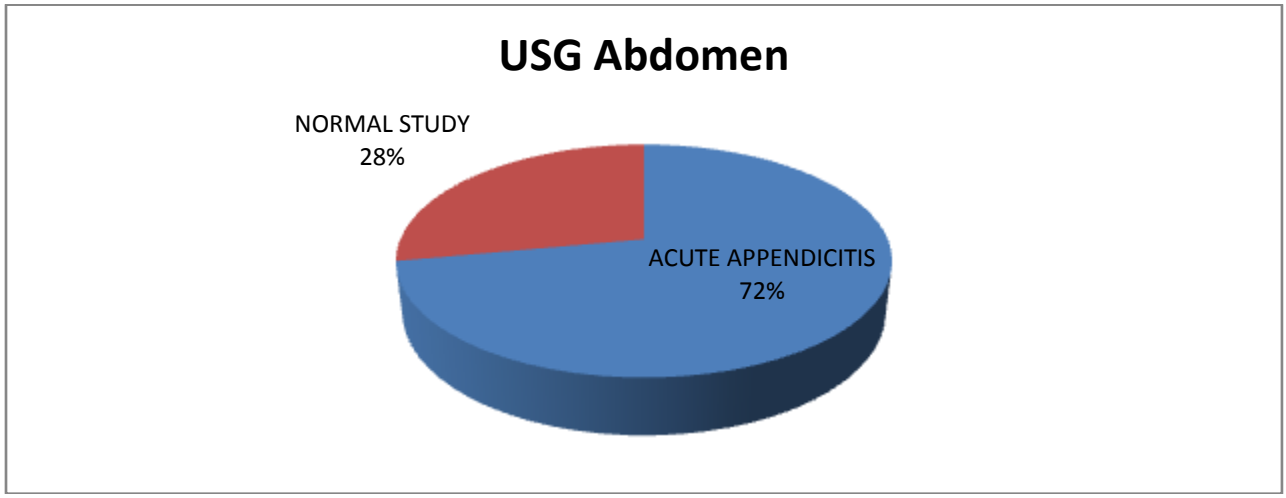


Graph 3:- Modified Alvarado score of patients.

In our study, the score of 1-4 had 10 patients, 5-7 score had 26 patients and score >7 had 64 patients, with maximum patients (64%) in the score of >7.

Table 5:- USG Abdomen Imaging of patients studied.

USG Imaging	No. of patients	Percentage (%)
Acute appendicitis	72	72.0
Normal study	28	28.0
Total	100	100.0

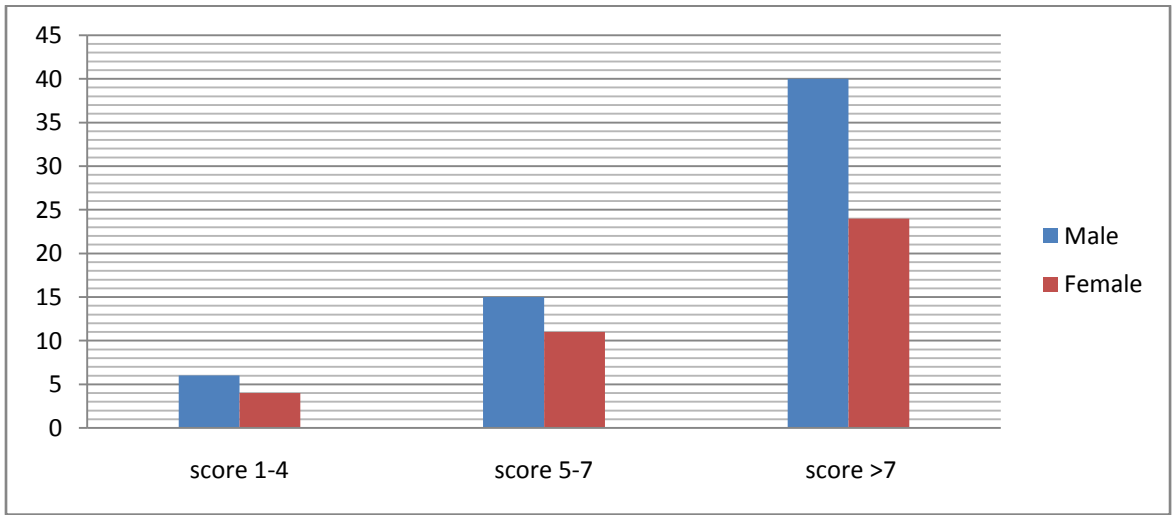


Pie chart 2:- USG abdomen imaging of patients

In our study, out of 100 patients, 72 patients who underwent USG abdomen imaging had positive result for Acute Appendicitis and 28 patients had normal study on USG abdomen.

Table 6:- Modified Alvarado score according to gender.

Modified Alvarado score	Gender		Total
	Male	Female	
1-4	6	4	10
5-7	15	11	26
>7	40	24	64
Total	61	39	100

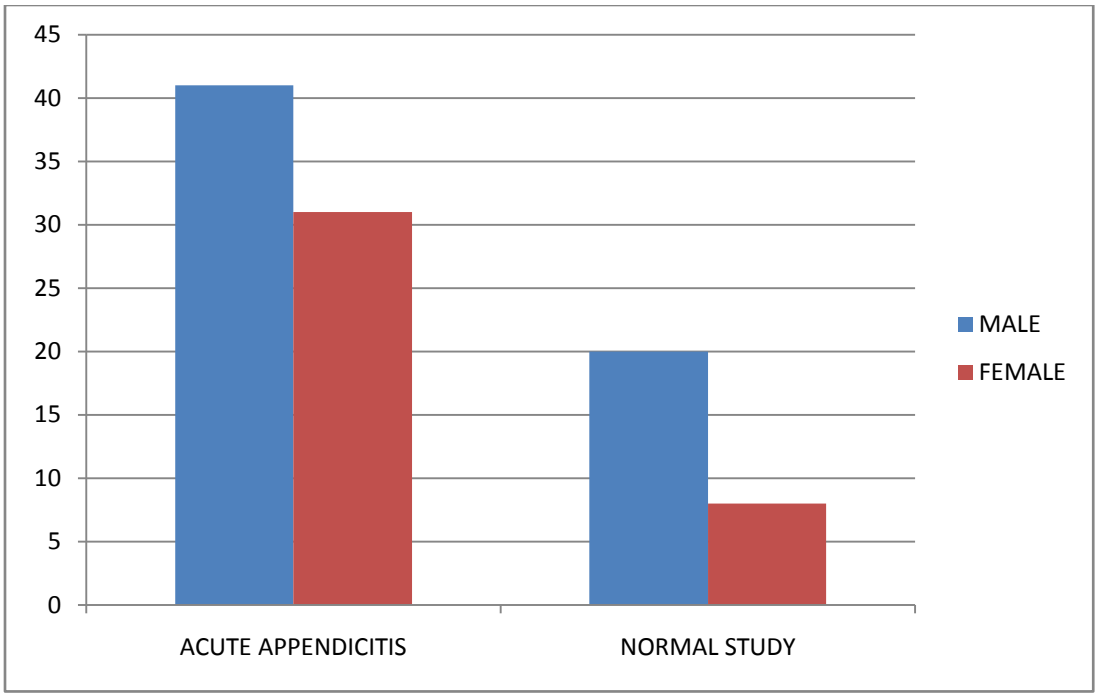


Graph 4:- Modified Alvarado score according to gender.

In our study, A total of 61 males and 39 females were study subjects in our study. Out of 10 patients in the score ranging between 1-4 had 6 males and 4 females, out of 26 patients in 5-7 score had 15 males and 11 females, and out of 64 patients with score >7 had 40 males and 39 females.

Table 7:- USG Abdomen Imaging according to gender.

USG Imaging	Gender		Total
	Male	Female	
Acute appendicitis	41	31	72
Normal study	20	08	28
Total	61	39	100

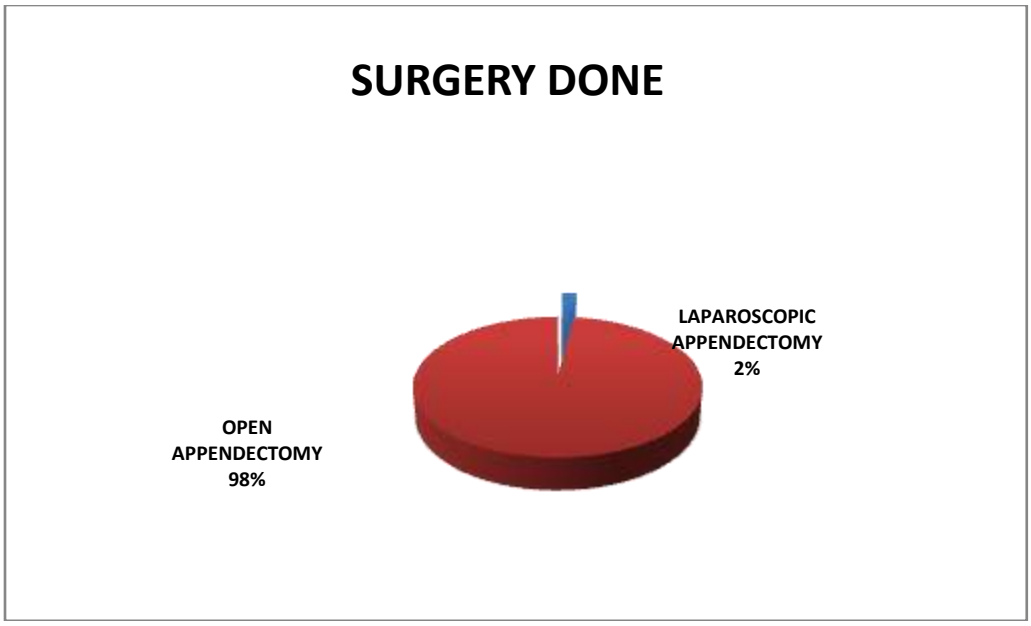


Graph 5:- USG Abdomen imaging according to gender.

In our study, 72 out of 100 patients were diagnosed as Acute Appendicitis on USG abdomen, out of which 41 were male and 31 were female. The remaining 28 patients had normal USG report with 20 males and 8 females.

Table 8:- Procedure of patients studied.

PROCEDURE	NUMBER OF PATIENTS	PERCENTAGE (%)
LAPAROSCOPIC APPENDECTOMY	**2**	**2.0**
OPEN APPENDECTOMY	**98**	**98.0**
TOTAL	**100**	**100.0**

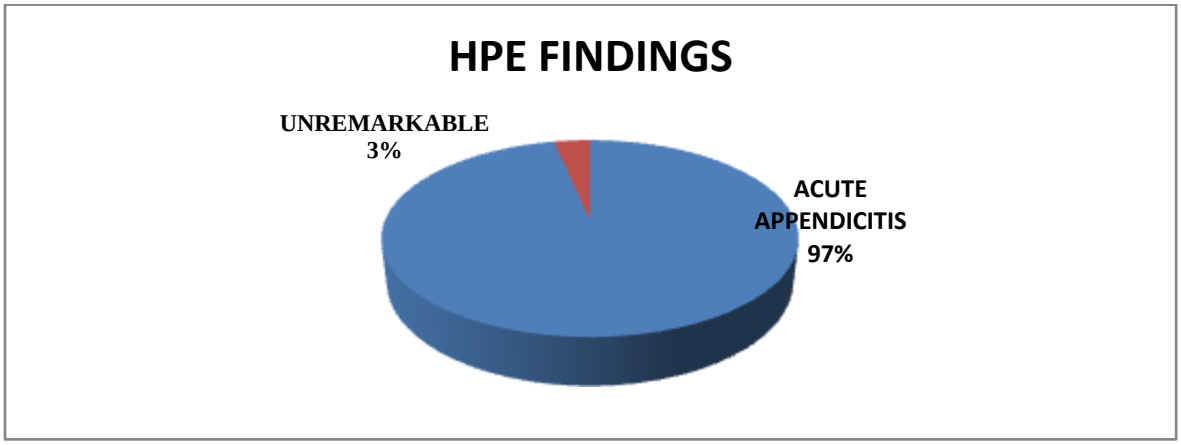


Pie chart 3:- Surgical procedure done.

In our study, 98 patients out of 100 underwent Open Appendicectomy and remaining 2 patients were taken up for Laparoscopic Appendicectomy.

Table 9:- HPE findings of patients studied.

HPE FINDINGS	No. of patients	Percentage (%)
Acute appendicitis	93	93.0
Unremarkable	7	7.0
Total	100	100.0



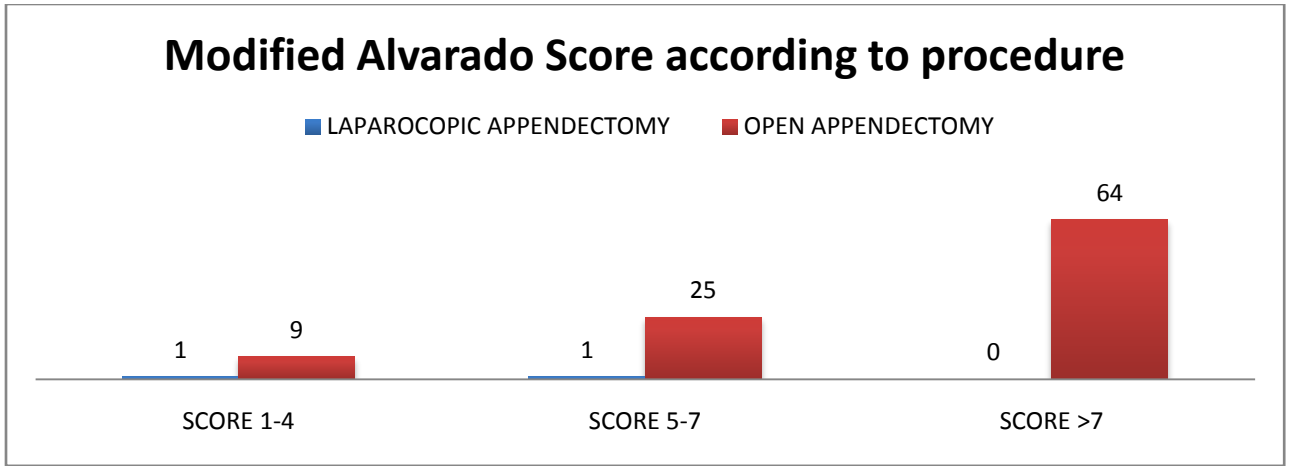
Pie chart 4:- HPE findings.

In our study, out of 100 patients, 93 patients were diagnosed with Acute Appendicitis on HPE basis and report was unremarkable in 7 patients.

Table 10:- Modified Alvarado score according to Procedure.

Modified Alvarado score	PROCEDURE		Total
	LAPAROCOPIC APPENDECTOMY	OPEN APPENDECTOMY	

1-4	1	9	10
5-7	1	25	26
>7	0	64	64
Total	02	98	100

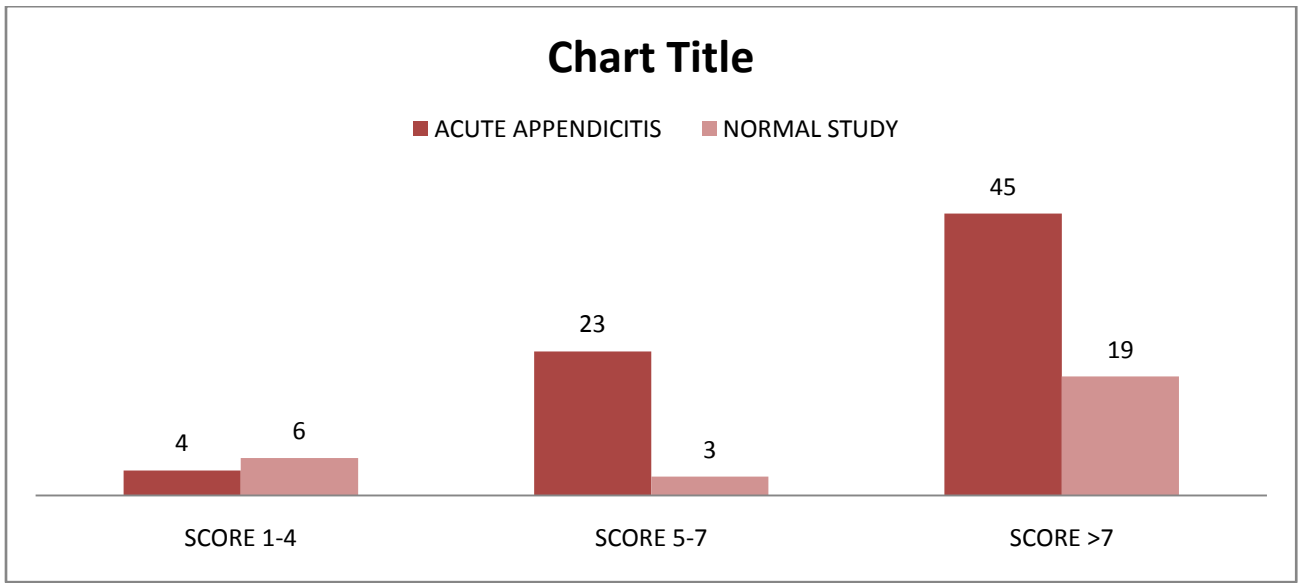


Graph 6:- Modified Alvarado score according to procedure.

In our study, 98 out of 100 patients underwent Open Appendicectomy while 2 patients were taken up for Laparoscopic Appendicectomy. One patient in each group of score system 1-4 and 5-7 , underwent Laparoscopic Appendicectomy.

Table 11:- Modified Alvarado score according to USG Imaging.

Modified Alvarado score	**USG IMAGING**		**Total**
	ACUTE APPENDICITIS	**NORMAL STUDY**	
1-4	4	6	10
5-7	23	3	26
>7	45	19	64
Total	72	28	100



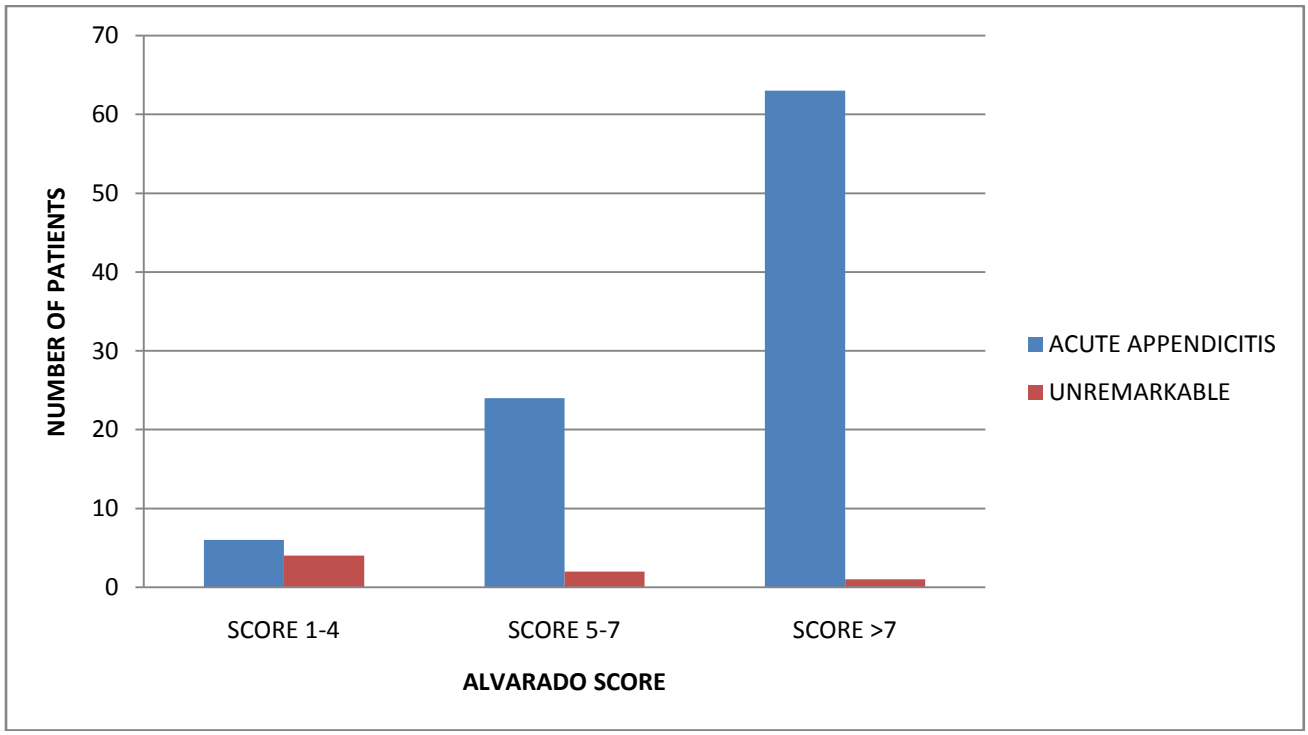
Graph 7:- Modified Alvarado Score according to USG abdomen imaging.

In our study, 4 out of 10 patients had USG abdomen confirmed Acute Appendicitis in the score ranging between 1-4, while 6 patients had normal study. 23 out of 26 patients had positive diagnosis for Acute Appendictis on USG abdomen imaging in the score ranging between 5-7, while 3 patients had normal study.

The maximum number of patients diagnosed with Acute Appendicitis on USG abdomen were 45 out of 64 patients and they fall in the Modified Alvarado score of >7, and the remaining 19 patients with score >7 had normal study.

Table 12:- Modified Alvarado score according to HPE.

Modified Alvarado score	HPE		Total
	ACUTE APPENDICITIS	UNREMARKABLE	
1-4	6	4	10
5-7	24	2	26
>7	63	1	64
Total	93	07	100



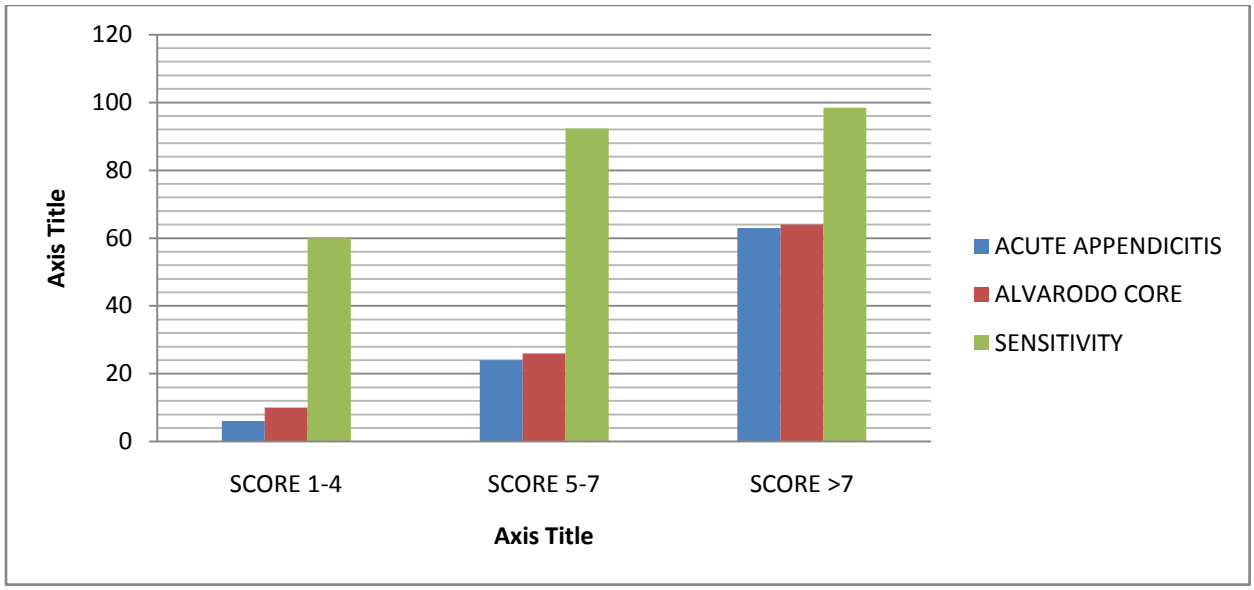
Graph 8:- Modified Alvarado score according to HPE.

In our study, 93 out of 100 patients, the diagnosis of Acute Appendicitis was confirmed using HPE. 6 out of 10 patients in the score ranging between 1-4 had Acute Appendicitis confirmed with HPE.

In the score between 5-7, 24 out of 26 patients showed positive HPE for appendicitis, and 2 patients had normal appendix. 63 out of 64 patients had HPE confirmed Acute Appendicitis in the score above 7.

Table 13:- Correlation of Modified Alvarado Score and HPE.

Modified Alvarado score	No. of patients	ACUTE APPENDICITIS (HPE)	SENSITIVITY
1-4	10	6	60.0%
5-7	26	24	92.30%
>7	64	63	98.43%
Total	100	93	93%



Graph 9:- Correlation of Modified Alvarado score & HPE.

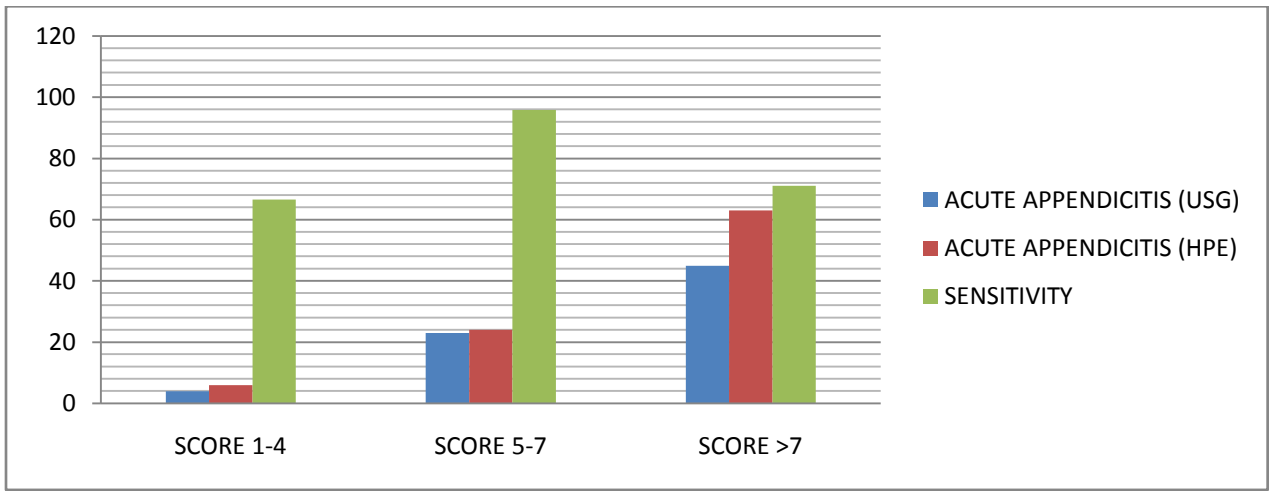
In our study, the sensitivity of Modified Alvarado score in diagnosing Acute Appendicitis in the score range of 1-4 is 60%, so 6 out of 10 patients were confirmed with Acute Appendicitis.

In the score range of 5-7, out of 26 patients, 24 patients were confirmed with Acute Appendicitis using HPE having 92.3% sensitivity.

In the score >7, out of 64 patients , 63 patients had Acute Appendicitis confirmed with HPE and the sensitivity of HPE was the highest among this score range and its found to be 98.43%.The remaining 7 patients had normal appendix.

Table 14:- Correlation of USG and HPE in different range of Modified Alvarado score.

Modified Alvarado score	**ACUTE APPENDICITIS (USG)**	**ACUTE APPENDICITIS (HPE)**	**SENSITIVITY**
1-4	4	6	66.6%
5-7	23	24	95.83%
>7	45	63	71.42%
Total	72	93	77.41%

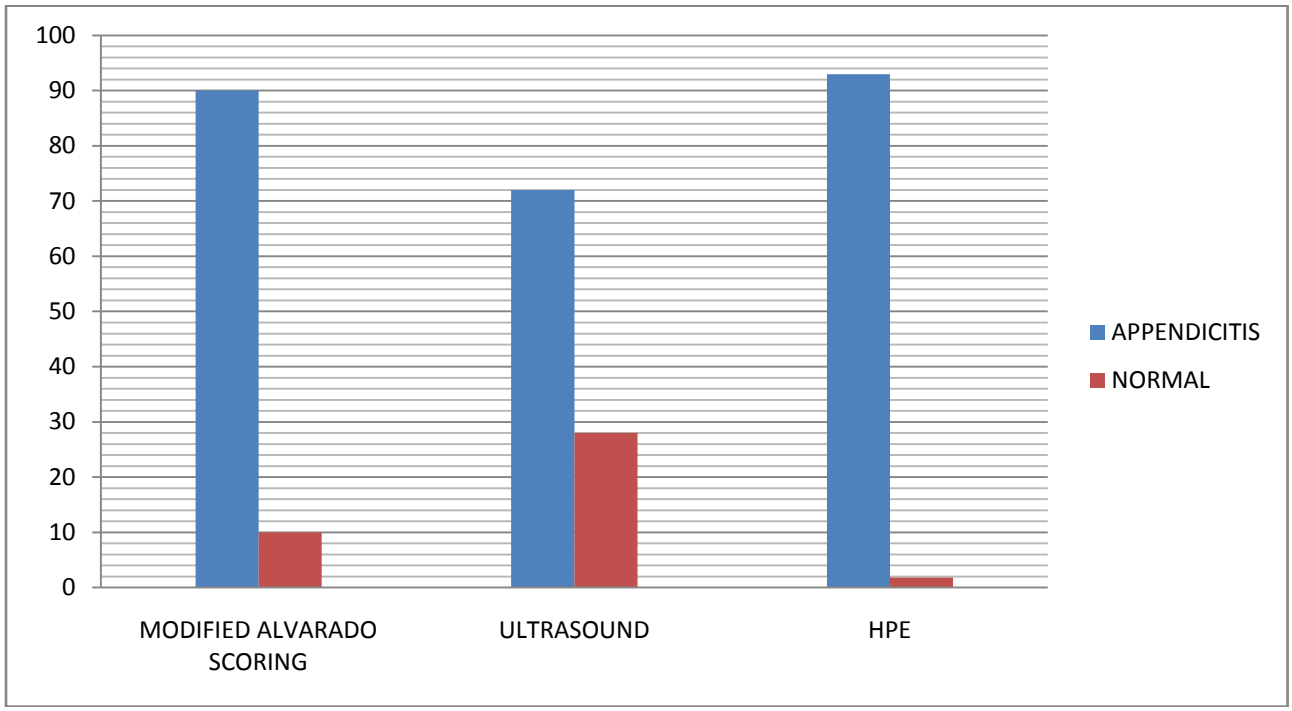


Graph 10:- Correlation of USG& HPE with Modified Alvarado score.

In our study, the sensitivity of USG Abdomen in diagnosing Acute Appendicitis was 95.83% in the score range of 5-7, 71.42% in score range of >7 and 66.6% in score range of 1-4.Out of 100 patients, USG abdomen showed positive result for Acute Appendicitis in only 72 patients when compared to HPE which showed 93 patients with Acute Appendicits.

Table 15:- Correlation of Modified Alvarado score, USG with per-operative and histopathological examination of the appendix.

	Appendicitis	**Normal**	**Total**
MAS	90	10	100
USG	72	28	100
HPE	93	7	100



Graph 11:- Correlation of USG & HPE with Modified Alvarado score.

In our study, the Modified Alvarado scoring system appears to be significant in diagnosing Acute Appendicitis with a total of 90 patients in-contrast to 72 patients with USG abdomen reporting, out of 100 patients in total.

However, diagnosis of Acute Appendicitis confirmed with HPE of the appendix specimen was with a total of 93 patients out of 100.

Discussion:-

Though there are lots of advances in the diagnostic field with the invention of sophisticated investigations diagnosis of acute appendicitis remains an enigma for the attendant surgeon .The main aim of the clinical decision making process is to reach an accurate diagnosis in the fastest and cheapest way.

Appendicitis still poses a diagnostic challenge and many methods have been investigated to try to reduce removal of a normal appendix without increasing the perforation rate. 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. Modified Alvarado score is one such simple system based on few symptoms, signs, and a basic laboratory investigation. Ultrasound is often used as the initial diagnostic imaging in which cases the clinical diagnosis is equivocal. USG is non invasive, rapidly available and avoids radiation exposure.

The present study was undertaken to evaluate the usefulness of Alvarado scoring system and Ultrasound abdomen in reducing the number of negative appendicectomy. Our results and observations were discussed and compared with various other studies.

In our study of 100 patients, on histopathological examination 93 patients had acute appendicitis, among which 51 were females and 42were males, with a negative appendicectomy rate of only 7%. In similar studies done by Khan et al, Ohmann et al, and Arian et al, negative appendicectomy rates of 14%,14.3% and 16.1% respectively were observed.

So even today a thorough clinical examination with basic investigation like WBC count remains cornerstone in the diagnosis of Acute appendicitis. With this background many eminent Surgeons & Physicians have been adopting different scoring systems in order to decrease negative appendectomy (Fenyo.G. 1987; Arnbjornsson E.1985; Teicher et al, 1983)47.We find the value of Alvarado score (Alvarado A. 1986), which was modified by Kalan et al 1994 for its routine use in clinical practice. The modified Alvarado score is simple to use and easy to apply, since it based only on history, clinical examination and a basic laboratory investigations.

In our present study, the usefulness of the scoring system was demonstrated beyond doubt by reducing number of negative appendiciectomy especially in males and children. However in females the negative appendicectomy was high and this can be avoided by laparoscopy.

Summary

- This study was undertaken in 100 patients with a provisional diagnosis of Acute Appendicitis getting operated in Navodaya Medical College Hospital from November 2019 to May 2021.
- Modified Alvarado score and USG findings were applied in the preliminary diagnosis, which was confirmed by intra operative and histopathological findings.
- According to this study 39 patients were female and 61 patients were male. There was no statistical difference in male to female ratio.
- The highest incidence of Acute Appendicitis (40%) was found in the age group of 21-30 and the lowest (6%) was seen in the age group of >50.
- According to this study, out of 100 patients, 72 patients who underwent USG abdomen imaging had positive result for Acute Appendicitis and 28 patients had normal study on USG abdomen. And , 72 out of 100 patients which were diagnosed as Acute Appendicitis on USG abdomen, 41 were male and 31 were female. The remaining 28 patients had normal USG report with 20 males and 8 females.
- According to this study, Out of 10 patients in the score ranging between 1-4 had 6 males and 4 females, out of 26 patients in 5-7 score had 15 males and 11 females, and out of 64 patients with score >7 had 40 males and 39 females.
- In our study, 98 patients out of 100 underwent Open Appendicectomy and remaining 2 patients were taken up for Laparoscopic Appendicectomy.
- In our study, out of 100 patients, 93 patients were diagnosed with Acute Appendicitis on HPE basis and report was unremarkable in 7 patients.
- In our study, 98 out of 100 patients underwent Open Appendicectomy while 2 patients were taken up for Laparoscopic Appendicectomy. One patient in each group of score system 1-4 and 5-7 , underwent Laparoscopic Appendicectomy.
- In our study, the sensitivity of Modified Alvarado score in diagnosing Acute Appendicitis in the score range of 1-4 is 60%, so 6 out of 10 patients were confirmed with Acute Appendicitis. In the score range of 5-7, out of 26 patients, 24 patients were confirmed with Acute Appendicitis using HPE having 92.3% sensitivity. In the score >7, out of 64 patients , 63 patients had Acute Appendicitis confirmed with HPE and the sensitivity of HPE was the highest among this score range and its found to be 98.43%.The remaining 7 patients had normal appendix.
- Out of 100 patients, USG abdomen showed positive result for Acute Appendicitis in only 72 patients when compared to HPE which showed 93 patients with Acute Appendicits.
- In our study, the Modified Alvarado scoring system appears to be significant in diagnosing Acute Appendicitis with a total of 90 patients in-contrast to 72 patients with USG abdomen reporting, out of 100 patients in total.
- However, diagnosis of Acute Appendicitis confirmed with HPE of the appendix specimen was with a total of 93 patients out of 100.

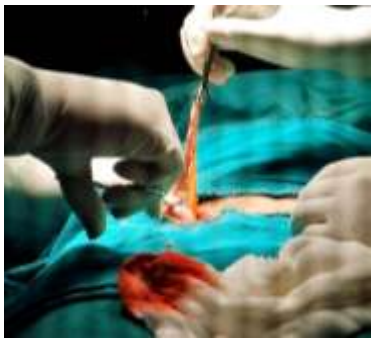
According to the findings from our study it is concluded that Modified Alvarado score and USG, considered in the diagnosis of acute appendicitis have a good statistical correlation. But when both are combined together to get a diagnosis, the sensitivity is less.

Conclusion:-

- ✔ USG imaging & Modified Alvarado score both are good diagnostic tool for predicting acute appendicitis in classical presentation of case of acute appendicitis.
- ✔ In Modified Alvarado score, it is recommended to proceed with emergency appendectomy in all patients both men and women whose clinical score is more than 7. In patients whose clinical scoring falls between 5 and 7,it is recommended to consider emergency appendectomy.
- ✔ Even though the literature (Alvarado A : A practical score for the early diagnosis of acute appendicitis. Ann Emerg Med 15:557, 1986) shows that Alvarado score is not very effective in predicting acute appendicitis in patients with a score of 5-7 but in our study 92.30% cases showed features of acute appendicitis in HPE.
- ✔ With the score less than 4, Alvarado score and USG imaging is not a good clinical diagnostic system for excluding or predicting acute appendicitis. Patients in this group needs further diagnostic tests to exclude acute appendicitis.
- ✔ When USG abdomen was correlated HPE diagnosis, the sensitivity was comparatively less when compared to the sensitivity of Modified Alvarado scoring system in diagnosing Acute Appendicitis.
- ✔ In our study, the sensitivity of USG Abdomen in diagnosing Acute Appendicitis was 95.83% in the score range of 5-7, 71.42% in score range of >7 and 66.6% in score range of 1-4.
- ✔ Out of 100 patients, USG abdomen showed positive result for Acute Appendicitis in only 72 patients when compared to HPE which showed 93 patients with Acute Appendicits.
- ✔ In our study, the Modified Alvarado scoring system appears to be significant in diagnosing Acute Appendicitis with a total of 90 patients in-contrast to 72 patients with USG abdomen reporting, out of 100 patients in total.
- ✔ However, diagnosis of Acute Appendicitis confirmed with HPE of the appendix specimen was with a total of 93 patients out of 100.
- ✔ Various diagnostic aids have been used to increase the diagnostic accuracy of acute appendicitis but still the clinical diagnosis is superior. On correlation of Alvarado score with USG imaging, both were significantly associated.
- ✔ In this study, Ultrasonography was used to see whether the diagnosis of acute appendicitis could be improved.
- ✔ For patients with typical clinical presentation, ultrasonography has no advantage over the Alvarado score. Moreover, the additional information given by USG was not useful in cases of low Alvarado score.
- ✔ Hence, we conclude that the Modified Alvarado scoring system is the better indicator for confirmation of diagnosis of Acute Appendicitis in the clinical setting rather than relying on USG abdomen imaging modality of investigation for diagnosing and treating the patient with Acute Appendicitis. When we incorporate both Modified Alvarado Scoring system and USG abdomen then we can diagnose Acute Appendicitis with accuracy close to HPE diagnosis of Acute Appendictis.
- ✔ Modified Alvarado score has a high diagnostic value. It is non invasive, not expensive, and fast
- ✔ Hence we finally recommend applying the Modified Alvarado clinical scoring in all patients presenting with a clinical diagnosis of acute appendicitis.

OT images





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