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RESEARCH ARTICLE

APPENDICITIS INFLAMMATORY RESPONSE SCORE FOR DIAGNOSIS OF ACUTE APPENDICITIS AS COMPARED TO ALVARADO SCORE

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Manuscript Info

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Abstract

Background: Acute appendicitis was first described by Reginald. H. Fitz in 1886. It is the most frequent cause of acute abdominal pain requiring surgical intervention. Annually appendectomy is the most common abdominal operation performed on emergency basis. Lifetime risk for developing acute appendicitis is 8.6% in men and 6.7% in women. Acute Appendicitis inciting event in most instances is obstruction of the appendix lumen. Acute Appendicitis is classified as; catarrhal phlegmonus, gangrenous and perforated. This classification describes the evolutionary stage of disease. Acute appendicitis is more of a clinical diagnosis present as pain abdomen with classical migration from peri-umbilical region to right iliac fossa in 75% of patient nausea and anorexia. Clinical signs are mostly pyrexia, localized tenderness in the right iliac fossa, muscle guarding and rebound tenderness. Laboratory and radiological investigation are also important tool for the diagnosis. Scoring system have been designed to aid in the clinical assessment of patient with acute appendicitis. The most used scoring is the Alvarado score is best performing in validation studies. Alvarado score doesn't incorporate C reactive protein as a variable, many studies shows the importance of C reactive protein in assessment of patient with appendicitis.

Objective: Appendicitis Inflammatory Response score as a diagnostic tool for acute appendicitis in our hospital setting.

Study design: A Prospective Study.

Study period: October 2016 – September 2018.

Study setting: Department of General Surgery, Justice K. S. Hegde charitable hospital.

Study population: Patients admitted with signs and symptoms of acute appendicitis at Justice K.S. Hegde charitable Hospital, Mangalore.

Sample size: 123 patients using epiinfo software for diagnostic test with PPV 64% with article reference (12) confidence interval of 95% and power of study at 80%.

Study group: Patients clinically diagnosed with acute appendicitis and giving consent for the study.

Methodology: The present study was conducted in the Department of General surgery, Justice K.S. Hegde charitable Hospital Mangalore, in 123 patients, of any age, who were admitted with complaint of acute appendicitis. Patients included in the study were finally correlate with the histopathological report.

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Result: The maximum patients were in the age group of 11-20 year compromising around 30.9%. Most of the patients were female around 56.1%. Histopathological report showed around 82.1% as Acute appendicitis, 6.5% acute on chronic, recurrent appendicitis 8.9%, chronic appendicitis, granulomatous appendicitis & lymphoid hyperplasia of appendix were .8% each. AIR classified around 46.3% in low probability, 48% indeterminate and 5.7% in high probability group. Alvarado classified around 3.3% in unlikely, 51.2% in possible diagnosis, 37.4% acute and 8.1% in definite group. On spearman correlation coefficient there was found to be a strong positive correlation between both the scoring system and statistically significant p value of 0.0001. AIR score showed a sensitivity of 56.44% and specificity of 59.09% at score >4. Alvarado had a sensitivity of 98.02 % and specificity of 9.09% at score >4. Alvarado and AIR showed 9.90% and 6.93% at score >8 respectively. The specificity of Alvarado and AIR was 100% respectively. The AIR at a low and higher score had a high PPV and NPV, that may help in correctly diagnosing the patient with acute appendicitis and ruling out from non- appendicitis patient.

Conclusion:

1. Alvarado score is better diagnostic tool for acute appendicitis as compared to the AIR score.
2. Alvarado score has higher sensitivity in score of >4 as compared to AIR.
3. AIR score with low sensitivity has low discriminatory power in ruling out patient with acute appendicitis.

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Introduction:-

Acute Appendicitis

Preamble[1-2]

Reginald Fitz physician from Massachusetts in 1886 described perforating inflammation of the appendix. He explained about appendix early diagnosis and treatment. In the year 1889 surgeon in chief of Roosevelt hospital Charles McBurney explained about surgical management of appendix. Charles McBurney was famously known for McBurney point, the point of greatest tenderness in appendicitis. Later, he went ahead to coin the McBurney incision previously known as Louis L Mac Arthur for surgical approach. Patient with appendicitis are mainly diagnosed with presenting complaints, clinical examination and hematological value. Patient with appendicitis, surgery remains gold standard management. Appendicitis inflammatory response scoring was recently introduced for suspected acute appendicitis with an added variable of CRP. As per a study in conducted in Netherland showed 15% of negative appendectomy [(3)]. Alvarado scoring system had remained a gold standard; AIR scoring system has shown promising result at low score and help in lowering therate of negative appendectomy.

Aims & Objectives:-

Implication Of Study:

To Demonstrate AIR as the better diagnostic score for acute appendicitis.

1. Appendicitis Inflammatory Response score as a diagnostic tool for acuteappendicitis in our hospital setting.
2. To evaluate AIR score in diagnosing patients with acute appendicitis.
3. To correlate AIR score value with intraoperative finding and HPE report andcompare with Alvarado score.

Review Of Literature:-

A prospective observational study done at a single Centre institution, a total of 464 patients were considered out of that 210 patients were non-appendicitis. Diagnostic performance of AIR score in low-risk group 90% sensitivity, 63% specificity and NPV of 94%. In case of advanced appendicitis 98% sensitivity, 54% specificity and 100% NPV. The

study showed the diagnostic accuracy of AIR score and showed the promising result in a high-risk group. AIR score in a patient with high risk of morbidityand mortality helped by early detection and intervention. [4]

Manne Anderson et al, in 2008 evaluated 545 patients with suspicion of appendicitis. Patient was randomly assigned the value of 0-9. Patient was divided in two group 0- 5 score construction group and 6-9 validation of the scoring system. In the validation group, AIR score had a better discriminating capacity as compared to Alvaradoscore with ROC area of 0.93 vs 0.88. Simplified score categorized 63% patient to low and high group with accuracy as compared to Alvarado was it stood 52%. 153 patient with non-appendicitis AIR score categorized 73% to a low probability group compared to Alvarado with 61%. Score with a value greater than 4 sensitivity was almost similar for both the scoring system, but specificity for simplified score as compared to Alvarado score. In case of a score greater than 8 the PPV was better as compared to Alvarado score. [5]

Sudhir et al in 2016 evaluated 200 patients with suspicious of acute appendicitis. The study included 110 male and 90 female patients. In phlegmonous appendicitis with value >4, Alvarado score had higher sensitivity (97.06) as compared to AIR (78.43). AIR score had higher specificity (89.80) to Alvarado (10.02). The NPV of AIR score was 80% compared to Alvarado 76.92%. Score of the more than 8 still Alvarado had higher sensitivity (33% and 20.59%) and specificity (97.96% and 96.94%) compared to AIR. Patient with advanced appendicitis of score >4 Alvarado score had 100% sensitivity as compared to AIR 89.8%, Specificity of AIR score was 69.54% as compared to Alvarado of 8.609%. NPV of 48.89% for AIR score and 26.2% for Alvarado. In patient with score >8 still, Alvarado had higher sensitivity 44.9% as compared to AIR score 34.69%, specificity of 90.73% for Alvarado score and 95.36% for AIR score. NPV of 83.54% for Alvarado and 81.82% AIR score. AIR scoring system has a high specificity with high negative predictive value thereby reducing negative appendectomy in low risk group. [6]

Patil et al in 2016 evaluated 100 patients with suspicious of acute appendicitis. The study demonstrated higher sensitivity in score >4 for AIR 89.9% as compared to Alvarado 78.6%. In score >8 sensitivity stood better for Alvarado 21.3% and AIR 12.3%. Specificity for AIR (63.6%) and Alvarado (54.5%) in score<4. The study concluded AIR as the better scoring system as compared to Alvarado scoring. [7]

Castro et al in 2009 evaluated 941 patients with acute appendicitis. Out of 941 patients, 410 were male and 531 females. In this study, they found in score >4 the sensitivity was almost similar for AIR (93%) and Alvarado 90%. But specificity had a major difference with AIR (85%) and Alvarado (55%). NPV of AIR score was 0.95 and Alvarado 0.90. Score >8 showed lower sensitivity for AIR (0.10) and Alvarado (0.29). The AIR still had better specificity 1.00 as compared to Alvarado 0.95. In this study, AIR had promising discrimination capacity as compared to Alvarado. [8]

Saha et al in 2017 studied 100 patients presented as pain abdomen suspected with acute appendicitis. The sensitivity of AIR showed the promising result in score >4 with 89.9% and specificity of 63.6%. This study concluded AIR scoring had good sensitivity and positive predictive value in a score of more than 4. [9]

Literature Survey:-

Acute Appendicitis [10-11]

Since the introduction of the appendix to the medical literature, the appendix has always been a mystery. In 1500 identification of this structure within the body was achieved. Dr Claudis Amyand in the year 1735 was able to perform the first-ever appendicectomy at Saint George Hospital London. The 11-year-old boy who swallowed pin had perforated appendix on which the surgery was performed. The first surgery performed for acute appendicitis was in 1759 by Bordeaux. ReginaldFitz presented a paper on "Perforating inflammation of vermiform appendix" at the first meeting of the association of American physician in 1886. A Clinical sign of appendicitis point of maximum tenderness in the right iliac region was described by Charles McBurney which was later resumed after him. The Lifetime risk of individual undergoing appendectomy is 8.6% and 6.7% in male and female. Alvarado scoring system was introduced to the ease the diagnosis of acute appendicitis as it remains the more of a clinical diagnosis. The reason behind the development of scoring was to decrease the rate of negative appendectomy and rule out another differential diagnosis. Appendicitis inflammatory response score was developed in the year 2008 to ease the diagnosis of appendicitis in an acute phase. CRP is the marker for inflammatory response.

Aetiology and Pathogenesis

Acute appendicitis has no single defined aetiology but the most common in the luminal obstruction of the appendix by faecolith. Other factors which may play a role are lymphoid hyperplasia, contrast studies, tumor, parasite, fruit and

vegetable. There is closed loop obstruction by faecolith, Hyperplastic lymphoid follicle, due to which secretion of fluid against the obstruction leading to which there is an increase in intraluminal pressure causing visceral pain manifested as periumbilical pain. Increased pressure in the appendiceal wall exceeds capillary pressure leading to mucosal ischemia. There is luminal bacteria overgrowth and translocation of bacteria across the appendiceal wall. There are inflammation, oedema and necrotic change.

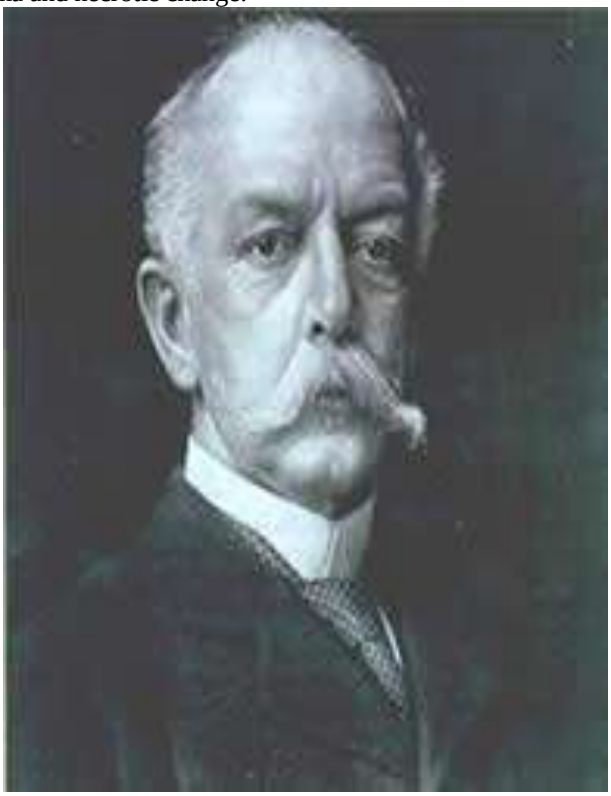

Figure 1:- Charles Mcburney.

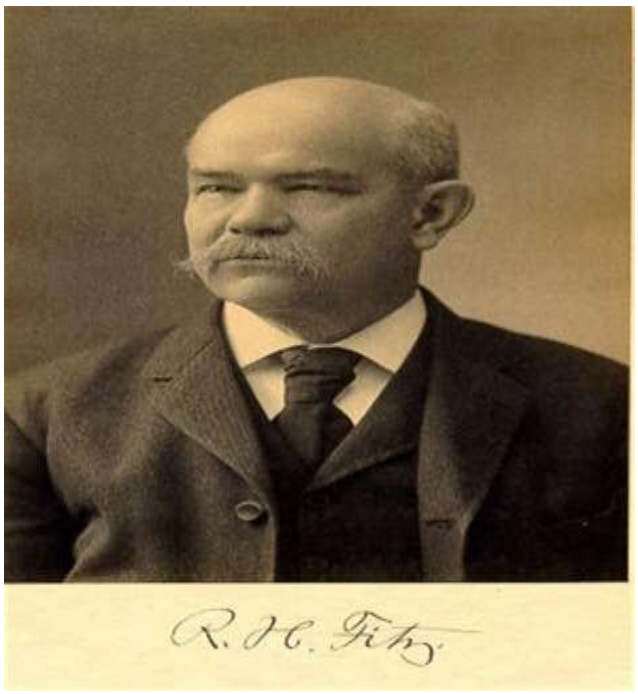

Figure 2:- Reginald H Fitz.

Appendix Embryology And Its Development [12]

In the 6 weeks of intrauterine life, it appears as outpouching from the caudal limb of midgut as appendix and caecum. At eight week its initially noted and continue to develop till about fifth month to achieve a vermiform appearance. During its development tip of cecum remains in its position. The identification of the base of the appendix is by the identification of taenia coli to their confluence in the caecum. Midgut malrotation and situs inversus there will be the abnormal location of the appendix. Incomplete rotation of the midgut along the axis of the superior mesenteric artery. The appendix may be found in the left lower quadrant.

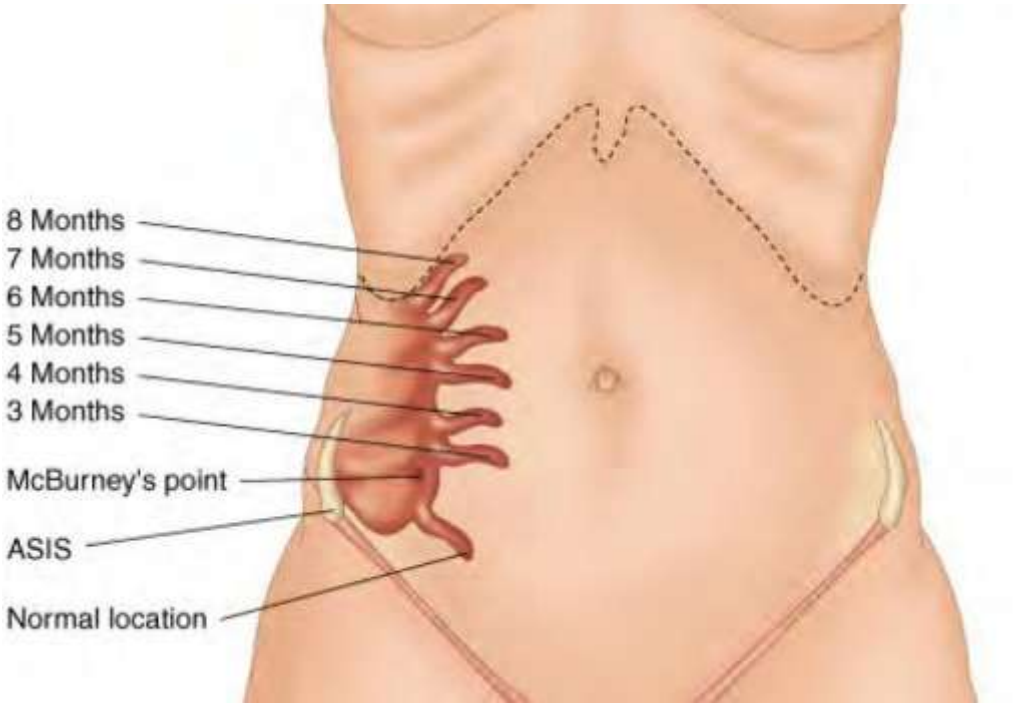

Figure 3:- Location of Appendix during pregnancy.

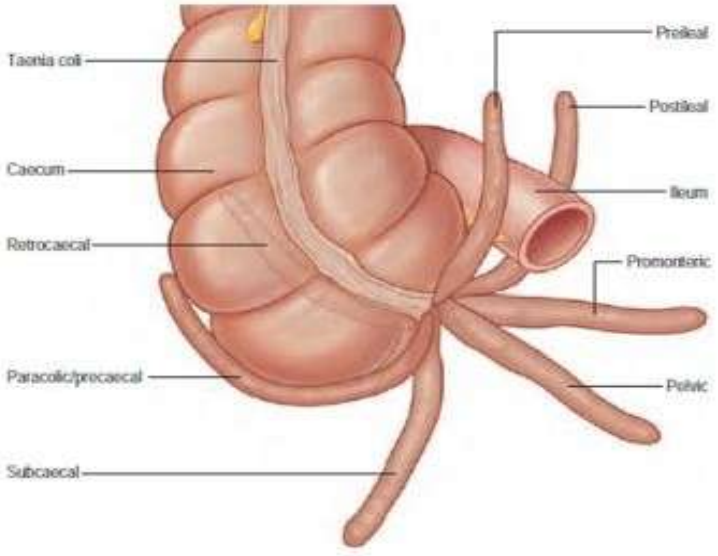

Figure 4:- Appendix anatomical location.

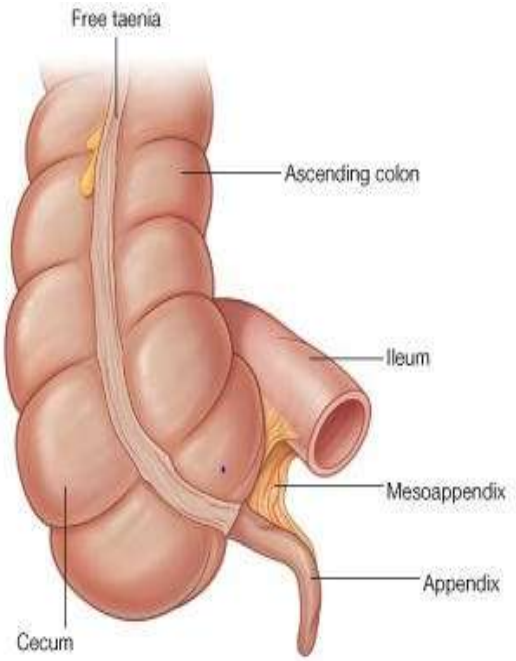

Figure 5:- Appendix anatomy.

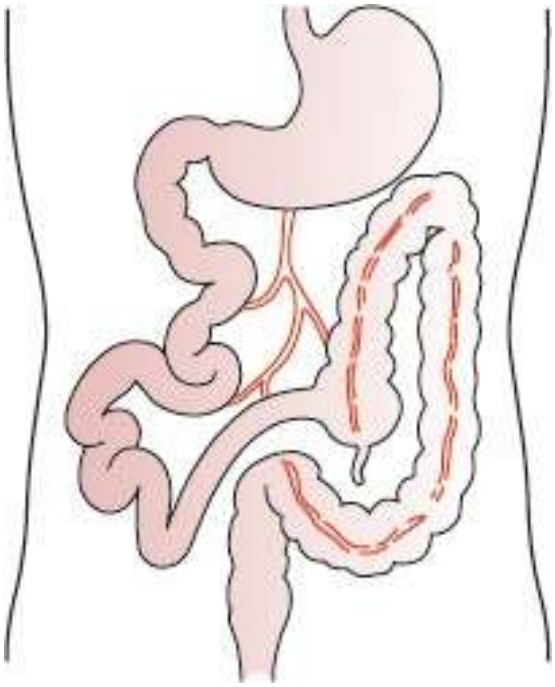

Figure 6:- Left sided caecum and appendix due to intestinal malrotation.

Anatomy [12]

It's a narrow blind ending tube like structure around 6-10cm is vermiform (worm like) appendix. Outer diameter varies between 3 and 8 mm whereas the luminal diameter is around 1 to 3 mm. Below the ileocolic junction, the appendix joins the posteromedial wall of the caecum. Appendix at 3 years of age reaches its mature dimension. The tip of the appendix may be located at several position retrocolic, retrocaecal, pelvic, pre or post ileal and sub-caecal are other such various position where they can be traced. A continuous layer of longitudinal muscle formed by coalescence of the three taenia coli is found. Appendix lumen is narrowed due to sub mucosal lymphoid tissue.

Blood Supply Of Appendix
Its supplied by appendicular artery branch of the ileocolic artery which is a branch of the superior mesenteric artery.

Venous Drainage
Venous tributary of appendix drains into superior mesenteric vein.

Lymphatic drainage of Appendix
Appendix lymphatic drainage is to ileocolic lymph node along the ileocolic artery and mesoappendix. The efferent lymphatic vessel goes to a superior mesenteric lymph node.

Figure 7:- Mesoappendix displayed demonstrating the appendicular artery.

Appendix Nerve Supply
The appendix is supplied by the parasympathetic and sympathetic nerve. Vagus nerve gives off the parasympathetic supply and lower thoracic part of the spinal cord gives off sympathetic nerve fibre.

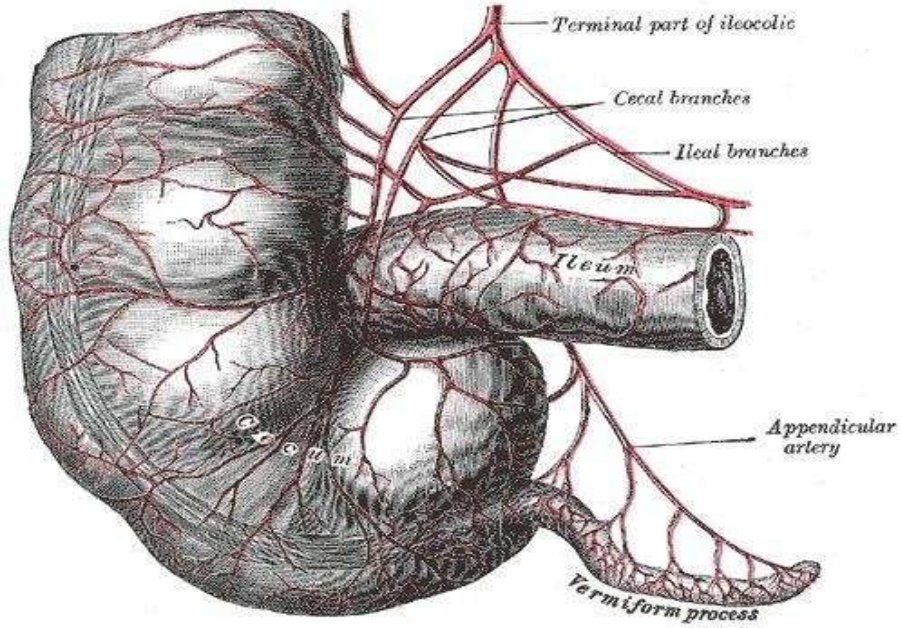

Figure 8:- Blood supply of Appendix.

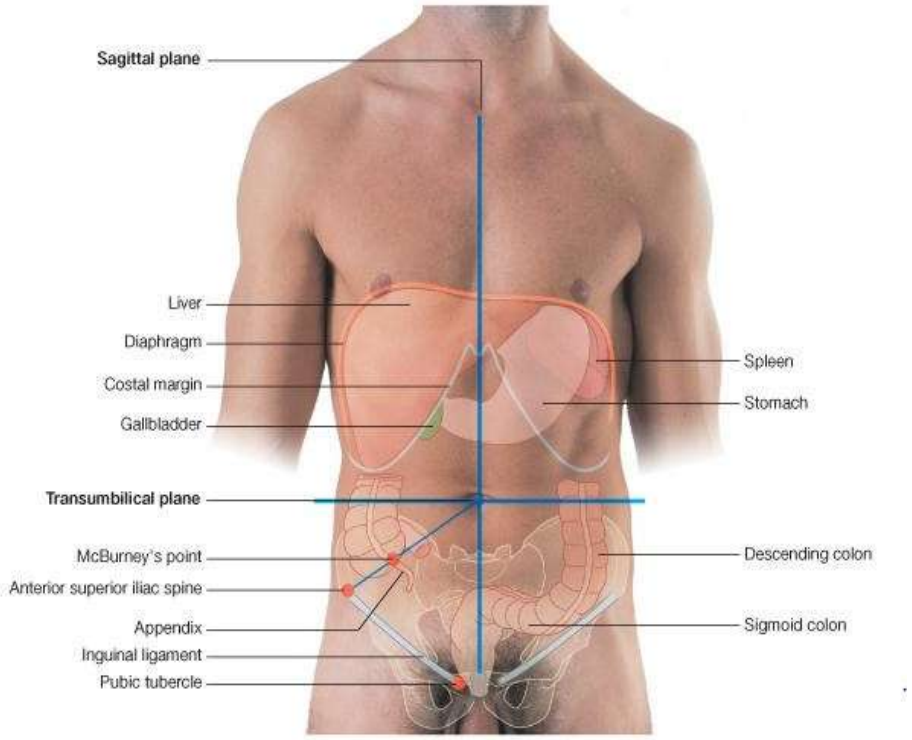

Figure 9:- McBurney Point.

Microstructure

There is a similarity between the wall of the appendix and large intestine but have some alteration. Columnar epithelium is found in mucosa which contains M cell.

Histology of Appendix

In Gut narrowest part is the appendix. Crypts are poorly defined in the appendix, the absence of taenia coli over the appendix. There is the absence of lymphoid tissue at birth. Appendix gradually increases in size and visualised best in 10-year-old.

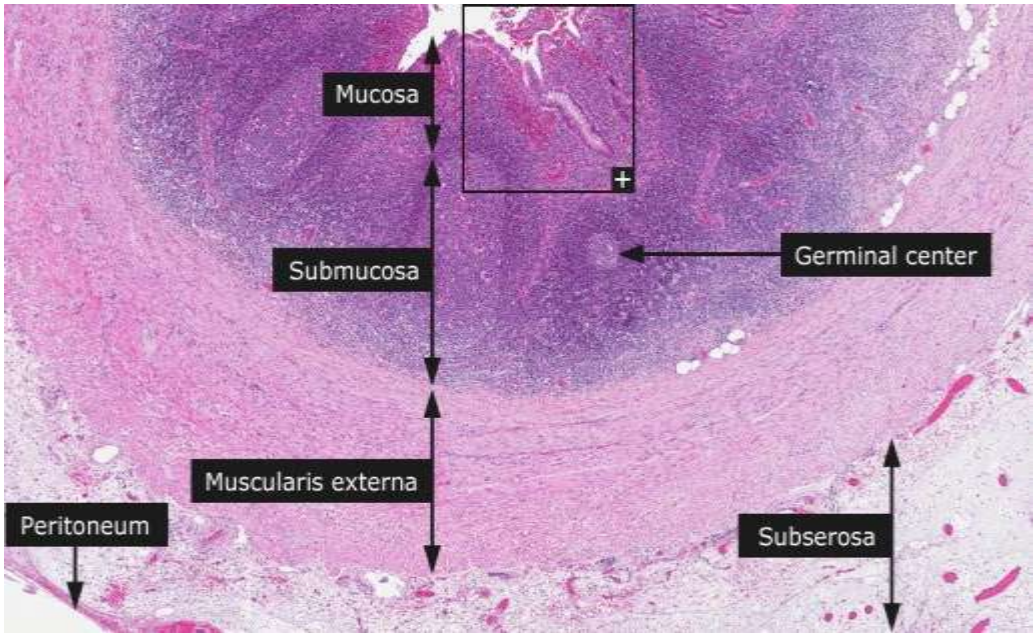

Figure 10:- Histology of Appendix.

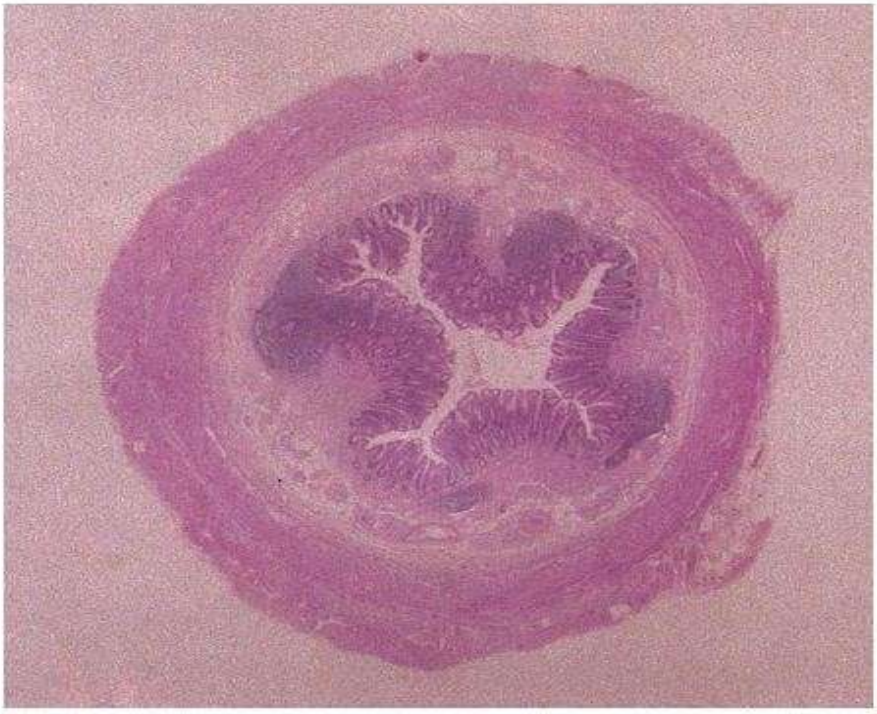

Figure 11:- Histology of Appendix.

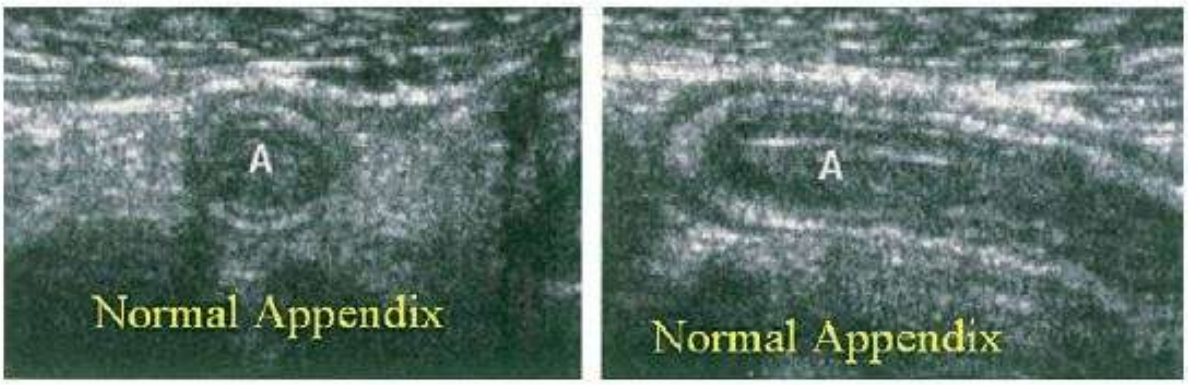

Figure 12:- Ultrasound of normal Appendix.

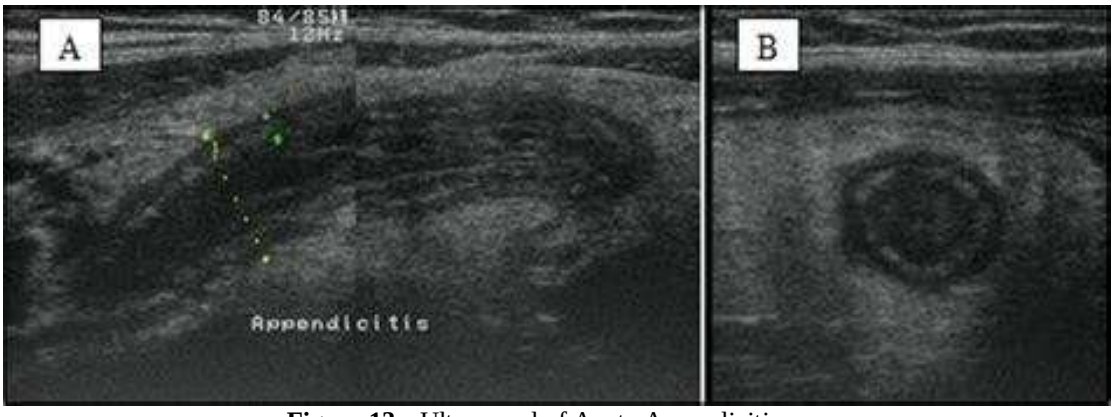

Figure 13:- Ultrasound of Acute Appendicitis.

Clinical Feature

The chief presenting complaints of acute appendicitis is periumbilical pain which last for 6 hours and then gets localised to right iliac fossa.

Symptom

1. Most commonly seen is vomiting around 70% of patient.
2. Anorexia
3. Diarrhoea
4. Obstipation initiates before abdominal pain.

Clinical Sign

Appendicitis is a more of clinical diagnosis rather than a radiological diagnosis. Its presentation begins with vague periumbilical visceral pain from a dilated appendix that migrates to the right inferior fossa and later turns to be somatic due to contact with serosa of the inflamed appendix against parietal peritoneum. The nature of the pain is migratory and settle down at McBurney point (one third of the distance from ASIS to Umbilicus). Rosving sign is elicited by palpation over the left lower quadrantand pain present in the right lower quadrant. Dunphys sign raised intensity of pain with coughing. Psoas sign is due to the continuous irritation of psoas muscle making the patient to lie with right hip flexed for pain relief. Obturator sign is a spasm of obturator internus on flexion and internal rotation of the hip joint. Inflamed appendix comes in contact with the muscles which causes pain in hypogastrium famously known as obturator test.

Laboratory Findings

There is a significant inflammatory response associated with appendicitis and relatesto the severity of appendicitis. There is mild leukocytosis in a patient with acute and uncomplicated appendicitis, mostly polymorphonuclear prominence. In the case of uncomplicated appendicitis, it's unusual for the count to be more then 18000cell/mm3.

Figure 14:- Cut section of appendix.

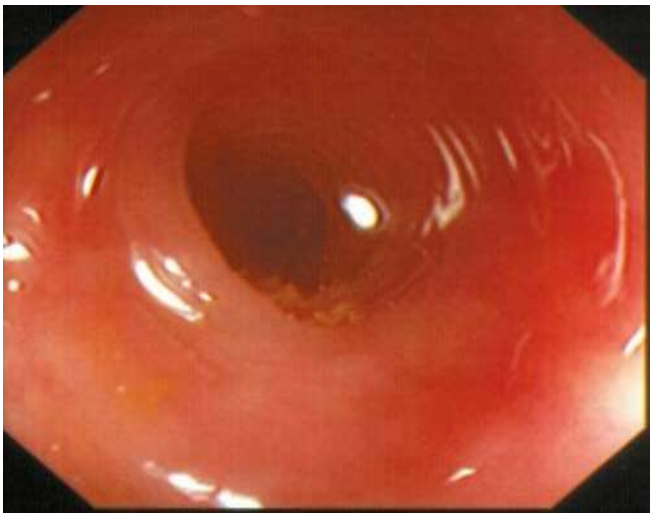

Figure 15:- Colonoscopy view of the lumen of the appendix.

Risk factor for perforation of the appendix

1. Extreme age
2. Immunosuppression
3. Diabetes mellitus
4. Faecolith obstruction
5. Pelvic appendix
6. Previous abdominal surgery.

Figure16:- Abdominal contrast enhanced computed tomography scan showing a faecolith (black arrow) at the base of a distended (>0.6cm) appendix with intramural gas (white arrow).

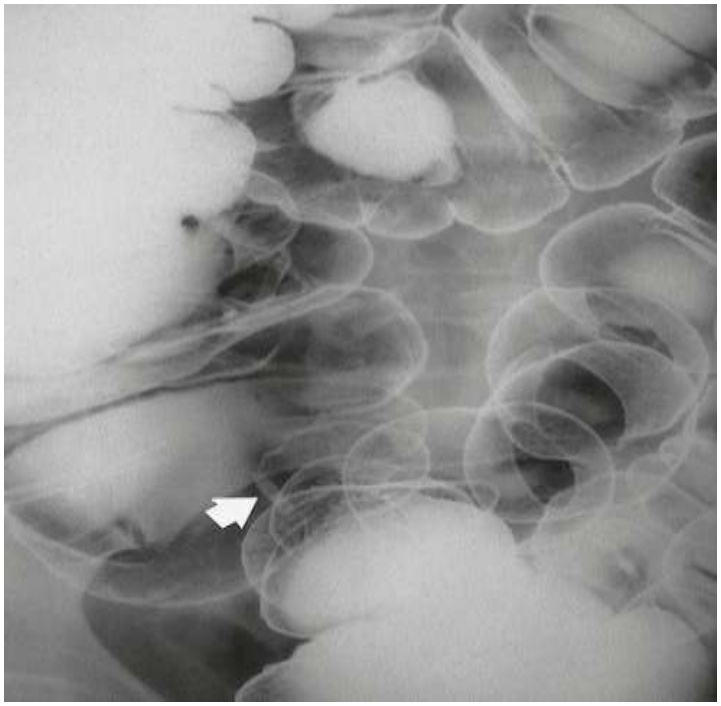

Figure 17:- Barium enema radiograph demonstrating faecoliths of the appendix(arrow) with distal stricture of the appendix.

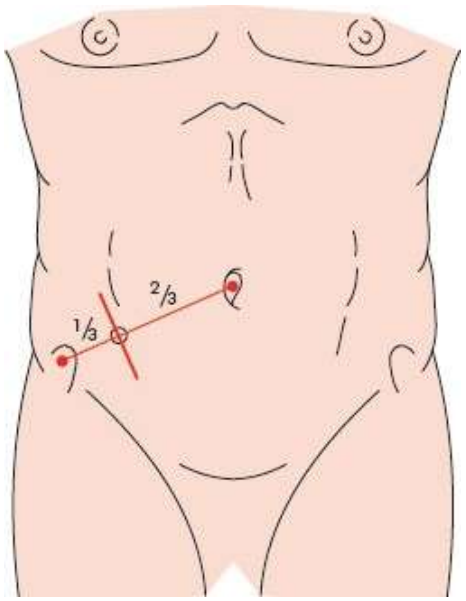

Figure 18:- Grid iron incision for appendicitis at a right angle to the line joiningthe anterior superior iliac spine and umbilicus centred on Mcburney point.

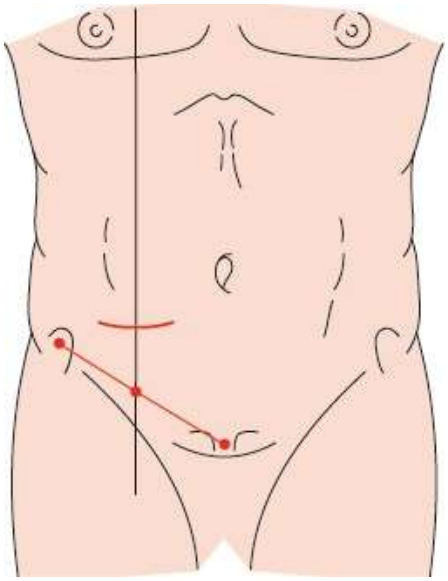

Figure 19:- Skin crease (Lanz) incision for appendicitis 2 cm below theumbilicus centred on the midclavicular & mid inguinal line.

Appendicitis Inflammatory Response Score Parameter

Appendicitis inflammatory response is first introduced in the year 2008 as a tool for diagnosis of acute appendicitis. AIR scoring system was used as a tool for diagnosisand avoiding the need for negative appendectomy.

Vomiting – 1 point

Pain in the right inferior fossa – 1 point

Rebound tenderness or muscular defenseLight – 1 point

Medium – 2 points

Strong – 3 points

. Body temperature >38.5 – 1 point

. Polymorphonuclear leukocytes

70-84% - 1 point

>85 % - 2 points

. White blood cell count

10.0 – 14.9 × 109 cell/L – 1 point
>15 × 109 cell/L 2 points

. C- reactive protein concentration

1 – 4.9 mg/l – 1 point

>5 mg/l - 2 point

Air Score
It's a decision-making scoring for an appendectomy. The patient are divided into 3groups and as per the scoring system the management guidelines were formulated. 0-4 – Low Probability. Outpatient follows up

– Indeterminate group. Active observation or diagnostic laparoscopy.9-12 – High probability. Surgical exploration

Alvarado Parameter
Alvarado score was the first scoring system introduced for the diagnosis of acute appendicitis. It's a scoring system with clinical cum haematological parameter.
Migratory right iliac fossa pain – 1 point

Anorexia – 1 point

Nausea or vomiting – 1 point

Tenderness right iliac fossa – 2 point

Rebound tenderness right iliac fossa- 1point

Fever >36.5 – 1 point

Leukocytosis > 10 × 109 cells/L – 2 point

Shift to the left of neutrophils – 1 point

Alvarado score
It's a decision making scoring for appendectomy using Alvarado score. It helps to classify the patient in three different groups according to that the patient can be treated.
<3 low likelihood of appendicitis4-6 consider further imaging
>7 High likelihood of appendicitis

Methodology:-

Study design:
A Prospective Study.

Study period:
October 2016 – September 2018.

Study setting:
Department of General Surgery, Justice K.S. Hegde charitablehospital.

Study population:
Patients admitted with signs and symptoms of acute appendicitis at Justice K.S. Hegde charitable Hospital, Mangalore.

Sample size:
123 patients using epi-info software for diagnostic test with PPV 64%with article reference (12) confidence interval of 95% and power of study at 80%.

Study group:
Patients clinically diagnosed with acute appendicitis and givingconsent for the study.

Inclusion criteria:
1. All patients admitted in Justice K.S. Hegde charitable hospital with signs and symptoms of acute appendicitis.
2. Patients giving consent for the study.

Exclusion criteria:
1. Patient on statins with cardiovascular disease
2. Patient is having acute or chronic inflammatory condition.
3. Patients on hormone replacement therapy

Patients are not giving consent for the study.

Statistical analysis
Data is tabulated using Microsoft excel 2010 software (Microsoft office 2010 v14.0) and analyzed with SPSS 22.0 (SPSS Inc. Chicago. Il, USA). The correlation coefficient between 2 scores is determined and analysis is done by calculating sensitivity, specificity, PPV and NPV to find an appropriate cut off value. Fischer's exact test was applied, and spearman correlation coefficient was applied to know thecorrelation and p value.

Results;-
Descriptive statistics of a patient suspected to have acute appendicitis.

As per age
Table 1:- Age.

Age	Count	Column N %
10 and below	12	9.8%
11 – 20	38	30.9%
21 – 30	29	23.6%
31 – 40	21	17.1%
41 – 50	11	8.9%
Above 50	12	9.8%
Total	123	100.0%

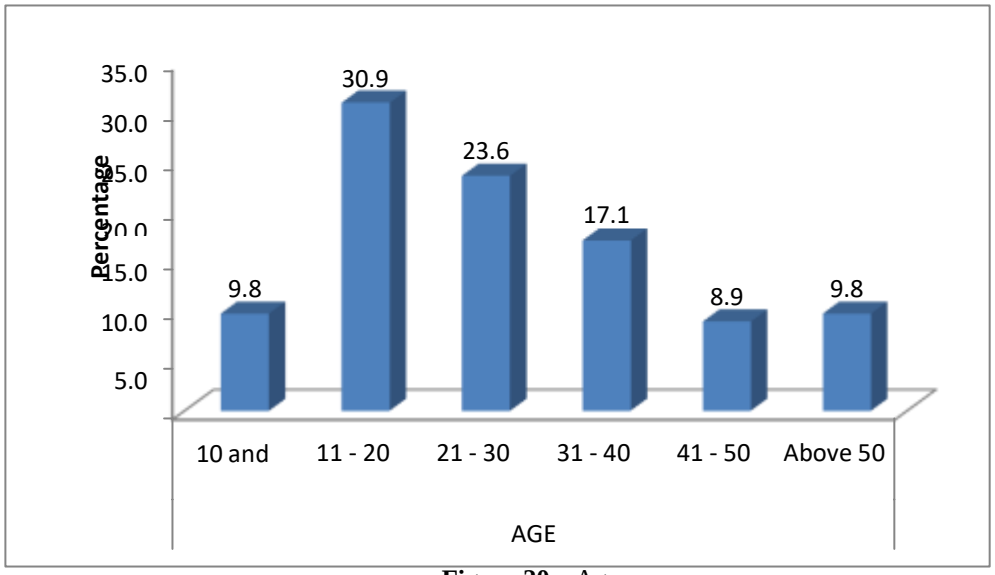

Figure 20:- Age.

A total of 123 patients were included in the study who underwent appendicectomy asshown in (Figure 20) with the mean age group of 10-20 year. 30.9% of patient were in the 11-20 year being the highest group, 23.6% of patient were in the 21-30 age group, 17.1% in 31 -40 age group, 9.8% were in above 50 and 9.8% in age below 10years and, 8.9% were in the 41-50 age group is the lowest group.

Table 2:- As per sex.

Sex	Frequency	Percentage
Females	69	56.1
Males	54	43.9
Total	123	100

In our study it was seen 69 patients were female and 54 were male with 56.1% and43.9% respectively. In this study, there were predominantly female patients.

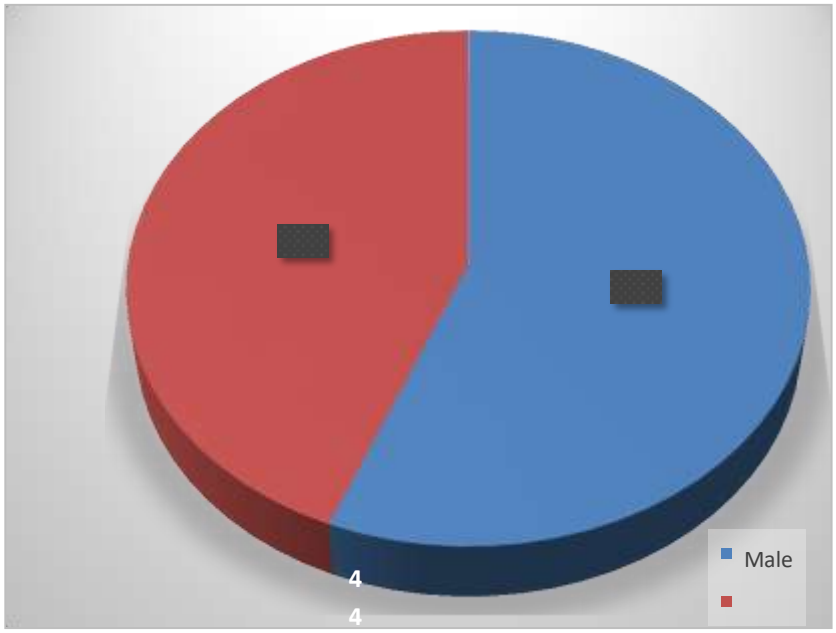

Figure 21:- As per sex.

Table 3:- As per Histopathology report Appendicitis.

HPR	Frequency	Percentage
Acute appendicitis	101	82.1%
Acute on chronic	8	6.5%
Recurrent appendicitis	11	8.9%
Chronic appendicitis	1	.8%
Granulomatous appendicitis	1	.8%
Lymphoid hyperplasia of appendix	1	.8%
Total	123	100.0%

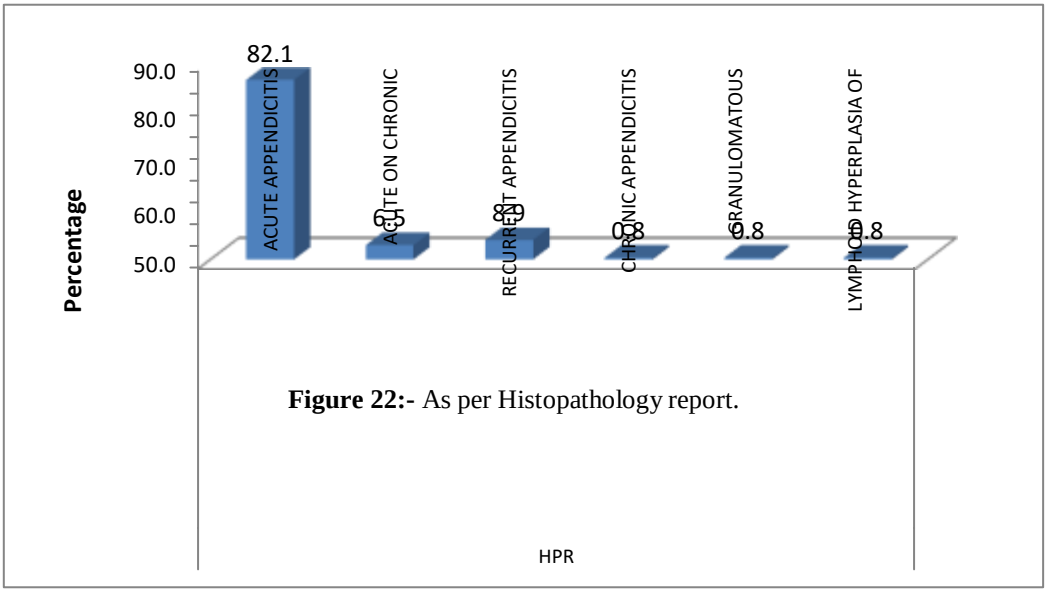

Figure 22:- As per Histopathology report.

Patients was distributed into acute appendicitis and non-acute appendicitis group (acute on chronic, chronic appendicitis, recurrent appendicitis, granulomatous appendicitis and lymphoid hyperplasia of the appendix as per the histopathology report). Total patient in acute appendicitis were 101 (82.1%) and in non-acute appendicitis were 22 patients (17.8%) respectively. Most of the patients in our study were in the acute appendicitis group, and very less patient was seen in the non- acute appendicitis group.

Table 4:- As per Intraoperative finding.

Intra-Op Findings	Frequency	Percentage
Acute appendicitis	119	96.7%
Acute on chronic	0	.0%
Recurrent appendicitis	0	.0%
Chronic appendicitis	4	3.3%
Granulomatous appendicitis	0	.0%
Lymphoid hyperplasia of appendix	0	.0%
Total	123	100.0%

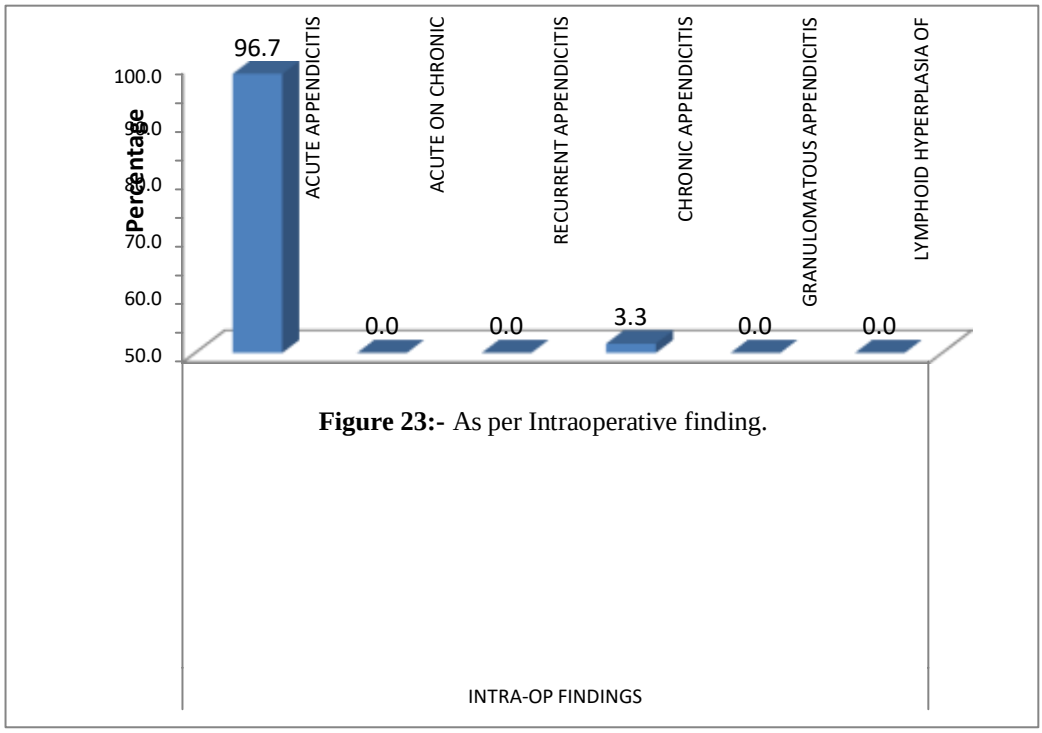

Figure 23:- As per Intraoperative finding.

Table 5:- As per the cut off score of AIR.

Cut off score of AIR	
Low probability	46.3
Indeterminate	48.0
High probability	5.7

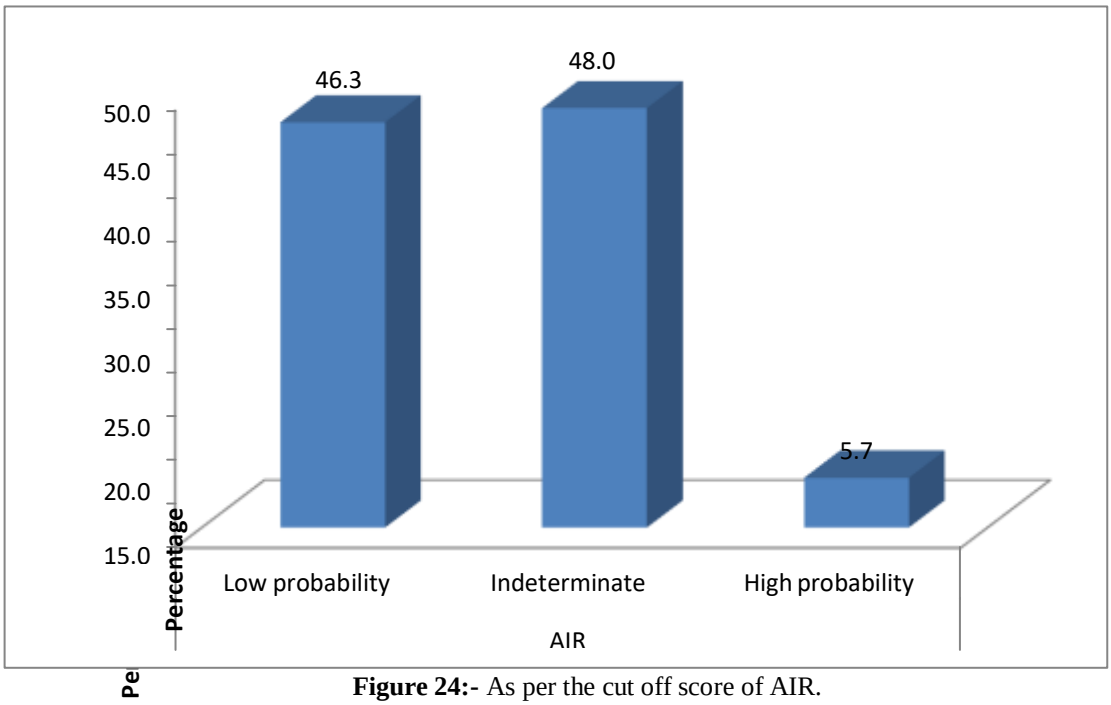

Figure 24:- As per the cut off score of AIR.

In this study patient with acute appendicitis as per the cut off AIR score was divided into 3 groups with Low probability, indeterminate and high probability. Patient in low probability group was around 46.3%, indeterminate group 48.0% and in high risk group were 5.7%.

Table 6:- As per the Alvarado cut off score.

Alvarado cut off score	
Unlikely	3.3
Possible diagnosis	51.2
Acute	37.4
Definite	8.1

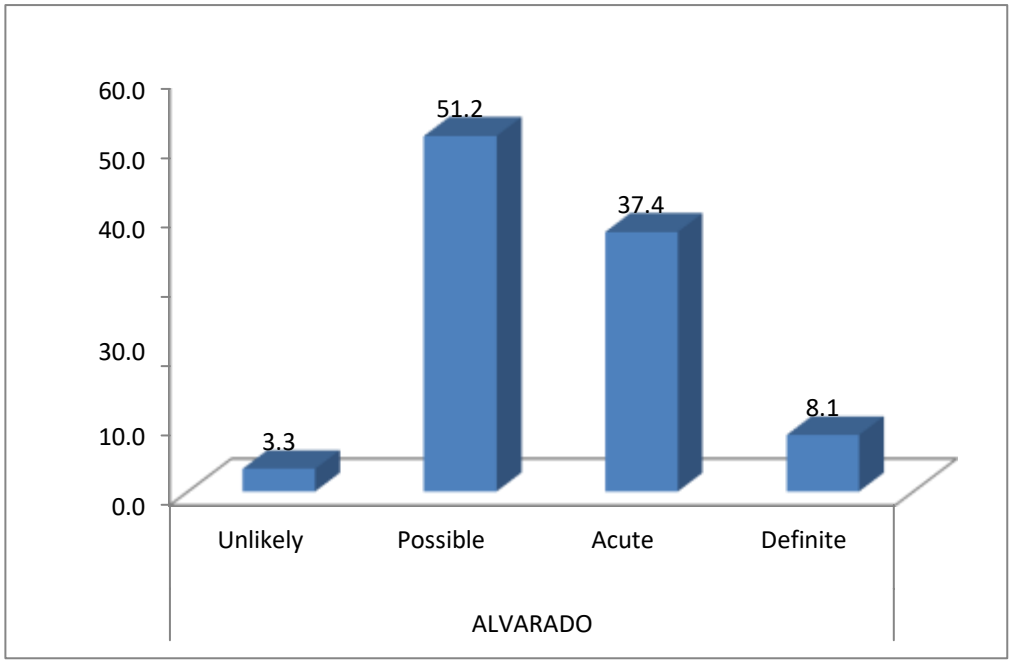

Figure 25:- As per the Alvarado cut off score.

In this study, Alvarado score was divided into four groups which were unlikely, possible diagnosis, acute and definite. Study demonstrated that 51.2% had a score of probable diagnosis, 37.4% had an acute presentation and 8.1% had definite.

Only 3.3% of patient had an unlikely score.

Table 7:- Correlation of AIR and Alvarado score.

		ALVARADO				
		Unlikely	Possible diagnosis	Acute	Definite	Total
AIR	Low probability	3	51	3	0	57
		5.3%	89.5%	5.3%	.0%	100.0%
		75.0%	81.0%	6.5%	.0%	46.3%
	Indeterminate	1	12	41	5	59
		1.7%	20.3%	69.5%	8.5%	100.0%
		25.0%	19.0%	89.1%	50.0%	48.0%
	High probability	0	0	2	5	7
		.0%	.0%	28.6%	71.4%	100.0%
		.0%	.0%	4.3%	50.0%	5.7%
Total		4	63	46	10	123
		3.3%	51.2%	37.4%	8.1%	100.0%
		100.0%	100.0%	100.0%	100.0%	100.0%

Fishers exact test p=0.0001, HS

Correlations

		spearman correlationcoeff icient	p	
ALVARADO	AIR	.848	.000	sig

Strong positive correlation between Alvarado and air

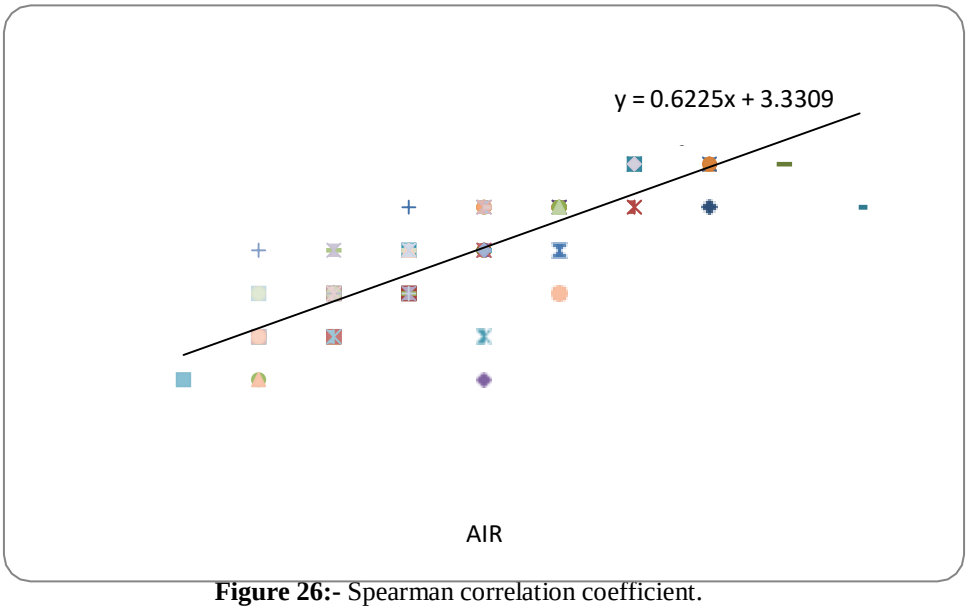

Figure 26:- Spearman correlation coefficient.

ALVARADO = 0.6225x AIR+ 3.3309

In this study, on the application of both the scoring system for acute appendicitis, it was found to have strong positive correlation on Spearman correlation coefficient 848 which was significant. In this study p value 0.01 was taken as significant and the p value 0.0001 which is statistically significant and shows a strong correlation between the Alvarado and AIR on Fischer's exact test.

Table 8:- Correlation of AIR score with HPR >4.

		HPR		
		ACUTE APPENDICITIS	Advanced	Total
AIR	>4	57	9	66
		86.4%	13.6%	100.0%
		56.4%	40.9%	53.7%
	<=4	44	13	57
		77.2%	22.8%	100.0%
		43.6%	59.1%	46.3%
Total		101	22	123
		82.1%	17.9%	100.0%
		100.0%	100.0%	100.0%

		Confidence Interval	
		Lower	**Upper**
Sensitivity	56.44	46.77	66.11
Specificity	59.09	38.55	79.64
PPV	86.36	78.08	94.64
NPV	22.81	11.91	33.70
Overall accuracy**	56.91	48.16	65.66

In our study, the AIR score of >4 demonstrated the sensitivity of 56.44% andspecificity 59.09%. It also demonstrated the PPV of around 86.36% and NPV 22.81%.

Table 9:- Correlation of Alvarado score with HPR >4.

		HPR		
		ACUTE APPENDICITIS	Advanced	Total
ALVARADO	>4	99	20	119
		83.2%	16.8%	100.0%
		98.0%	90.9%	96.7%
	<=4	2	2	4
		50.0%	50.0%	100.0%
		2.0%	9.1%	3.3%
Total		101	22	123
		82.1%	17.9%	100.0%
		100.0%	100.0%	100.0%

		Confidence Interval	
		Lower	**Upper**
Sensitivity	98.02	95.30	100.74
Specificity	9.09	-2.92	21.10
PPV	83.19	76.47	89.91
NPV	50.00	1.00	99.00
Overall accuracy**	82.11	75.34	88.89

In our study, the Alvarado score of >4 demonstrated high sensitivity of 98.02 and specificity 9.09%. It also demonstrated the PPV of around 83.19% and NPV 50.00%.

Table 10:- Correlation of Alvarado score with HPR at score >8.

		HPR		
		ACUTE APPENDICITIS	Advanced	Total
ALVARADO	>8	10	0	10
		100.0%	.0%	100.0%
		9.9%	.0%	8.1%
	<=8	91	22	113
		80.5%	19.5%	100.0%
		90.1%	100.0%	91.9%
Total		101	22	123
		82.1%	17.9%	100.0%
		100.0%	100.0%	100.0%

		Confidence Interval	
		Lower	**Upper**
Sensitivity	9.90	4.08	15.73
Specificity	100.00	100.00	100.00
PPV	100.00	100.00	100.00
NPV	19.47	12.17	26.77
Overall accuracy**	26.02	18.26	33.77

In our study, the Alvarado score of >8 demonstrated the sensitivity of 9.90 and specificity 100.00%. It also demonstrated the PPV of around 100.00% and NPV 19.47%.

Table 11:- Correlation of AIR score with HPR at score >8.

		HPR		
		ACUTE APPENDICITIS	Adv anced	Total
AIR	>8	7	0	7
		100.0%	.0%	100.0%
		6.9%	.0%	5.7%
	<=8	94	22	116
		81.0%	19.0%	100.0%
		93.1%	100.0%	94.3%
Total		101	22	123
		82.1%	17.9%	100.0%
		100.0%	100.0%	100.0%

		Confidence Interval	
		Lower	**Upper**
Sensitivity	6.93	1.98	11.88
Specificity	100.00	100.00	100.00
PPV	100.00	100.00	100.00
NPV	18.97	11.83	26.10
Overall accuracy**	23.58	16.08	31.08

In our study, the AIR score of >8 demonstrated the sensitivity of 6.93 and specificity100.00%. It also demonstrated the PPV of around 100.00% and NPV 18.47%.

Discussion:-

Acute appendicitis is a most common disease encountered as a surgical emergency presenting with acute abdominal pain [13]. Patient with the obvious disease with medical management and close observation decreases the risk of unwanted appendectomy and perforation [14-16]. Patient with advanced appendicitis has to be picked up early where the medical management is being advocated [17]. Alvarado is the most used scoring system in case of acute appendicitis as it was first reported in the year 1986 [18]. A clinical scoring system is made to simplify the management of Acute appendicitis and decision making in the emergency room. Scoring system help to classify the patient for emergency surgery, extra examination with radiological modality or medical management. The use of the scoring system is to distinguish and increase the probability of diagnosis. Acute appendicitis is a more of history-based disease like pain abdomen, Nausea, peritonitis feature, migratory right iliac fossa pain, vomiting, rebound tenderness and fever [7]. Appendicitis inflammatory response score came first into the picture in the year 2008. It was a prospective study, 545 patients admitted with complaints of acute appendicitis. The scoring system was created in 316 patient and was used in the remaining 229 patients. AIR scoring system was the same as Alvarado with added variable CRP [5].A meta- analysis showed raised White blood cell count and C- Reactive protein are there fivefold rise in likelihood ratio for acute appendicitis [19]. Eugene albu et al studied the C reactive protein diagnostic value and showed the sensitivity of 86.6% and positive predictive value of 100% [20]. Today ultrasound and CT scan are used routinely in a patient with suspected acute appendicitis; radiological procedure don't work well in a patient of low and high prevalent disease. Moreover, the use of CT scan should be kept with high suspicion of disease and decrease the exposure to radiation [21]. In our study total of 123 patient with suspected acute appendicitis, it was seen maximum patients were in the age group of 11-20 year (30.9%), 38 out of 123 patients. In our study group 53 female and 70 male patients. Histopathological study was kept as the gold standard for the diagnosis of acute appendicitis. Patient presented with symptom and sign of acute appendicitis were evaluated on AIR and Alvarado score. Study by Andersson et al classified 63% of patient in low a group, 37% of patient to the indeterminate group and 13 % of the patient to high risk group, Alvarado classified 52% low, 48% indeterminate and 10% in a high-risk group [5]. In our study AIR score classified 46.3% of the patient to low, 48% to indeterminate and 5.7% in high probability group, Alvarado classified 54.5% low group, 37.4% indeterminate and 8.1% in a high-risk group.

In a study done by Patil et al in 2017 showed the sensitivity of 89.9% at score >4 and 12.3% at score >8. AIR and Alvarado showed specificity of 12.3% and 21.3% at score >4 & >8 respectively [7]. In our study the sensitivity of

AIR at score >4 is 56.44% and at score >8 is 6.93%, and specificity of at score >4 is 59.09% and at score >8 is 100%. Alvarado showed sensitivity of 98.02 % at score >4 & 98.02% at score >8 respectively. Alvarado showed specificity of 9.09% at score >4 and 9.09% at score >8.

In a study by M. Andersson et al in 2017 AIR classified around half of the population into the Intermediate risk group. In our study also, AIR scoring system classified 48% to the indeterminate group. [5] It may help to correctly classify the patient for theneed of imaging, in hospital management and decrease unwanted exploration.

In a study done by saha et al PPV of AIR score >4 was 95.23 and 100% at score >8,NPV of AIR >4 is 43.75% and >8 is 12.3% [9]. In our study the PPV of AIR is 86.36% at score >4 and 100% at score >8, NPV of AIR is 22.81% and 18.97% at score >4 and >8 respectively. In a study done by patil et al the sensitivity of AIR >4 was 89.9% and 12.3% at score >8. The specificity of AIR was 63.6% and 100% at score >4 & >8 respectively [7]. In our study, the sensitivity of AIR >4 score was 56.44% and6.93% in score >8, specificity of the AIR >4 was 59.09% and 100% at score >8.

Conclusion:-

In the present study we came to the following conclusion

1. Alvarado score is better diagnostic tool for acute appendicitis as compared tothe AIR score.
2. Alvarado score has higher sensitivity in score of >4 as compared to AIR.
3. AIR score with low sensitivity has low discriminatory power in ruling outpatient with acute appendicitis.

Summary

In the present study we evaluated 123 patients who presented with complaints of acute appendicitis and were as per the inclusion criteria. The patients were subjected to the AIR and Alvarado scoring system. The diagnosis was confirmedwith the histopathology report.

The maximum patients were in the age group of 11-20 year compromising around 30.9%. Most of the patients were female around 56.1%. Histopathological report showed around 82.1% as Acute appendicitis, 6.5% acute on chronic, recurrent appendicitis 8.9%, chronic appendicitis, granulomatous appendicitis & lymphoid hyperplasia of appendix were .8% each. AIR classified around 46.3% in low probability, 48% indeterminate and 5.7% in high probability group. Alvarado classified around 3.3% in unlikely, 51.2% in possible diagnosis, 37.4% acute and 8.1% in definite group. On spearman correlation coefficient there was found to be a strong positive correlation between both the scoring system and statistically significant p value of 0.0001. AIR score showed a sensitivity of 56.44% and specificity of 59.09% at score >4. Alvarado had a sensitivity of 98.02 % and specificity of 9.09% at score >4. Alvarado and AIR showed 9.90% and 6.93% at score >8 respectively. The specificity of Alvarado and AIR was 100% respectively. The AIR at a low and higher score had a high PPV and NPV that may help in correctly diagnosing the patient with acute appendicitis and ruling out from non- appendicitis patient.

Limitations and Recommendations:-

Limitations Of The Study

1. The study was a single center, as it was confined to the one surgicaldepartment and there may be biased in the clinical judgement.
2. The short duration of study and small sample size is not enough to implicatethe result.

Recomendations Of The Study:-

We recommend that further studies be done on a larger scale in a population-based setting and the study to be conducted at the level ofprimary health center as most of the patient present primarily to this health center.

References:-

1. Russell RCG, Williams NS. The Vermiform Appendix. In: Ed(s) Connell PR. Bailey & Love: Short practice of surgery. 26th ed. London: Hodder Arnold;2008. p.1204-18.
2. MORRIS RT. Mcburney's point and another point in appendix diagnoses. J Am Med Assoc. 1908 Jan 25; L(4):278–79.
3. Andersson RE, Hugander A, Thulin AJ. Diagnostic accuracy and perforation rate in appendicitis: association with age and sex of the patient and with appendicectomy rate. Eur J Surg Acta Chir. 1992 Jan;158(1):37–41.

4. Scott AJ, Mason SE, Arunakirinathan M, Reissis Y, Kinross JM, Smith JJ. Risk stratification by the Appendicitis Inflammatory Response score to guide decision-making in patients with suspected appendicitis. Br J Surg. 2015 Apr;102(5):563–72.
5. Andersson M, Andersson RE. The appendicitis inflammatory response score: a tool for the diagnosis of acute appendicitis that outperforms the Alvarado score. World J Surg. 2008 Aug;32(8):1843–9.
6. Sudhir S, Sekhar AP. Evaluation of appendicitis inflammatory response score as a novel diagnostic tool for diagnosis of acute appendicitis and its comparisonwith Alvarado score. Int Surg J. 2017 Jan;3(1):21-6.
7. Patil S, Harwal R, Harwal S, Kamthane S. Appendicitis inflammatory response score: a novel scoring system for acute appendicitis. Int Surg J. 2017 Mar;4(3):1065-70.
8. de Castro SMM, Ünlü Ç, Steller EP, van Wagensveld BA, Vrouenraets BC. Evaluation of the Appendicitis Inflammatory Response Score for Patients with Acute Appendicitis. World J Surg. 2012 Jul;36(7):1540–5.
9. Saha AK, Chatterjee TK, Sohail S. Evaluation of the appendicitis inflammatory response score for patient with suspected acute appendicitis. Int Surg J. 2018 Feb;17(2):40-4.
10. Jackson PG, Evan SR. The Appendix. In; Ed(s) Sabiston DC, Ed(s) Townsend CM. Sabiston textbook of surgery: The biological basis of modern surgical practice. 19th ed. Philadelphia: Elsevier Saunders; 2002. p. 1296-9.
11. Zinner MJ. Appendix. In; Ed(s) Ashley SW. Maginot's: Abdominal operation.12th ed. London: The McGraw-Hill; p. 623-41.
12. Jones DB, Upchurch JR. Appendicitis. In: Ed(s) Fischer JE. Fischers Mastery of Surgery: 6th ed, Philadelphia: Lippincott Williams & wilkins, Wolters Kluwer; 2012. p1603-6.
13. Velanovich V, Satava R. Balancing the normal appendectomy rate with the perforated appendicitis rate: implications for quality assurance. Am Surg. 1992 Apr;58(4):264–9.
14. Andersson R, Hugander A, Thulin A, Nystrom PO, Olaison G. Indications for operation in suspected appendicitis and incidence of perforation. BMJ. 1994 Jan 8;308(6921):107–10.
15. Bachoo P, Mahomed AA, Ninan GK, Youngson GG. Acute appendicitis: the continuing role for active observation. Pediatr Surg Int. 2001 Mar;17(2–3):125– 8.
16. Kirby CP, Sparnon AL. Active observation of children with possible appendicitis does not increase morbidity. ANZ J Surg. 2001 Jul;71(7):412–3.
17. Andersson RE. The natural history and traditional management of appendicitis revisited: spontaneous resolution and predominance of prehospital perforations imply that a correct diagnosis is more important than an early diagnosis. WorldJ Surg. 2007 Jan;31(1):86–92.
18. Alvarado A. A practical score for the early diagnosis of acute appendicitis. Ann Emerg Med. 1986 May;15(5):557–64.
19. Andersson REB. Meta-analysis of the clinical and laboratory diagnosis of appendicitis. Br J Surg. 2004 Jan;91(1):28–37.
20. Albu E, Miller BM, Choi Y, Lakhanpal S, Murthy RN, Gerst PH. Diagnostic value of C-reactive protein in acute appendicitis. Dis Colon Rectum. 1994 Jan;37(1):49–51.
21. Terasawa T, Blackmore CC, Bent S, Kohlwes RJ. Systematic review: computed tomography and ultrasonography to detect acute appendicitis in adults and adolescents. Ann Intern Med. 2004 Oct 5;141(7):537–46.

Background:

1. Acute appendicitis was first described by Reginald.H.Fitz in 1886. Acute Appendicitis is the most frequent cause of acute abdominal pain requiring surgical intervention. Annually appendectomy is the most common abdominaloperation performed on emergency basis. Lifetime risk for developing acute appendicitis is 8.6% in men and 6.7% in women.
2. Acute Appendicitis inciting event in most instances is obstruction of the appendices lumen. Acute Appendicitis is classified as; catarrhal phlegmonus, gangrenous and perforated. This classification describes the evolutionary stage of disease. Acute appendicitis is more of a clinical diagnosis present as pain abdomen with classical migration from peri-umbilical region to right iliac fossa in 75% of patient nausea and anorexia.
3. Clinical signs are mostly pyrexia, localized tenderness in the right iliac fossa, muscle guarding and rebound tenderness. Laboratory and radiological investigation are also important tool for the diagnosis.
4. Scoring system have been designed to aid in the clinical assessment of patient with acute appendicitis. The most used scoring is the Alvarado score is best performing in validation studies. Alvarado score doesn't incorporate C reactive protein as a variable, many studies shows the importance of C reactive protein in assessment of patient with appendicitis.

Review Of Literature:-

A prospective observational study done at a single Centre institution, a total of 464 patients were considered out of that 210 patients were non-appendicitis. Diagnostic performance of AIR score in low-risk group 90% sensitivity, 63% specificity and NPVof 94%. In case of advanced appendicitis 98% sensitivity, 54% specificity and 100% NPV. The study showed the diagnostic accuracy of AIR score and showed the promising result in a high-risk group. AIR score in a patient with high risk of morbidityand mortality helped by early detection and intervention. [(1)]

Manne Anderson et al, in 2008 evaluated 545 patients with suspicion of appendicitis.Patient was randomly assigned the value of 0-9. Patient was divided in two group 0- 5 score construction group and 6-9 validation of the scoring system. In the validation group, AIR score had a better discriminating capacity as compared to Alvaradoscore with ROC area of 0.93 vs 0.88. Simplified score categorized 63% patient to low and high group with accuracy as compared to Alvarado was it stood 52%. 153 patients with non-appendicitis AIR score categorized 73% to a low probability group compared to Alvarado with 61%. Score with a value greater than 4 sensitivity was almost similar for both the scoring system, but specificity for simplified score as compared to Alvarado score. In case of a score greater than 8 the PPV was better as compared to Alvarado score. [(2)]

Sudhir et al in 2016 evaluated 200 patients with suspicious of acute appendicitis.The study included 110 male and 90 female patients. In phlegmonous appendicitis with value >4, Alvarado score had higher sensitivity (97.06) as compared to AIR (78.43). AIR score had higher specificity (89.80) to Alvarado (10.02). The NPV of AIR score was 80% compared to Alvarado 76.92%. Score of the more than 8 still Alvarado had higher sensitivity (33% and 20.59%) and specificity (97.96% and 96.94%) compared to AIR. Patient with advanced appendicitis of score >4 Alvarado score had 100% sensitivity as compared to AIR 89.8%, Specificity of AIR score was 69.54% as compared to Alvarado of 8.609%. NPV of 48.89% for AIR score and 26.2% for Alvarado. In patient with score >8 still, Alvarado had higher sensitivity 44.9% as compared to AIR score 34.69%, specificity of 90.73% for Alvarado score and 95.36% for AIR score. NPV of 83.54% for Alvarado and 81.82% AIR score. AIR scoring system has a high specificity with high negative predictive value thereby reducing negative appendectomy in low risk group. [(3)]

Patil et al in 2016 evaluated 100 patients with suspicious of acute appendicitis. The study demonstrated higher sensitivity in score >4 for AIR 89.9% as compared to Alvarado 78.6%. In score >8 sensitivity stood better for Alvarado 21.3% and AIR 12.3%. Specificity for AIR (63.6%) and Alvarado (54.5%) in score<4. The study concluded AIR as the better scoring system as compared to Alvarado scoring. [(4)]

Castro et al in 2009 evaluated 941 patients with acute appendicitis. Out of 941 patients, 410 were male and 531 females. In this study, they found in score >4 the sensitivity was almost similar for AIR (93%) and Alvarado 90%. But specificity had a major difference with AIR (85%) and Alvarado (55%). NPV of AIR score was 0.95 and Alvarado 0.90. Score >8 showed lower sensitivity for AIR (0.10) and Alvarado (0.29). The AIR still had better specificity 1.00 as compared to Alvarado 0.95. In this study, AIR had promising discrimination capacity as compared to Alvarado. [(5)]

Aim:

Appendicitis Inflammatory Response score as a diagnostic tool for acute appendicitis in our hospital setting.

Objectives:-

1. To evaluate AIR score in diagnosing patient with acute appendicitis.
2. To corelate AIR score value with intra operative finding and HPE reportand compare with alvarado score

Methodology:-

Study design:

A Prospective Study.

Study period:

October 2016 – September 2018.

Study setting:
Department of General Surgery, Justice K.S. Hegde charitablehospital.

Study population:
Patients admitted with signs and symptoms of acute appendicitis at Justice K.S. Hegde charitable Hospital, Mangalore.

Sample size:
123 patients using epiinfo software for diagnostic test with PPV 64%with article reference (12) confidence interval of 95% and power of study at 80%.

Study group:
Patients clinically and radiologically diagnosed with acute appendicitis

Inclusion criteria:
1. All patients admitted in Justice K. S. Hegde charitable hospital with signsand symptoms of acute appendicitis.
2. Patients giving consent for the study.

Exclusion criteria:
1. Patient on statins with cardiovascular disease
2. Patient having acute or chronic inflammatory condition.
3. Patient on hormone replacement therapy
4. Patients not giving consent for the study.

Method:-
1. Informed consent
2. Patient information - Detailed patient information and history obtained.
3. Duration of symptoms - <48 hours/>48 hours
4. Right iliac fossa pain
5. Migratory pain in RIF
6. Vomiting
7. Fever:>38.5 c
8. RIF tenderness +/-
9. Rebound tenderness +/-
10. Total Counts
11. Differential counts
12. CRP Value
13. Surgical procedure with intra-op finding
14. Histopathology report

Data management and statistical methods:
After collecting the data sensitivity and specificity of the AIR and ALVARADO scoring will be compared. Statistical analysis will be performed with SPSS (SPSS inc,Chicago, IL). A p value of<0.001 will be considered statistically significant

Budget Requirement
Self-funded.
1. This study requires funds for Measurement of CRP.
2. CRP costs 150 per test, thereby total cost will be approximatelyRs.15000/-

References:-
1. Andersson RE, Hugander A, Thulin AJ. Diagnostic accuracy and perforation rate in appendicitis: association with age and sex of the patient and with appendicectomy rate. Eur J Surg Acta Chir. 1992 Jan;158(1):37–41.
2. Scott AJ, Mason SE, Arunakirinathan M, Reissis Y, Kinross JM, Smith JJ. Risk stratification by the Appendicitis Inflammatory Response score to guide decision-making in patients with suspected appendicitis.

Br J Surg. 2015 Apr;102(5):563–72.
3. Andersson M, Andersson RE. The appendicitis inflammatory response score: a tool for the diagnosis of acute appendicitis that outperforms the Alvarado score. World J Surg. 2008 Aug;32(8):1843–9.
4. Sudhir S, Sekhar AP. Evaluation of appendicitis inflammatory response score as a novel diagnostic tool for diagnosis of acute appendicitis and its comparisonwith Alvarado score. Int Surg J. 2017 Jan;3(1):21-6.
5. Patil S, Harwal R, Harwal S, Kamthane S. Appendicitis inflammatory response score: a novel scoring system for acute appendicitis. Int Surg J. Mar;4(3):1065-70.
6. de Castro SMM, Ünlü Ç, Steller EP, van Wagensveld BA, Vrouenraets BC. Evaluation of the Appendicitis Inflammatory Response Score for Patients with Acute Appendicitis. World J Surg. 2012 Jul;36(7):1540–5.