Journal of Cardiovascular Disease Research

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 10, 2023

Title -

A CROSS-SECTIONAL STUDY ON COMPARISON OF OUTER DIAMETER OF APPENDIX ON ULTRASONOGRAPHY, C-REACTIVE PROTEIN AND SERUM BILIRUBIN LEVELS IN COMPLICATED VERSUS UNCOMPLICATED APPENDICITIS.

Authors

1. **DR ANOOP S RAO – Senior Resident**
2. **DR AKSHATHA H S – Senior Resident**
3. **DR PRAMOD T* - Associate Professor**

*corresponding author

Mailing address – No 48, 31st B cross, 4th T block, Corporation layout, Jayanagar, Bangalore 560041

Email – pramodthejoram@gmail.com

Mobile - 9844558073

Institution – Kodagu Institute of Medical Sciences, Madikeri, Karnataka.

ABSTRACT

Background:

It is estimated that accuracy of clinical diagnosis of acute appendicitis is only between 76 percent and 92 percent. Parameters like outer diameter of appendix on ultrasonography, and biochemical parameters like raised CRP and hyperbilirubinemia helps to improve the accuracy of pre- operative diagnosis of acute appendicitis. Our objective is to compare the outer diameter of the inflamed appendix on ultrasonography, values of CRP and total serum bilirubin in complicated versus uncomplicated appendicitis.

Methods:

In our study 60 patients diagnosed to have acute appendicitis clinically were subjected to Ultrasonography, CRP and Total Serum Bilirubin. Chi-square test and unpaired 't' test were used to compare categorical and continuous variables respectively. Receiver operating characteristics (ROC) curve was used for different cut off points of appendicular diameter, CRP and total serum bilirubin.

Results:

In our study, maximum number of patients were in the 21 to 40 years age group accounting for 58.34% of total cases. The mean total serum bilirubin in cases of uncomplicated appendicitis was 0.85 ± 0.39 mg/dl and in complicated appendicitis, it was 1.98 ± 0.55 mg/dl. The mean CRP in cases of uncomplicated appendicitis was 2.50 ± 1.86 mg/dl and in complicated appendicitis, it was 15.07 ± 7.28 mg/dl. The mean appendicular diameter in

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 10, 2023

uncomplicated appendicitis was 8.65±1.98 mm and in complicated appendicitis it was 10.07 ± 1.42 mm. Pre - operative total serum bilirubin and CRP values have higher sensitivity (95.24%) and specificity (84.61%) than appendicular diameter on USG in diagnosing complicated appendicitis.

Conclusion:

Use of biochemical parameters such as total serum bilirubin and CRP, radiological such as outer diameter of appendix on USG helps in diagnosing complicated appendicitis pre-operatively

Keywords:

Complicated appendicitis, Serum bilirubin, CRP, Appendicular diameter

INTRODUCTION

Acute appendicitis is the commonest cause of "acute surgical abdomen". [1,2.] Appendicectomy is the most frequently performed urgent abdominal operation and is often the first major procedure performed by a surgeon in training. The clinical presentation of acute appendicitis varies from mild symptoms, like lower abdomen pain with associated fever to severe diffuse peritonitis and sepsis. The most common complaint is right lower quadrant abdominal pain. Associated fever and chills point more towards the involvement of sepsis. The diagnosis of Appendicitis still remains a dilemma in spite of advances in the radiological and laboratory investigations. Experienced clinicians accurately diagnose appendicitis based on a combination of history, physical examination and laboratory studies about 80% of the time.[3] Acute appendicitis is a common and urgent surgical illness with protean manifestations with frequent overlap with other clinical syndromes that results in significant morbidity. It is estimated that the accuracy of clinical diagnosis of acute appendicitis is lying between 76% and 92%[4].

Despite intense research and discussion, the diagnosis of acute appendicitis is still difficult and remains perhaps the most common problem in clinical surgery. On the one hand normal appendix on appendicectomy represents misdiagnosis; on the other hand, a diagnostic delay of appendicitis may lead to perforation, peritonitis and septicaemia. In spite of careful clinical, laboratory and ultrasound examinations, the rates of removing non-diseased appendix and of appendiceal perforation remains at around 20% of all cases subjected to appendicectomy. No single sign, symptom or diagnostic test accurately makes the diagnosis of appendiceal inflammation in all cases.

The surgeons goal is to evaluate a relatively small population of patients referred for suspected appendicitis and to minimize the negative appendicectomy rate without increasing the incidence of complications[5,6].

As the incidence of perforation is usually proportional to the duration of disease process, traditional teaching has encouraged surgeons to operate even when the diagnosis is probable rather than wait until it is certain. The morbidity and mortality rates associated with appendicitis are greatly increased when perforation ensues; wound infection rates may treble,

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 10, 2023

intra-abdominal abscess formation increases 15-fold and mortality rates may be 50 times greater.

Thus, a surgeon confronting a patient suspected of having acute appendicitis is wedged between negative appendicectomy and perforation on the other hand. Diagnostic accuracy of acute appendicitis remains insufficient, with a high rate of unnecessary operations. Only the promotion of routine ultrasonography might contribute to an improvement in the near future.[7]

Despite improvements in diagnostic methods, negative appendicectomy rates still remain between 10 and 30% in acute appendicitis. Cost-effective and easily applicable diagnostic methods with prompt results are required to reduce negative appendectomy rates.

Thus, improving the diagnosis of acute appendicitis in order to prevent unnecessary surgery is a critical topic that has been debated often and vigorously. The use of 3 laparoscopy, ultrasonography, and CT scanning has improved diagnostic accuracy, but these diagnostic approaches are not available in primary health care setting. However, diagnostic efficiency can be improved, and unnecessary surgeries can be prevented, by performance of an appropriately selected combination of laboratory tests combined with evaluation of clinical symptoms[6] .

Parameters such as the diameter of the appendix of ultrasonography have been considered to have very high sensitivity and specificity in diagnosing cases of complicated appendicitis. Elevated levels of C-reactive protein have a good predictive value for diagnosing cases of gangrenous appendicitis. Recent studies have also demonstrated that elevated levels of serum bilirubin in patients diagnosed with acute appendicitis have a predictive potential for the diagnosis of appendiceal perforation[8,9] . In this study, we would like to use parameters such as measuring outer diameter of appendix on ultrasound, and biochemical investigations such measuring CRP levels and total serum bilirubin in establishing a clinical diagnosis of complicated or uncomplicated appendicitis and comparing it with intra-operative findings to improve the accuracy of pre- operative diagnosis of acute appendicitis

OBJECTIVES OF THE STUDY:

1. To compare the outer diameter of the inflamed appendix on ultrasonography and values of CRP and total serum bilirubin in complicated versus uncomplicated appendicitis.

2. To pre-operatively predict complicated appendicitis based on the above parameter values.

MATERIALS AND METHODS:

This study was carried out in the Department of General Surgery, in association with Department of Radiology, Karnataka Institute of Medical Sciences, Hubballi. Patients admitted in General Surgery Department with diagnosis of acute appendicitis and/or its complication undergoing open appendicectomy were studied in the study period.

INCLUSION CRITERIA

Patients diagnosed as acute appendicitis clinically and with confirmation on

ultrasound undergoing open appendicectomy

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 10, 2023

EXCLUSION CRITERIA

Patients being treated conservatively for acute appendicitis

Patients with age less than 12 years

Patients under psychiatric treatment

Patients with acute or chronic liver diseases and alcoholics with decompensated chronic liver disease

Patients with other conditions causing elevation of CRP

Patients with COVID-19 positive status.

SAMPLE SIZE:

Sample is calculated to estimate the proportion of complicated appendicitis among all appendicitis undergoing operative management.

Based on hospital data proportion of complicated appendicitis among all appendicitis undergoing operative management was 0.45 (45%).

To estimate the true proportion of complicated appendicitis among all appendicitis undergoing operative management within 15 percentage points with 95 % confidence we require a minimum of 43 cases of appendicitis undergoing operative management. A final total sample size of 60 acute appendicitis undergoing operative management was taken.

METHOD OF COLLECTION OF DATA:

The patients presenting to General Surgery Department and diagnosed to have acute appendicitis clinically are subjected to Ultrasonography where the confirmation of appendicitis and/or its complications is done. During ultrasonography the outer diameter of appendix is noted. Similarly, the blood investigations such as CRP and Total Serum Bilirubin is also collected pre-operatively.

The operative findings are being classified into complicated appendix if any one of the following is noted:

Perforation of Appendix

Empyema or abscess formation

Gangrenous appendix

Faecal peritonitis

Patients whose intra-operative findings did not conform under abovementioned criteria were classified as uncomplicated appendicitis. Institutional ethical committee clearance was obtained. Statistics were calculated based on master chart developed on Microsoft Excel and IBM SPSS software version 26.

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 10, 2023

RESULTS

Age Groups	Complicated		Uncomplicated		Total	
	N	%	N	%	N	%
<20	5	23.81%	6	15.38%	11	18.33%
21-30	2	9.52%	20	51.28%	22	36.67%
31-40	6	28.57%	7	17.95%	13	21.67%
41-50	5	23.81%	5	12.82%	10	16.67%
51-60	2	9.52%	0	0.00%	2	3.33%
>60	1	4.76%	1	2.56%	2	3.33%
Total	21	100.00%	39	100.00%	60	100.00%
The chi-square statistic with Yates correction is 7.811. The p-value is 0.166964. Not significant at $p < 0.05$.						

Table 1- Age group wise distribution among complicated and uncomplicated appendicitis

In our study it was noted that maximum number of patients who underwent operative management of acute appendicitis and/or its complications were in 21-30 years age group (36.67%) followed by 31- 40 year age group (21.67%). Similarly, complicated appendicitis were high in 31 40 year age group (28.57%) whereas uncomplicated appendicitis were more seen in 21 30 year age group (51.28%). The mean ± standard deviation of age of our study population was 31.35 ± 11.07 years.

GENDER DISTRIBUTION

In our study, 41 participants were male and 19 were female. Complicated appendicitis was more in males as compared to females i.e., of the 21 complicated appendicitis, 16 were male (76.19%) and 5 were female (23.81%).

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 10, 2023

COMPARISON OF PARAMETERS

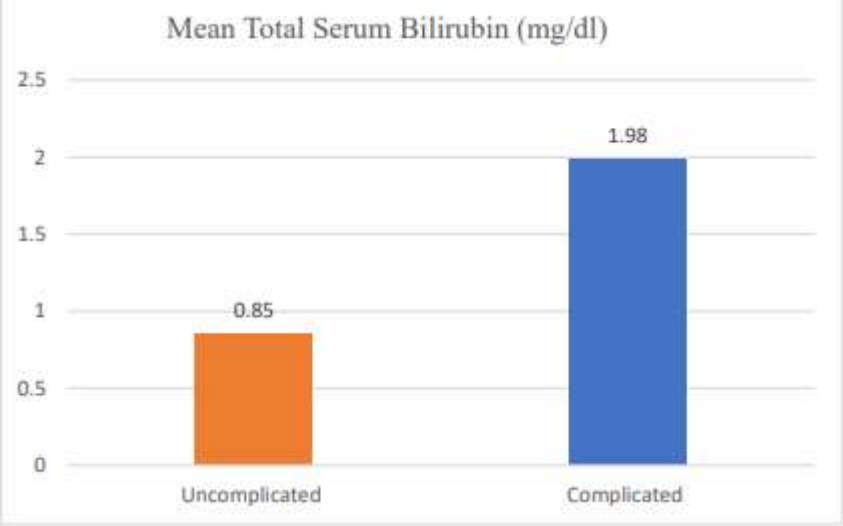

Fig 1 - Graph showing comparison of mean total serum bilirubin in uncomplicated and complicated appendicitis

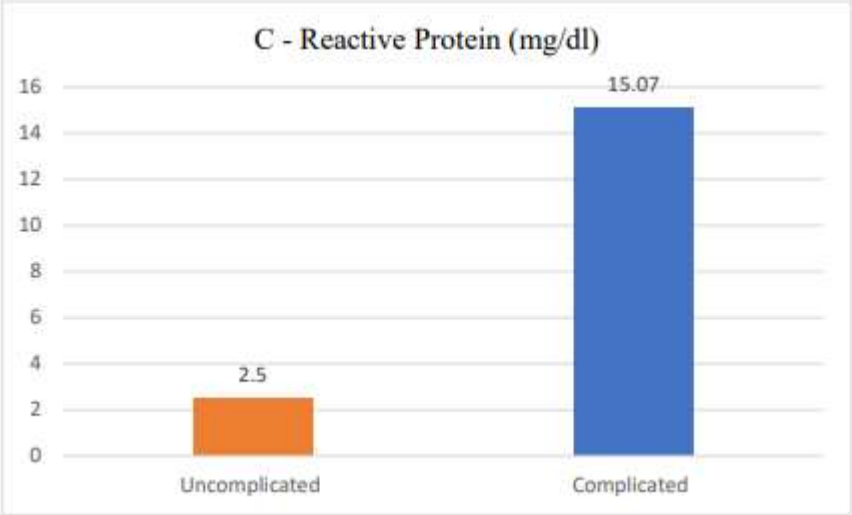

Fig 2 - Graph showing comparison of mean CRP in uncomplicated and complicated appendicitis.

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 10, 2023

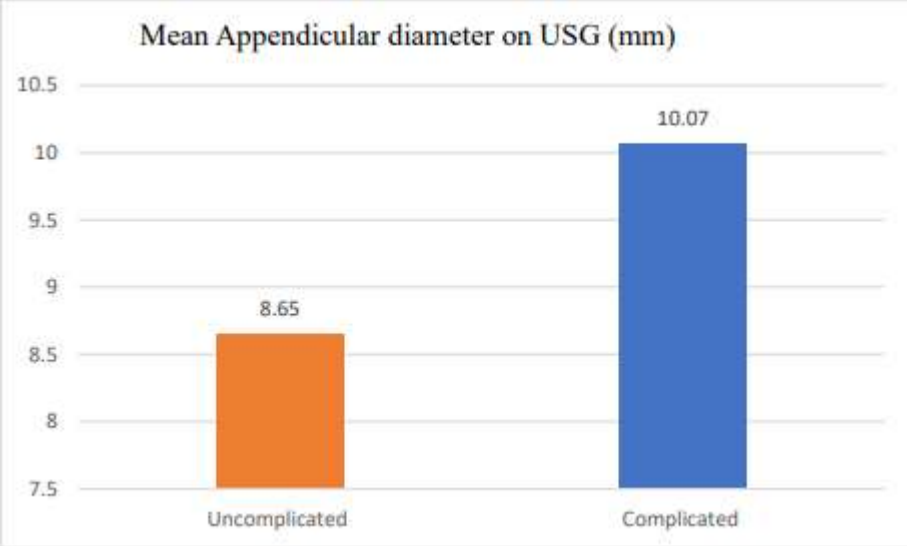

Fig 3 - Graph showing comparison of mean appendicular diameter in uncomplicated and complicated appendicitis

Pre-op Parameters	Intra-op Findings		p-value
	Uncomplicated (n=39)	Complicated (n=21)	
Total Serum Bilirubin (mg/dl)	0.85 ± 0.4	1.98 ± 0.55	<0 .00001
C - Reactive Protein (mg/dl)	2.50 ± 1.85	15.07 ± 7.28	< 0.00001
Appendicular diameter on USG (mm)	8.65 ± 1.98	10.07 ± 1.42	< 0.0028

Table 2 - Correlation between preoperative parameters and intraoperative findings

As depicted in the above table, mean total serum bilirubin, mean CRP values and mean appendicular diameter on USG were significantly higher in patients with complicated appendicitis as compared to patients with uncomplicated appendicitis with p-value significant (<0.05).

Using the above statistics, we have determined the cut-off value for each of the parameters using ROC curve. Using those values, we have determined sensitivity, specificity, PPV and NPV in cases of complicated appendicitis.

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 10, 2023

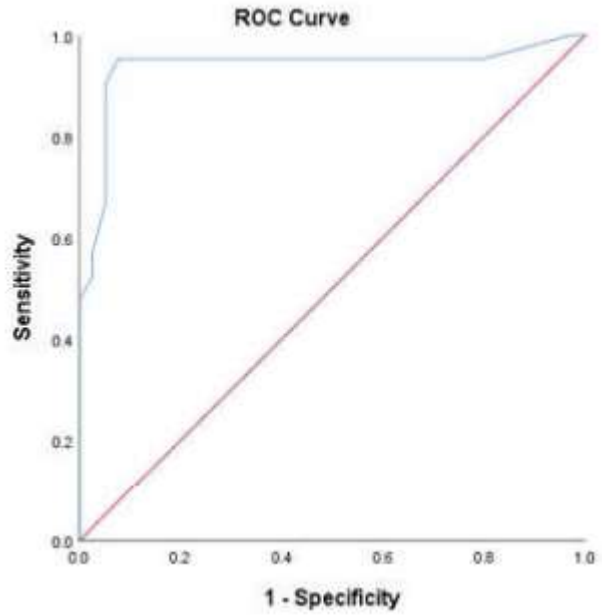

Fig 4 - Receiver operating characteristics (ROC) curve for Total serum bilirubin as a predictor of complicated appendicitis.

Cut-off for Total serum bilirubin based on ROC curve is >1.05 mg/dl.

Based on the cut-off obtained, out of the 60 participants 26(43.33%) had values higher than 1.05mg/dl and 34 (56.67%) had values less than the cut-off. In 21 patients with complicated appendicitis, Total serum bilirubin was > 1.05mg/dl in 20(95.24%) of them. Similarly in 39 patients with uncomplicated appendicitis, total serum bilirubin was <1.05mg/dl in 33(84.62%) patients.

The area under the ROC curve with 95% CI = 0.937 and the p-value is < 0.00001. The cut-off (> 1.05 mg/dl) of total serum bilirubin by ROC has relatively high sensitivity (95.24%) and specificity (84.61%) in predicting the incidence of complicated appendicitis.

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 10, 2023

Diagnostic correlation of Total Serum Bilirubin						
	Complicated		Uncomplicated		Total	
	N	%	N	%	N	%
>1.05	20	95.24%	6	15.38%	26	43.33%
<1.05	1	4.76%	33	84.62%	34	56.67%
Total	21	100.00%	39	100.00%	60	100.00%
The chi-square statistic is 35.4463. The p-value is < 0.00001.						

Table 3 Diagnostic correlation of Total serum bilirubin

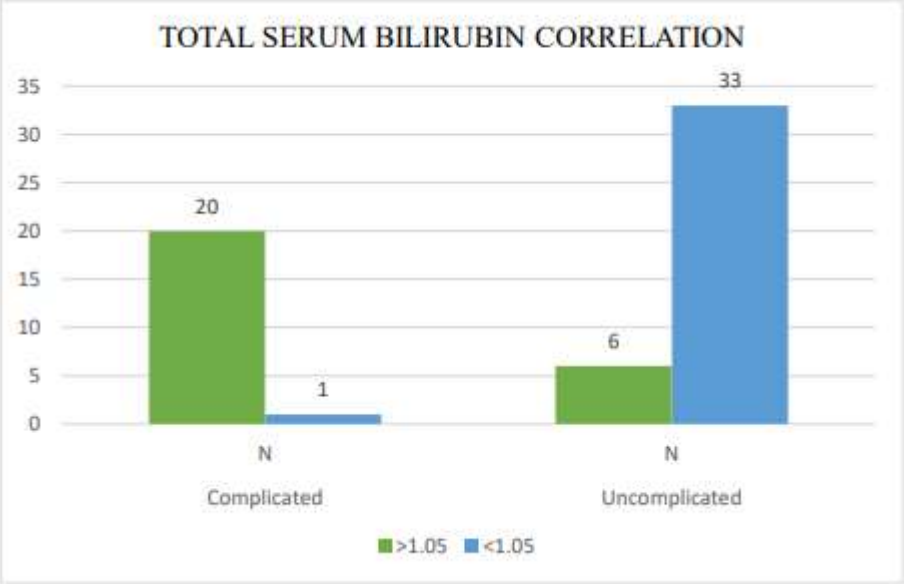

Fig 5 - Graph showing correlation of Total serum bilirubin according to cut-offs

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 10, 2023

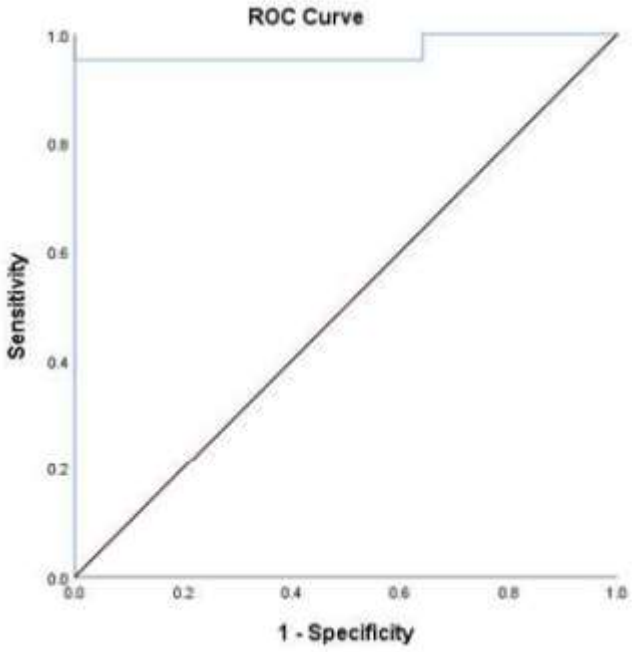

Fig 6 - Receiver operating characteristics (ROC) curve for CRP as a predictor of complicated appendicitis.

Cut-off for CRP based on ROC curve is >4.65 mg/dl.

Based on the cut-off obtained, out of the 60 participants 26(43.33%) had values higher than 4.65 mg/dl and 34 (56.67%) had values less than the cut-off.

In 21 patients with complicated appendicitis, CRP was > 4.65 mg/dl in 20(95.24%) of them. Similarly in 39 patients with uncomplicated appendicitis, CRP was <4.65mg/dl in 33(84.62%) patients.

The area under the ROC curve with 95% CI = 0.969 and the p-value is < 0.00001. The cut-off (>4.65 mg/dl) of CRP by ROC has relatively high sensitivity (95.24%) and specificity (84.61%) in predicting the incidence of complicated appendicitis.

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 10, 2023

Table 4- Diagnostic correlation of C-Reactive protein

Diagnostic correlation of C- Reactive Protein						
	Complicated		Uncomplicated		Total	
	N	%	N	%	N	%
>4.65	20	95.24%	6	15.38%	26	43.33%
<4.65	1	4.76%	33	84.62%	34	56.67%
Total	21	100.00%	39	100.00%	60	100.00%
The chi-square statistic is 35.4463. The p-value is < 0.00001. Significant at p < 0.05.						

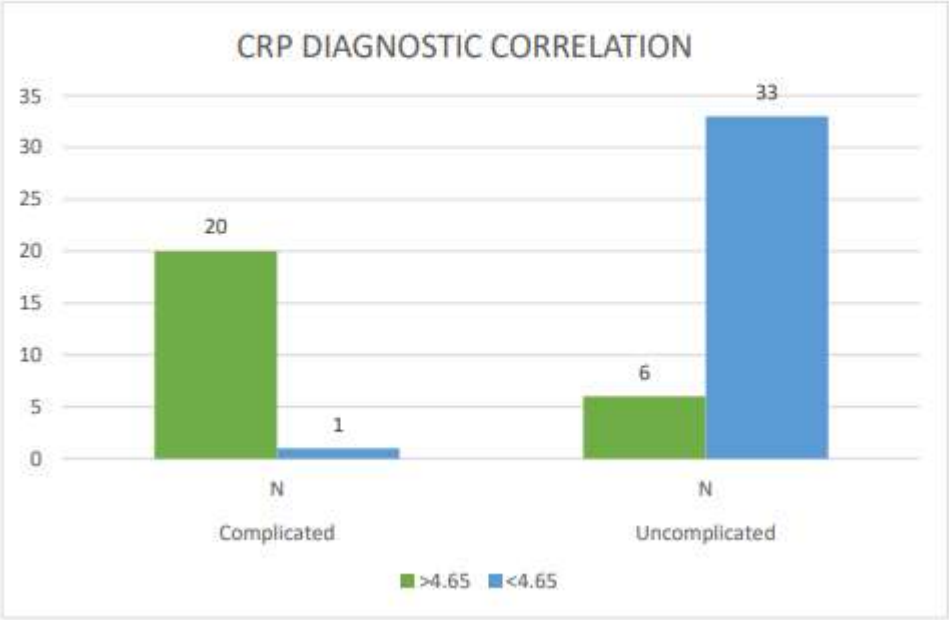

Fig 7 - Graph showing correlation of CRP according to ROC cut-offs

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 10, 2023

DIAGNOSTIC CORRELATION OF OUTER DIAMETER OF APPENDIX ON USG

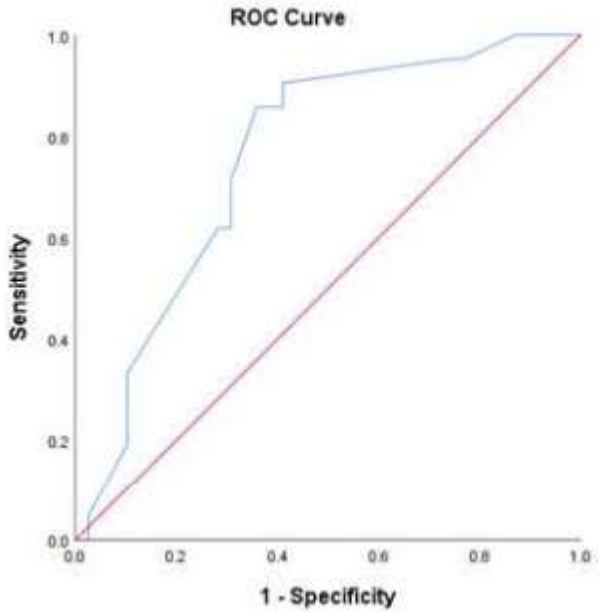

Fig 8 - Receiver operating characteristics (ROC) curve for appendicular diameter on USG as a predictor of complicated appendicitis.

Cut-off for outer diameter of appendix on USG based on ROC curve is >8.9mm.

Based on the cut-off obtained, out of the 60 participants 32(53.33%) had values higher than 8.9 mg/dl and 28 (46.67%) had values less than the cut-off.

In 21 patients with complicated appendicitis, outer diameter of appendix on USG was > 8.9mm in 18(85.71%) of them. Similarly in 39 patients with uncomplicated appendicitis, outer diameter of appendix on USG was <8.9mm in 25(64.10%) patients.

The area under the ROC curve with 95% CI = 0.757 and the p-value is 0.000225. The cut-off (>8.9 mm) of outer diameter of appendix on USG by ROC has sensitivity of 85.71% and specificity of 64.10% in predicting the incidence of complicated appendicitis.

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 10, 2023

Table 5 Diagnostic correlation of Outer diameter of Appendix on USG

Diagnostic correlation of Outer diameter of Appendix on USG						
	Complicated		Uncomplicated		Total	
	N	%	N	%	N	%
>8.9	18	85.71%	14	35.90%	32	53.33%
<8.9	3	14.29%	25	64.10%	28	46.67%
Total	21	100.00%	39	100.00%	60	100.00%
The chi-square statistic is 13.6107. The p-value is 0.000225. Significant at $p < 0.05$.						

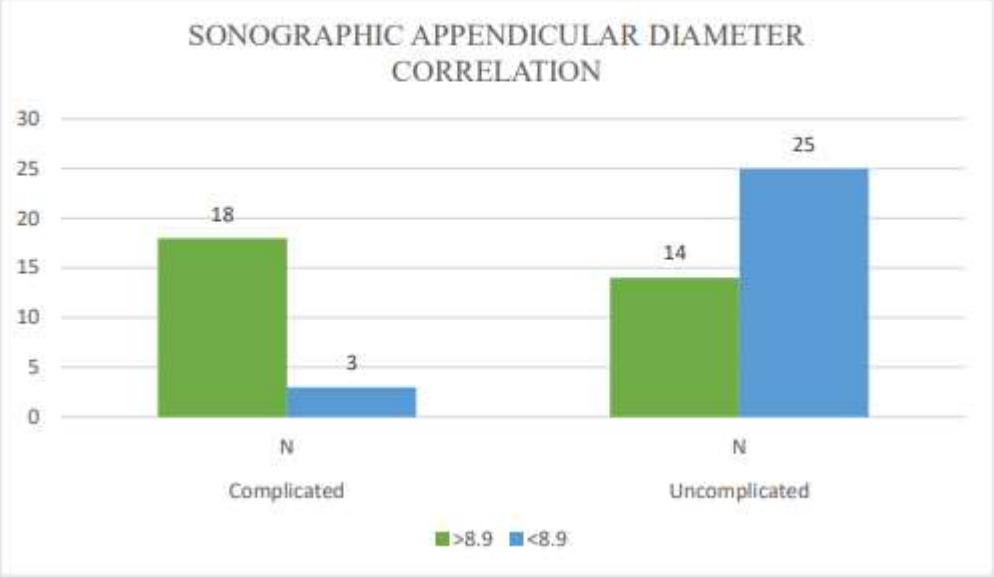

Fig 9 - Graph showing correlation of Outer diameter of Appendix on USG according to ROC cut-offs

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 10, 2023

ROC COMPARING THREE PARAMETERS

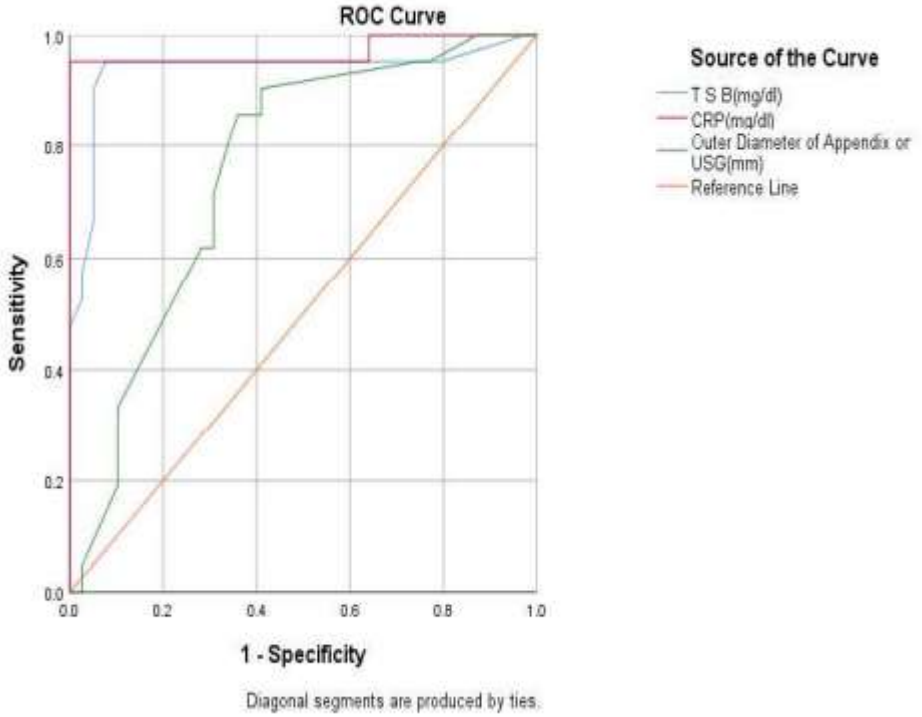

Fig 10 - ROC curve comparing all three parameters

Preop Parameter	Sensitivity	Specificity	PPV	NPV
Total Serum Bilirubin	95.24	84.61	76.92	97.06
CRP	95.24	84.61	76.92	97.06
Outer Diameter of Appendix on USG	85.71	64.1	89.29	71.67

Table 6 Sensitivity, Specificity, PPV, NPV of various parameters

Based on the above obtained statistics, sensitivity and specificity of pre-operative total serum bilirubin and CRP are 95.24% and 84.61% respectively for determining complicated appendicitis, which are statistically higher. Whereas outer diameter of appendix on USG had much lesser sensitivity of 85.71% and specificity of 64.1%.

However positive predictive value is higher for appendicular diameter on USG and negative predictive value is higher for both CRP and total serum bilirubin.

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 10, 2023

Therefore, appendicitis suspected patients with values of CRP and total serum bilirubin below cut-off values are unlikely to have complicated appendicitis.

DISCUSSION

Acute appendicitis remains the world's most frequent surgical condition in the emergency room, with a lifetime risk of 7%. The management of acute appendicitis remains an ongoing problem for surgeons since 50 percent of patients have atypical symptoms. Acute appendicitis diagnosis is based on the medical history of the condition, clinical evaluation, and lab investigations. For early and correct preoperative diagnosis, acute appendicitis always poses a mysterious challenge. For this case, delay in diagnosis and surgery may contribute to multiple complications such as appendicular perforation, intestinal abscess, small bowel obstruction, and peritonitis, triggering a rise in patient morbidity and even mortality. Too vigorous surgical action, on the other hand, may lead to an increased incidence of negative appendectomies. A negative appendectomy average of 20-30 % has been widely recognized.

In our study, maximum number of patients were in the 21 to 40 years age group accounting for 58.34% of total cases taken with male preponderance 2:1. This is in accordance with various studies conducted in the past which show acute appendicitis being common in 2nd to 4th decade of life but with slighter less male preponderance of 1.2 to 1.5:1 26-28. The mean ± standard deviation of age of our study population was 31.35 ± 11.07 years.

Similarly, the incidence of complicated appendicitis was more common in males as compared to females (3:1). Complicated cases of appendicitis were high in 31- 40year age group (28.57%) whereas uncomplicated cases of appendicitis were more seen in 21- 30 year age group (51.28%).

TOTAL SERUM BILIRUBIN AND COMPLICATED APPENDICITIS

In our study, the mean total serum bilirubin of all the appendicitis cases was 1.25 ± 0.71 mg/dl which is more than the usually considered normal value(1.2mg/dl).

However, the mean total serum bilirubin in cases of uncomplicated appendicitis was 0.85 ± 0.39 mg/dl and in complicated appendicitis, it was 1.98 ± 0.55 mg/dl.

As determined earlier, cut-off of 1.05 mg/dl yielded high sensitivity and specificity in determining complicated appendicitis.

This in accordance with studies conducted by Sand et al64 and Chaudhary et al.9, who reported that serum bilirubin should be added to the list of preoperative investigations as they do have a predictive potential for diagnosing appendiceal perforation. Many studies have reported that a raised serum bilirubin level is a good indicator of complicated acute appendicitis and should be included in the assessment of patients with suspected complicated acute appendicitis.

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 10, 2023

Studies	Cut-off value(mg/dl)	Sensitivity	Specificity
Sand et al	1	70%	86%
Khan[10]	1.09	-	100%
Chaudhary et al	2.1	100%	92.90%
Present study	1.05	95.24%	84.61%

Table 7- Comparison between various studies for total serum bilirubin in complicated appendicitis

C-REACTIVE PROTEIN AND COMPLICATED APPENDICITIS

In our study, the mean CRP of all the appendicitis cases was 6.91 ± 7.53mg/dl.

However, the mean CRP in cases of uncomplicated appendicitis was 2.50 ± 1.86 mg/dl and in complicated appendicitis, it was 15.07 ± 7.28 mg/dl.

As determined earlier, cut-off of 4.65 mg/dl yielded high sensitivity and specificity in determining complicated appendicitis.

CRP has been established as one of the serum markers in identifying inflammatory process in the body and extensive studies have been noted regarding the raised CRP levels during acute appendicitis. Recently many studies including Chaudary et al, Beltran et al and Parekh et al have noted proportional increase in CRP levels in complicated appendicitis especially in perforated appendicitis.

Studies	Mean CRP (mg/dl)	Sensitivity	Specificity
Kaser et al[11]	14	98%	28%
Kim et al[12]	11.47	78%	90%
Chaudhary et al[9]	16.82	100%	95.20%
Parekh et al[13]	6.6	94%	90.90%
Present Study	15.07	95%	84.61%

Table 8 - Comparison between various studies for CRP in complicated appendicitis

OUTER DIAMETER OF APPENDIX ON USG AND COMPLICATED APPENDICITIS

The most sensitive sign on USG is a non-compressible appendix with a diameter of 7 mm or greater. In our study, the mean appendicular diameter of all the cases was 9.14±1.93 mm.

However, the mean appendicular diameter in uncomplicated appendicitis was 8.65±1.98 mm and in complicated appendicitis it was 10.07 ± 1.42 mm. Kinyas et al. in their retrospective study compared the outer diameter of the appendix in non-complicated acute

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 10, 2023

appendicitis and complicated acute appendicitis. They reported that the diameter of the vermiform appendix was 6.9 mm (± 4.08 mm) and 7.6 mm (± 3.92 mm) in non-complicated and complicated appendicitis respectively which was statistically significant (p value < 0.01). Lin et al. also concluded that the appendiceal diameter was larger in patients with ruptured appendicitis than in those with simple appendicitis (p < 0.001).

Studies	Cut -off value (mm)	Sensitivity	Specificity
Kinyas et al[14]	7.2	68.22%	71.79%
Kim et al[12]	10	73%	53%
Parekh et al[13]	7.95	86.10%	88.60%
Present study	8.95	85.71%	64.10%

Table 9 - Comparison between various studies for outer diameter of appendix USG in complicated appendicitis

CONCLUSION

Diagnosis of Appendicitis still remains a dilemma in spite of the advances in various laboratory and radiological investigations.

From our study we would like to conclude that use of biochemical parameters such as total serum bilirubin and CRP, radiological such as outer diameter of appendix on USG with clinical acumen helps in diagnosing complicated appendicitis pre-operatively.

Hyperbilirubinemia and raised CRP pre-operatively directs more towards complicated appendicitis which in turn helps in further operative management and post-op care.

References

1. O'Connell PR “The Vermiform Appendix”. In: William NS, Bulstrode CJK. Bailey and Love's - Short practice of surgery. 25 ed. London: Arnold: 2008; p.1204-8.
2. Smink DS, Soybel DI, “Appendix and Appendicectomy” In: Zinner MJ, Stanley W. Maingot’s abdominal operations. 11th ed. Ashley: McGraw Hill; 2007.p.589-612.
3. John Maa. “The Appendix”. Townsend CM, Beauchamp RD, Evers BM, Mattox KL,. Sabiston Textbook of Surgery. 18th ed. Philadelphia, Pa: Saunders Elsevier; 2008. p: 1333-1347.
4. Lewis FR, Holcroft JW, Boey J, Dumphu JE; Appendicitis; A critical review of diagnosis and treatment in 1,000 cases. Arch Surg 1975; 110:677.
5. Anderson RE, Hugander A, Thulin AJ. Diagnostic accuracy and perforation rate in appendicitis: association with age sex of the patient and with appendicectomy rate. Eur j surg 1992: 158; 37-41.
6. Van Dieijen- Visser MP, Go PMNYH, Brombacher PJ. The value of lab tests in patients suspected of appendicitis. Eur J Clin Chem Clin Biochem 1991, 29: 749-52.

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 10, 2023

7. Tepel J, Sommerfeld A, Klomp HJ, Kapischke M, Eggert A, Kremer B. Prospective evaluation of diagnostic modalities in suspected acute appendicitis. Langenbecks Arch Surg. 2004 Jun; 389(3):219-24. Epub 2003 Nov 22.
8. JamaluddinM, Hussain S, Ahmad H (2013) Hyperbilirubinaemia a predictive factor for complicated acute appendicitis: a study in a tertiary care hospital. J Pak Med Assoc 63(11):1374 1378
9. Chaudhary P, Kumar A, Saxena N, Biswal UC (2013) Hyperbilirubinemia as a predictor of gangrenous/perforated appendicitis: a prospective study. Ann Gastroenterol 26(4):325
10. Khan S. Elevated serum Bilirubin in Acute Appendicitis: a new Diagnostic tool. Kathmandu University Medical Journal 2008; 6 (2): 161- 5.
11. Kaser SA, Fankhauser G, Willi N, Maurer CA. C-reactive protein is superior to bilirubin for anticipation of perforation in acute appendicitis. Scand J Gastroenterol 2010; 45:885-92.
12. . Kim TH, Cho BS, Jung JH, Lee MS, Jang JH, Kim CN (2015) Predictive factors to distinguish between patients with noncomplicated appendicitis and those with complicated appendicitis. Ann Coloproctol 31:192 197
13. Parekh, Dhanish & Jain, Dinesh & Phalgune, Deepak. (2019). Comparison of Outer Diameter of Appendix, C-reactive Protein, and Serum Bilirubin Levels in Complicated Versus Uncomplicated Appendicitis. Indian Journal of Surgery. 10.1007/s12262-019- 01931-2.
14. Kartal K, Yazici P, Unlu TM, Uludag M, Mihmanli M. How to avoid negative appendectomies: Can US achieve this? Ulus Travma Acil Cerrahi Derg. 2017 Mar;23(2):134-138. doi: 10.5505/tjtes.2016.79328. PMID: 28467580.