NEGATIVE APPENDICECTOMY: EVALUATION OF ULTRASONOGRAPHY AND ALVARADO SCORE

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A dissertation submitted in partial fulfillment of the degree in Masters in Medicine (Surgery)

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I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material to which a substantial extent has been accepted for the award of any other degree or diploma of a University or other institute of higher learning within Zimbabwe or internationally, except where due acknowledgement is made.

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DR. INNOCENT KUNDIONA

DEDICATION

I dedicate this dissertation to my wife *Juliana* and my son *Andrew*. Thank you for all the support during my postgraduate training.

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US - ultrasound

NAR - negative appendicectomy rate

CT- computed tomography

CI- confidence interval

LA- laparoscopic appendicectomy

MASS- modified Alvarado scoring system

IA- interval appendicectomy

AS- Alvarado score

CPR- clinical prediction rule

1 ABSTRACT

1.1 BACKGROUND

High negative appendicectomy rates are no longer acceptable with improvements in imaging techniques and clinical prediction rules. The use of ultrasound and CT scan in addition to clinical assessment and blood investigations has greatly reduced the negative appendicectomy rate to less than 10%. The aim of this study was to assess the negative appendicectomy rate at the two University Teaching Hospitals in Harare.

1.2 OBJECTIVES

The aim of the study was to determine the negative appendicectomy rate at the two major teaching hospitals in Harare and to evaluate the accuracy of the Alvarado score and ultrasound scan in diagnosing acute appendicitis.

1.3 DESIGN

Prospective observational, cross sectional study

1.4 SETTING

Parirenyatwa Group of Hospitals and Harare Central Hospital, in Zimbabwe

1.5 MATERIALS AND METHODS

A total of 206 patients undergoing appendicectomy at the two major teaching hospitals in Harare were included in this study between June 2012 and May 2013. Information recorded included: age, sex, clinical features, investigations and treatment. Alvarado score was calculated from the data in the case notes and ultrasound scan results were also captured. All appendices removed at operation were sent for histopathological examination. Appendicitis was confirmed at histology. The positive predictive value of Alvarado score and sensitivity and specificity of ultrasound scan were calculated.

1.6 RESULTS

The overall negative appendicectomy rate was 16.5%. The negative appendicectomy rate for men was 13.3% and that for females was 29.9%. The negative appendicectomy rate for Parirenyatwa Group of Hospitals was 19.0% and that for Harare Central Hospital was 12.1%. The mean age for the study was 28 years (SD 12.8). Appendicitis was diagnosed commonly in the second and third decades of life. Sensitivity of ultrasound scan in diagnosing acute appendicitis was 89.5% with a positive predictive value of 77.2%. Females were 2.6 times more likely to have an ultrasound scan done to diagnose appendicitis than males. Alvarado score had a sensitivity of 95.3% with a positive predictive value of 90.3%.

1.7 CONCLUSION

Negative appendicectomy rate (16.5%) at the two University Teaching Hospitals in Harare is relatively high when compared with modern trends. Alvarado score had a high sensitivity (95.3%) and predictive value (90.3%). Ultrasound scan had a high sensitivity (89.5%) and a relatively low predictive value (77.2%) in diagnosing acute appendicitis. Regular use of these assessment modalities should contribute substantially to reduction in the negative appendicectomy rate in our practice.

2 INTRODUCTION

Acute appendicitis is one of the commonest conditions requiring surgery [1 2] .Six to seven percent of the population is expected to have appendicitis in their lifetime; 8.6% for males and 6.7% for females[1 2]. However, the lifetime risk of having appendicectomy is 12% for men and 23.1% for females [3.] In the developed countries the rate of appendicitis has been declining, while in the developing countries, the incidence of appendicitis has been rising especially in urban centers.[4]The diagnosis of appendicitis is mainly clinical and it is impossible to have a definitive diagnosis by the gold standard (histopathology) preoperatively. [2] The clinical diagnosis is accurate in 80% of cases. [5 6] If a clinical diagnosis of appendicitis is made, an appendicectomy is done as the standard treatment. Histopathological examination must be done on every appendiceal specimen that is removed. Histology will confirm the diagnosis of appendicitis or even reveal other pathology in the appendix, e.g. malignancy. If on histopathological examination the specimen is found to be normal, this will be referred to as negative appendicectomy. [2] Negative appendicectomy is defined as one which is performed for a clinical diagnosis of acute appendicitis but in which the appendix is found to be normal on histological examination. A high negative appendicectomy rate is likely caused by limitations in our diagnostic abilities.[7]This study aims to evaluate the negative appendicectomy rate at the two University Teaching Hospitals in Harare. Flum et al showed that negative appendicectomy accounted for nearly US$740 million in healthcare costs in a single year in the United States of America alone. [7]There has been no study done, to the author's knowledge, which evaluated the negative appendicectomy rate in Zimbabwe. In 2000 Mushede looked at the Clinicopathological aspects of appendicitis at Harare Central Hospital and Parirenyatwa Group of Hospitals.[8]

Appendicitis affects people of all age groups but is rare in the very young and in the very old. [9]It is common in the second and third decades of life. [9]Appendicitis occurs more commonly in males than females[4]. The rate of having an appendicectomy is however more in females than males because females have other conditions which mimic appendicitis which include ovarian torsion, salpingitis, ectopic pregnancy and

oophritis. There is also a higher negative appendicectomy rate in females than in males.[10]

The clinical features of appendicitis overlap with those of much other disease conditions.[11]The typical presentation will be a previously well patient with vague periumbilical pain which then shifts to the right iliac fossa and becomes more localized and intense.[9]In most patients, the pain will be preceded by anorexia and this may be followed by vomiting. The vomiting is not severe, usually once or twice. On examination, these patients have right lower quadrant tenderness and with guarding or rebound tenderness. Patients might also have a raised temperature. Blood investigations will show a raised white cell count with left sided shift. White cell count above 18000cells/mm^3 is usually associated with perforated appendix. [9] Other inflammatory markers like C-reactive protein and interleukin 6 can also be elevated.[12]

Delayed management of simple appendicitis may result in complications like abscess, perforated or gangrenous appendix, peritonitis and sepsis which will increase morbidity and mortality.[10] [13] Patients with perforated appendix might present with generalized peritonitis and occasionally the diagnosis maybe confused with small bowel obstruction[10].

Surgery has become the standard of care in acute appendicitis. This can be done with open or laparoscopic surgery. Laparoscopic surgery is finding favor with most surgeons because it is associated with a reduced negative appendicectomy rate[13], good visualization of other intraabdominal structures and reduced hospital stay. The mortality associated with appendicitis is less than 1 % for both open or laparoscopic surgery, the morbidity is around 10 %.[13] The mortality rate can be as high as 20% in children who are less than 2years old.[16] Perforated appendicitis is associated with a much higher morbidity and mortality, and most surgeons prefer to operate when the diagnosis is probable rather than wait until it is certain. [17] [18]

Christian et al cited late complications of appendicectomy such as intestinal obstruction, incisional hernias, and an increased risk of developing right sided inguinal hernia.[19]There is also a 1% chance of getting stump appendicitis.[20]The complication

rates are slightly reduced with the laparoscopic approach and fear of intraabdominal abscesses with laparoscopy has recently been dismissed. [21]

A negative appendicectomy rate of fifteen to thirty percent was generally accepted in clinical practice. [22]In some centers where they are now using US scan and CT scan, negative appendicectomy rates of between 5-10% are being reported.[23]Studies have shown that the use of these tests indeed reduce the negative appendicectomy rate.[10]Where the diagnosis is still in doubt after computed tomography, a laparoscopic approach is favored since it is able to rule out other intraabdominal pathologies.[23]These additional investigations have proved to be useful especially in women where the diagnosis might be confused with other pelvic conditions. Traditionally a higher negative appendicectomy rate was accepted as a way of trying to reduce the morbidity and mortality associated with a perforated appendix. [19]Recent studies have shown that the rate of perforation is due to patient delay in presenting to hospital, rather than a delay in treatment. [7 17]

Historically surgeons have accepted a high negative appendicectomy rate based on the premise that delay would inevitably lead to perforated appendicitis and thus increased morbidity and even mortality. [6 24] It was believed that the perforated appendicitis rate is inversely related to the negative appendicectomy rate. Studies have shown that most perforations occur outside the hospital due to patient delay. The rate of perforated appendicitis has remained the same (13.2%-41.9%) over the years despite the use of US scan and CT scan to try and reduce the negative appendicectomy rate. [24]Currently most surgeons regard a high negative appendicectomy rate as unacceptable. [6 24]

Various scoring systems (Linderberg, Eskelinen, Fenyo, The Van Way and Teicher) have been developed to try and reduce the negative appendicectomy rate.[26]The commonly used is the Alvarado score. American College of Emergency Physicians recommended the use of the Alvarado score in predicting the presence or absence of appendicitis.[26] Alvarado score has been reproduced in many other centers since the paper by Alfredo Alvarado in 1985.[15 26 27]Other centers have used the modified Alvarado score to try and improve the diagnosis of appendicitis.[13]Our study evaluated the

accuracy of Alvarado score in diagnosing appendicitis. Alvarado recommended that a score of seven or higher means that the patient should be taken for surgery[11]. The Alvarado score is a simple, easy and cheap scoring system which can be easily adopted by centers where ultrasound scan or computed tomography are not readily available (poor or low resourced countries).[13 16]Overall, the score is more specific and sensitive for males as compared to females.[26]

This study also evaluates the use of ultrasound scan in confirming or ruling out the diagnosis of appendicitis. Ultrasound scan is relatively cheap compared to CT scan and does not expose patients to ionizing radiation[10] and is readily available in most hospitals in Zimbabwe unlike CT scan. Studies have shown high sensitivity and specificity of ultrasound scan. However ultrasound scan has a high interobserver variability and is not reliable particularly in obese patients.[18]

In this study we correlate the results of US scan and those of Alvarado score with the gold standard and absolute diagnostic modality, histopathology. Every appendix specimen should be sent for histopathological evaluation. There is a 0.9 to 1.4% chance of malignancy in appendiceal specimens and this can be revealed at histopathological examination. [16]

2.1 OBJECTIVES

2.1.1 MAJOR OBJECTIVES

1. To determine the negative appendicectomy rate at Parirenyatwa Group of Hospitals and Harare Central Hospital, Zimbabwe.
2. To determine the sensitivity of the Alvarado score in diagnosing acute appendicitis
3. To determine the sensitivity of ultrasound scan in diagnosing acute appendicitis
4. To compare the negative appendicectomy rates at the two hospitals

2.1.2 MINOR OBJECTIVES

1. To compare the negative appendicectomy rates among men and women
2. To compare ultrasound use between men and women in diagnosing acute appendicitis
3. To determine the common pathologies of the appendix

2.2 JUSTIFICATION

In western countries the negative appendicectomy rate has been reduced from around 20% to 7% because of the use of CT scan.[28] Traditionally negative appendicectomy rates of between 15 to 30% were accepted before the use of CT scan.[17] In Madagascar a very high negative appendicectomy rate of 85% was found.[29]Negative appendicectomy was associated with a significantly longer hospital stay; total charge admission and case fatality rate. [7] [18]This study is aimed at evaluating the negative appendicectomy rate in our set up where CT scan is not readily available.

Negative appendicectomies are associated with unnecessary costs to patients and hospitals[12], loss of productive time, congestion of theatres, exposure to general anesthetics, morbidity, unwarranted permanent scar and other complications of surgery like incisional hernia.

3 LITERATURE REVIEW

3.1 BACKGROUND

The appendix was unknown in the time of Hippocrates, and throughout the middle ages. It also follows that the disease entity 'appendicitis' was unknown to the practitioners of that time. Galen, despite giving the most complete anatomical descriptions, did not find the appendix since he used to dissect monkeys which do not have the appendix.[30]

Amyand is credited with performing the first appendicectomy in 1736. It was in a boy with enterocutaneous fistula with inguinal hernia. The appendix had been perforated by a pin resulting in a fecal fistula.[31]A hernia that contains an appendix carries Amyand's eponym to this day.

A lot of names were given to this disease entity that presented with right lower quadrant pain and tenderness. Names such as Stercord typhilitis, simple typhilitis, chronic typhilitis and pericaecitis were used. In 1886, Reginald Fitz in his landmark paper coined the term appendicitis.[10] In the 1890s, Frederick Treves advocated for conservative management of acute appendicitis, followed by appendicectomy after infection had subsided.[30]Unfortunately his daughter suffered from perforated appendicitis and died from such treatment.

Charles McBurney in 1889 added his name to the history of appendicitis when he described the characteristic migratory pain and localization of pain along an oblique line from the anterior superior iliac spine to the umbilicus. [10] Consequently, McBurney's point is located one third of the way from the anterior superior iliac spine to the umbilicus. [33]He described a point of maximum tenderness when one examines with a finger tip. This point is named after him. He later published a paper in 1894, describing the incision that bears his name. [16]

The first laparoscopic appendicectomy was performed by a gynecologist, Kurt Semm in 1982. [34]

3.2 ANATOMY

The appendix is an out pouching from the cecum which is located at the base of the cecum. It develops from the midgut and first appears at the eighth week of gestation. The appendiceal base is at the convergence of the tinae coli and is constant. The appendix is variable in length ranging from 2 to 20cm.The average length is 9cm. The blood supply of the appendix is from the appendiceal artery which is a branch of the ileocolic artery and it is an end artery. The artery is within the mesoappendix.[9 10 35]The appendiceal tail can lie in various locations. The pelvic appendix is most likely to have appendicitis because of its orientation (Figure 1). The most common location is the retrocecal but within the peritoneal cavity. The appendix can be retroperitoneal in 7% of the cases. The appendiceal tail location is retrocecal in 60%, pelvic 30%, pre or post ileal in 12% and subcecal in 2%.[36]The appendix is part of gut associated lymphoid tissue and produces immunoglobulins e.g. IgG, IgA and IgM. [37]

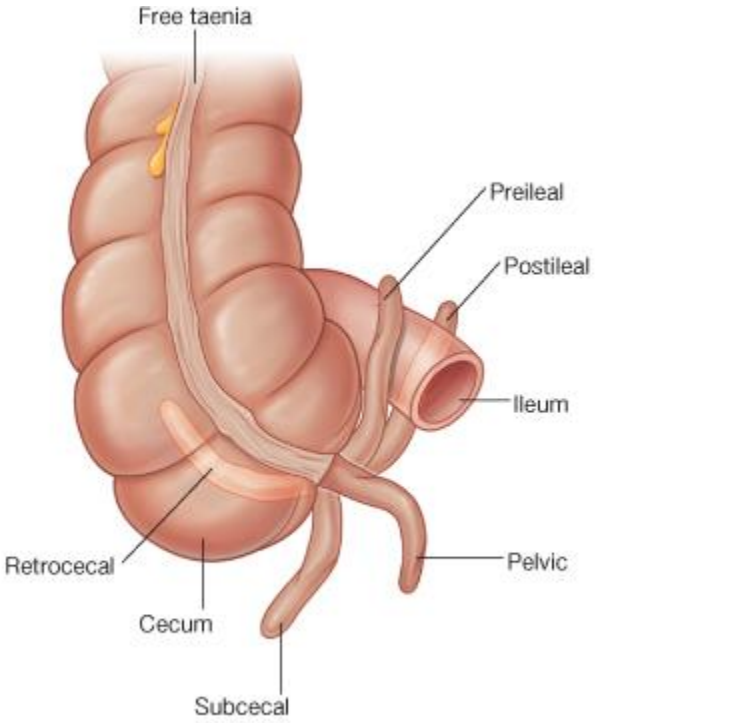

Figure 1: Various locations of appendiceal tip[38]

3.3 PATHOPHYSIOLOGY

Acute appendicitis (AA) can be due to obstructive and non obstructive causes with the obstructive causes being the most common. Obstruction of the appendiceal lumen is believed to be the primary pathogenic event in acute appendicitis.[39] Fecolith causes most of the obstructions[40], other causes include, inspissated barium from previous x-ray studies, tumors, lymphoid hyperplasia (especially in children), straight pins, seeds and intestinal parasites. [10] [41] Continued secretion within the appendix with the presence of obstruction causes elevated intraluminal pressures. Initially there is reduced venous return once the pressure exceeds the venous capillary pressures with continued arteriolar flow. [10]

If the appendix is not removed, the wall pressure continues to rise and block the arterial flow resulting in mucosal ischemia, mucosal ulceration and ultimately infection by luminal micro-organisms (translocation of bacteria).[41]Perforation typically occurs after at least 48hrs. This is accompanied by an abscess cavity walled off by omentum or bowel.[10]

Appendicitis has been termed the disease of the developed civilizations by Burkitt. He also showed a higher incidence of appendicitis in Western countries compared to Africa. Appendicitis has been shown to affect wealthy urban areas more than the rural areas. [1] The reason for these differences has been attributed to westernized diets which are low in dietary fiber. Western diet also contains high proteins and fat. This has been associated with high intraluminal pressures.[1] Wangensteen showed that the structure and function of the appendix have a role in the pathogenesis of appendicitis. Mucosal folds and sphincter like orientation of muscle fibers make the appendix more susceptible to obstruction.[42]The lumen of the appendix is small compared to its length and this configuration predisposes to a closed loop obstruction.[10]

There are theories to explain appendicitis apart from obstruction. These have been supported by the fact that you can find a normal appendix with a fecolith. In many of the appendices that are removed for appendicitis, the majority of them do not have a fecolith.[10]

3.4 CLINICAL FEATURES

Classical appendicitis presents with vague periumbilical abdominal pain which later migrates to the right iliac fossa. Initially the pain is visceral and is referred to the umbilicus and shift to the right iliac fossa when the parietal peritoneum is irritated. The shifting of the pain occurs any time between 1 to 12 hours although it is common within 4 to 6 hours. The abdominal pain is preceded by anorexia which might go unnoticed by the patient. The abdominal pain can be followed by vomiting. At times the abdominal pain might be crampy from the peristaltic waves against an obstruction. The vomiting is neither prolonged nor prominent. Most patients vomit once or twice. The sequence of the symptoms is usually anorexia, abdominal pain followed by vomiting. This is true in 95% of the time. [24 41 43]

Due to the different positions of the appendiceal tail, it is not unusual to get pain in unusual places. Patients can present with back pain if the appendix is retrocecal. A pelvic appendix can irritate the urinary bladder and patients present with urinary symptoms. An inflamed pelvic appendix can get in contact with bowel resulting in either an ileus or diarrhea.[9]

Patients with appendicitis usually lie still in bed. They have a moderately elevated temperature. There is right lower quadrant tenderness with guarding. Patients may also have rebound tenderness. If the appendix is retrocecal they might have flank tenderness. They may also have suprapubic tenderness on digital rectal exam if the appendix is retrocecal. There are several signs that are described with regard to appendicitis. Rovsing's sign is tenderness in the right lower quadrant on palpating the lower left quadrant due to parietal peritoneal irritation.[10]Other signs are the Obturator sign, Dunphy's sign and psoas sign. The Obturator sign is when there is pain on internally rotating a flexed right hip joint. This maneuver puts the obturator internus on the stretch. An inflamed appendix in contact with and adherent to this muscle will be irritated by this movement. Pain will be experienced in the hypogastrium. The psoas sign is pain that is felt on hyperextending the right hip with the patient lying on the left side. This is caused by an inflamed focus in contact with the psoas muscle. Dunphy's sign is characterized by increased abdominal pain on coughing. It may be an indicator

of appendicitis. Patients with perforated appendicitis will be ill- looking. They may present with a right iliac fossa mass or with generalized peritonitis. A free perforation into the abdominal cavity might make the diagnosis of appendicitis difficult preoperatively. Acute appendicitis should be considered in every case of an acute abdomen. A previous history of appendicectomy should not rule out appendicitis completely as there are reports of stump appendicitis, though it is a rare phenomenon. [9] [10]

3.5 LABORATORY STUDIES

White blood cell count is usually elevated in appendicitis. In patients with immunosuppression the white cell count might be low. A raised count of between 10000cells/mm^3 and 15000cells/mm^3 is usually present. Counts greater than 18000cells/mm^3 are suggestive of complicated appendicitis with either gangrene or perforation. There is also a left sided shift (left bandemia) of the white cell differential, with polymorphonuclear cell constituting >75%. Ten percent of patients will have a completely normal leukocyte count and differential. Other laboratory tests like C-reactive protein have been shown to increase the diagnostic accuracy of appendicitis. [24] [43]

3.6 ALVARADO SCORE

Different scoring systems have been developed to try and improve the diagnosis of appendicitis and reduce negative appendicectomies. Most of the scoring systems were developed from retrospective studies and computer generated scores. Most of the computer generated scores are cumbersome and difficult to memorise. [11] [12] [14] [16] [19] [26] [27] [44] [45]The commonly used is the Alvarado score; it is simple, easy and reliable tool in diagnosing appendicitis. Other scoring systems include Linderberg, Eskelinen, Fenyo, The Van Way, Teicher and Arnbjornssion. According to Ohman et al. the Alvarado score outperformed each of these other scores. [26]

Alfredo Alvarado, a surgeon at a hospital in Florida published an article in 1985, with a ten point score to try and diagnose appendicitis. He retrospectively looked at 305 patients who were admitted with a diagnosis of acute appendicitis. From the records of these patients he looked at the common signs and symptoms. He also looked at their

haematological results. He came up with a score consisting of three symptoms, three signs and two laboratory findings. Two of the parameters have two points each and the rest have a point each making a total of 10points. According to Alvarado tenderness in the right lower quadrant and leucocytosis had more diagnostic weight; he therefore awarded them two points each. The Alvarado score (Table 1) is also known as the MANTRLES score. A score of 5 or 6 is compatible with a diagnosis of acute appendicitis. A score of 7 or 8 indicates a probable appendicitis, and a score of 9 or 10 indicates a very probable appendicitis. All patients with a score of seven or greater should be taken to theatre for appendicectomy. He also recommended that patients with a score of 5 to 6 have a probable diagnosis of appendicitis and should be observed in hospital and re- evaluated. This system is not 100% certain because there is a chance of overlapping of symptoms with other diseases. [11]

Several studies have been done in different centres to try and reproduce the work of Alvarado. [26 34 46] Others have used a modified Alvarado scoring system (MASS).[14] The score is out of nine, leaving out left bandemia from the Alvarado score. Patients with a score of seven and above will likely have acute appendicitis and patients with a score of less than seven will be unlikely to have acute appendicitis.[14] The Alvarado score has been reproducible in male patients and is less valid in women and children. [11 26 43 44]The use of this score has been found to be very helpful to residents, since they are the ones who deal with most of the cases of appendicitis. Alvarado score is superior to ultrasound scan in patients with acute appendicitis.[15]

3.6.1 Calibration of the Alvarado score

The Alvarado score is divided into three risk strata, namely low risk, intermediate risk and high risk group. The low risk group will have an Alvarado score (AS) of 1 to 4. Intermediate risk group, an AS of 5 to 6 and high risk group 7 to 10. A systematic review of the Alvarado score was done by Ohle et al. The systematic review showed that the Alvarado score at the cut point of 5 performs well as a “rule out” clinical prediction rule (CPR) in all patient groups with suspected appendicitis.[26]

Pooled diagnostic accuracy in terms of “ruling in” appendicitis at a cut-point of seven is not sufficiently specific in any age group to proceed directly to surgery. In terms of calibration, the observed, predicted estimates in men suggest the score is well calibrated in all risk strata. Application of the Alvarado score in women over predicts the probability of appendicitis across all strata and should be used with caution. The validity of the Alvarado score in children was inconclusive.[26]

Table 1: The Alvarado score

	Manifestations	**Value**
Symptoms	Migration of pain	1
	Anorexia	1
	Nausea/ vomiting	1
Signs	RLQ tenderness	2
	Rebound tenderness	1
	Elevated temperature	1
Laboratory values	Leukocytosis	2
	Left shift	1
Total points		10

3.7 ULTRASOUND SCAN

Ultrasound scan is a readily available, non invasive and cheap imaging modality for diagnosing acute appendicitis. Graded compression sonography has become a very important tool in helping diagnose appendicitis.[10 43]Ultrasound scan is widely available, does not expose patients to ionizing radiation hence it can be used safely in pregnancy and there are no side effects related to contrast administration.[43] Gynaecological causes of abdominal pain in women of child bearing age can also be assessed by ultrasound scan. The main disadvantage of ultrasound scan is that it is operator dependant. Ultrasonography might not be readily available at night or weekends since it requires hands on participation by radiologist. Graded compression sonography has limited use in obese patients; the appendix may not be compressible because of overlying fat. [10]

Sonographically, the appendix is identified as a blind ending, non peristaltic bowel loop originating from the cecum. Sonographic criteria for the diagnosis of acute appendicitis are [10 18 43]

(1) Non compressible appendix of 6mm or greater in the anteroposterior diameter

(2) Periappendiceal fluid or mass

(3) A fecolith/ appendicolith

(4) Loss of integrity of submucosal layer

(5) Thickening of appendiceal wall

(6) Increased echogenicity of surrounding fat of >4mm

False positive studies can be due to secondary inflammation of the appendix as a result of inflammatory bowel disease, salpingitis or other causes. False negative results may occur with sonography if:

(i) Appendicitis is confined to appendiceal tip

(ii) The appendix is retrocecal

(iii) Appendix markedly enlarged and mistaken for small bowel

(iv) Appendix is perforated and therefore compressible

Results of sonography may be inconclusive if the appendix is not visualized and there is no pericecal fluid or mass. Ultrasound scan use is limited in obese patients and patients with peritoneal signs where graded compression is not very reliable.[47]The overall sensitivity of ultrasound is 86% with a specificity of 81 %.[43]

Current evidence, mostly from series of patients and retrospective studies, suggests there is probably no role for ultrasonography where clinical evidence of appendicitis is convincing, given the known false negative rate for graded compression ultrasonography and the knowledge that it might delay appropriate surgery. Moreover, the low false positive rate (6%) in clinically obvious cases of appendicitis does not

warrant routine ultrasonography. One prospective observational multicentre study of 2280 patients found no clinical benefit when routine ultrasonography was performed in all patients. [22]

3.8 COMPUTED TOMOGRAPHY

CT scan is a useful diagnostic aid where the diagnosis of appendicitis is in doubt despite clinical examination and ultrasonography (especially those patients with an Alvarado score between one and five. [18] [43] It has been associated with a higher diagnostic accuracy. It also allows visualization and diagnosis of many other causes of abdominal pain that can be confused with appendicitis. CT scan has a high sensitivity of 96.5% and specificity of 98 %.[35]It has a high negative predictive value, and is useful in excluding appendicitis in patients for whom the diagnosis is in doubt. In confusing cases the CT scan can be repeated after 24hours. CT scan is very useful in elderly patients with a lengthy differential diagnosis, confusing clinical signs and appendicectomy carries an increased risk.[35]

Features on CT scan which suggest appendicitis are [25]

(i) A dilated appendix, >7mm in diameter
(ii) Circumferential wall thickening and enhancement
(iii) Thick walled appendix that does not fill with enteric contrast
(iv) Periappendiceal fat stranding
(v) Periappendiceal fluid
(vi) Mural thickening greater than 2mm
(vii) Phlegmon or periappendiceal abscess
(viii) Arrow head sign-thickening of the cecum, which funnels contrast agent toward the orifice of the inflamed appendix

Although failure to fill during a barium enema has been associated with appendicitis it is important to remember that 20% of normal appendices do not fill with barium. Filling with barium therefore excludes appendicitis and no determination can be made if the appendix does not fill. [25]

The disadvantages of CT scan are that it is expensive, predisposes patients to ionizing radiation, cannot be used during pregnancy and predisposes patients to complications associated with administration of contrast. CT scan also involves moving a sick patient to an imaging centre or room. [43] [46]Andersson et al suggested that CT scan is overly sensitive in diagnosing appendicitis since he speculated that early appendicitis frequently undergoes spontaneous resolution. [18]Routine use of CT scan in diagnosing acute appendicitis is not cost effective.[35] [46]CT scan has been associated with a reduced negative appendicectomy rate and avoids unwarranted admissions. Some studies have argued that CT scan is cheap since it prevents unnecessary admissions where the diagnosis of appendicitis is in doubt and patients are admitted for observation.[35] [46]Studies have also been done to compare US and CT scan. Although the differences are rather small, CT scanning has consistently proven superior. [18]

3.9 APPENDICEAL PERFORATION

The rate of appendiceal perforation has always been thought to be inversely related to the negative appendicectomy rate. Surgeons have therefore tolerated higher than zero rate of negative appendicectomy to try and reduce the perforation rates. [7] [47] Recent studies have shown that the perforation rate has remained unchanged despite success in lowering the negative appendicectomy rate. The perforation rates are even higher for children less than 5 years and patients >65years due to delayed or missed diagnosis. Diagnosis of appendicitis is difficult in under fives because there are numerous conditions that mimic appendicitis in the paediatric population (e.g gastroenteritis and mesenteric adenitis). [48] [49] Perforated appendicitis has much higher rates of death, morbidity and complications[45], longer hospital stays and higher health care costs. Perforated appendicitis rates are an indicator of access to and quality of healthcare. [18] Higher perforation rates are now believed to be due to delayed presentation than during in-hospital observation when the diagnosis is being confirmed or ruled out.[7] [18] [47] [48]

There is no way of accurately predicting if and when an appendix will perforate. However you can suspect appendiceal perforation in the presence of temperature >39^{o}C and a white cell count of >18,000 cells/mm3. Perforation will result in either a

localized peritonitis if perforation is contained or generalized peritonitis if the walling-off process is ineffective in containing the perforation.[50]

Patients might present with a palpable mass in the right iliac fossa. This might represent a phlegmon, which consists of matted loops of bowel adherent to the adjacent inflamed appendix or periappendiceal abscess. If a mass is found preoperatively the management may be different. The standard treatment for appendiceal mass was introduced by Oschner in 1901 advocating a conservative regimen (nil by mouth, intravenous antibiotics, bed rest and watchful observation) has proved popular over the years and has been shown to be safe and effective.[51]After conservative management interval appendicectomy (IA) can be performed 8-12 weeks later when inflammation has settled. Interval appendicectomy identifies hidden pathology such as cecal cancer, Crohn's disease and ileo-cecal tuberculosis [52]. Kumar *et al* showed that patients treated conservatively without IA had shortest hospital stay and duration of work-days lost, and only 10% of patients developed recurrent appendicitis during a median follow- up of more than 33.5 months.[53]Interval appendicectomy can be safely omitted after exclusion of other ileo-cecal pathologies. This avoids a second hospital admission and a surgical procedure which is associated with 10-20% complication rate.[52] Patients with recurrent symptoms can be managed safely by laparoscopic means. Senapati *et al* reported experience with emergency laparoscopic appendicectomy (LA) in patients with appendiceal mass. It was found that early emergency LA for appendiceal mass is feasible and safe.[54]

3.10 DIFFERENTIAL DIAGNOSIS

Appendicitis should be a differential diagnosis in any case of an acute abdomen. The differential diagnosis of appendicitis depends on four major factors: the anatomic location of inflamed appendix; the patient's age; sex of the patient and the stage of the process (simple or ruptured).[16]Some of the differentials include acute mesenteric adenitis, gynaecological disorders (pelvic inflammatory disease, ruptured graafian follicle, twisted ovarian cyst, and ectopic pregnancy), Crohn's enteritis, and Meckel's diverticulitis. [10 25] Gynaecologic conditions of the ovary are the most common conditions

to be misdiagnosed as appendicitis in women.[49] Medical conditions that might mimic acute appendicitis include gastroenteritis, hepatitis, cytomegalovirus colitis and lower lobe pneumonia.

3.11 HISTOLOGY

Histology remains the gold standard for diagnosing appendicitis. There is no test that is 100% accurate in diagnosing appendicitis.[35]Histology is also able to detect other pathologies that occur in the appendix like neoplasia. An appendix which is found to be normal on histopathological examination constitutes a negative or non curative appendicectomy. However histopathologists acknowledge that there is a group of pathologists who never call an appendix normal.[55]There is a school of thought which suggest that there is a form of appendicitis that is microscopically normal and that it can only be identified through the expression of inflammatory markers (such as cyclooxygenase 1 and 2 and prostaglandin E). [41 55]

The pathologic features of appendicitis are ulceration in the mucosa with a hyperemic background. There is fibrinous or purulent coating of the serosa, with engorgement of vessels. A fecolith is found in up to a third of cases. Microscopically there is mucosal inflammation, which can extend to the submucosa and there can be total necrosis of appendiceal wall. In advanced stages, the mucosa is absent, and the wall is necrotic. Neutrophils might be found in the epithelium and they support the diagnosis of appendicitis.[2] [41] [55]There is controversy regarding the minimal requirements for diagnosing acute appendicitis. Inflammation limited to the mucosa and submucosa may not be adequate according to some authorities. Some authors require extension of the neutrophilic infiltrate into the muscularis propria for the diagnosis of acute appendicitis.[41]

There is controversy regarding a clinical entity called ‘chronic appendicitis’. Although it is a well described by surgeons, histopathologists seem to dispute this. They argue that many cases clinically diagnosed as chronic appendicitis represent recurrent acute appendicitis. The finding of a significant increase in neural fibers, Schwann cells, and

enlarged ganglia in cases of clinically acute appendicitis may be indicative of repeated bouts of inflammation. [2 41 55]

There are usually four stages of appendicitis as reported by histology. These are acute, acute suppurative, gangrenous (phlegmonous), and perforated. Periappendicitis refers to acute or chronic inflammation of the appendiceal serosa. This usually occurs in advanced stages of appendicitis, but can also be seen in the absence of appendicitis. It can occur through spread of inflammatory process from another site, such as the female adnexae. [10 41]

There are other inflammatory processes that occur in the appendix. These include oxyuriasis, eosinophilic appendicitis, schistosomiasis, H. pylori, acute necrotizing arteritis, measles, ulcerative colitis, Crohn's disease to name a few. Tumors of the appendix are rare. Carcinoid tumor is the commonest tumor of the appendix. It is found in 1 in every 300 routine appendicectomies.[55]

The general recommendation is to send every appendix specimen for histopathological examination. This has been supported by the fact that 1% to 3.5% of specimens contain unusual pathologies apart from appendicitis. Studies have also shown that surgeons are able to detect less than 50% of these appendices with unusual pathologies.[9 10 41] Matthyssens *et al* suggest that appendices should not be routinely sent unless there is an obvious macroscopic abnormality at surgery. They argue that this practice is justified by the rarity of aberrant findings, together with the significant costs of specimen processing.[56]

3.12 SURGICAL PROCEDURE

Once a diagnosis of appendicitis is made, intravenous fluids are instituted. Resuscitation can be done if there is a perforated appendix and the patient is dehydrated. In these patients a Foley catheter will be helpful to monitor response to fluid

resuscitation. All patients are put on antibiotics after diagnosis of acute appendicitis. The decision to continue antibiotics depend on intraoperative findings.[56]

Appendicectomy may be performed by laparatomy (usually through a limited right lower quadrant incision) or laparoscopy.[56]Both open and laparoscopic appendicectomy are done under general anesthesia. Open appendicectomy is usually easily performed through a transverse right lower quadrant incision (Davis-Rockey) or an oblique incision (McArthur-McBurney).[10] If diagnosis is in doubt, a lower midline incision is recommended to allow a more extensive examination of the peritoneal cavity.[16]

There have been several randomized control trials comparing open versus laparoscopic appendicectomy.[20] First successful laparoscopic appendicectomy was performed by Semm in 1982.[32]Laparoscopic appendicectomy only started gaining momentum after success with laparoscopic cholecystectomy. Some surgeons consider open appendicectomy as minimal access surgery since it can be done through a very small incision. Laparoscopic surgery is now gaining favor with most surgeons. It is associated with reduced pain, reduced hospital stay, reduced negative appendicectomy rate[15] and access to the whole abdominal cavity. It also has an advantage in obese patients where open appendicectomy might be difficult with a very small incision. Although laparoscopic appendicectomy can be performed in all age groups of patients, surgeons agree that for women of child bearing age, laparoscopic appendicectomy is unquestionably the method of choice because of the diagnostic dilemma in this subset of patients.[20]Some authors argue that postoperative pain is not different whether it is open or laparoscopic appendicectomy. [16]

Open appendicectomy is still being widely used. It is faster, cheaper and has acceptable cosmetic results. A transverse or oblique incision (Lanz or McBurney incision) is used in the right lower quadrant. Local anesthetic can be infiltrated before operation to reduce post operative pain. Skin and fascia are opened and the incision should avoid the rectus sheath. The muscles are split along the direction of their fibers. The external oblique, internal oblique and the transversas abdominis muscles are encountered. The

peritoneum is opened and entered. The cecum is identified and the tinae are followed down to where they converge. The appendiceal base is located in this area and a finger can be used to sweep out the appendix.[13]

Once the appendix is identified, mesoappendix is ligated either in a retrograde or antegrade fashion, as denoted in Figure 2. The appendix is ligated at the base with an absorbable suture. The stump can be buried within the cecal wall or can be left hanging in peritoneal cavity.(Figure 3) Studies have not shown any difference in infections or adhesions whether you bury the stump or not. The peritoneum is closed and muscles are apposed using absorbable suture. Fascia is closed with interrupted suture and skin is closed with subcurticular absorbable sutures. A drain might be left in situ if there was an abscess and a cavity remains behind after draining the abscess. For perforated appendix the skin is left open.[10]

Three ports are normally used for laparoscopic appendicectomy. [10 20] A 10mm port at the umbilicus, followed by a 5mm port in the suprapubic midline region and a 5mm port midway between the first two ports and to the left of the rectus abdominis muscle.[10]Patient will be in supine position and in Trendelenburg's position and rotated left-side down.[10 20] the abdomen is thoroughly explored to exclude other pathology before starting the LA. The appendix is identified by following the anterior tinae to its base. Gentle dissection at the base of the appendix enables the surgeon to create a window between the mesentery and the base. The mesentery and appendiceal base are then secured and divided separately using endoscopic linear cutting stapler, pretied sutures ligatures, clips or other haemostatic devices. The base is not inverted. When the mesoappendix is involved with the inflammatory process, it is often best to divide the appendix first with a linear stapler and then to divide the mesoappendix immediately adjacent to the appendix with clips, electrocautery, harmonic scalpel or staples. The appendix is placed in a retrieval bag or withdrawn into a trocar. Trocars are removed under direct vision after evaluating for haemostasis.[57 58]

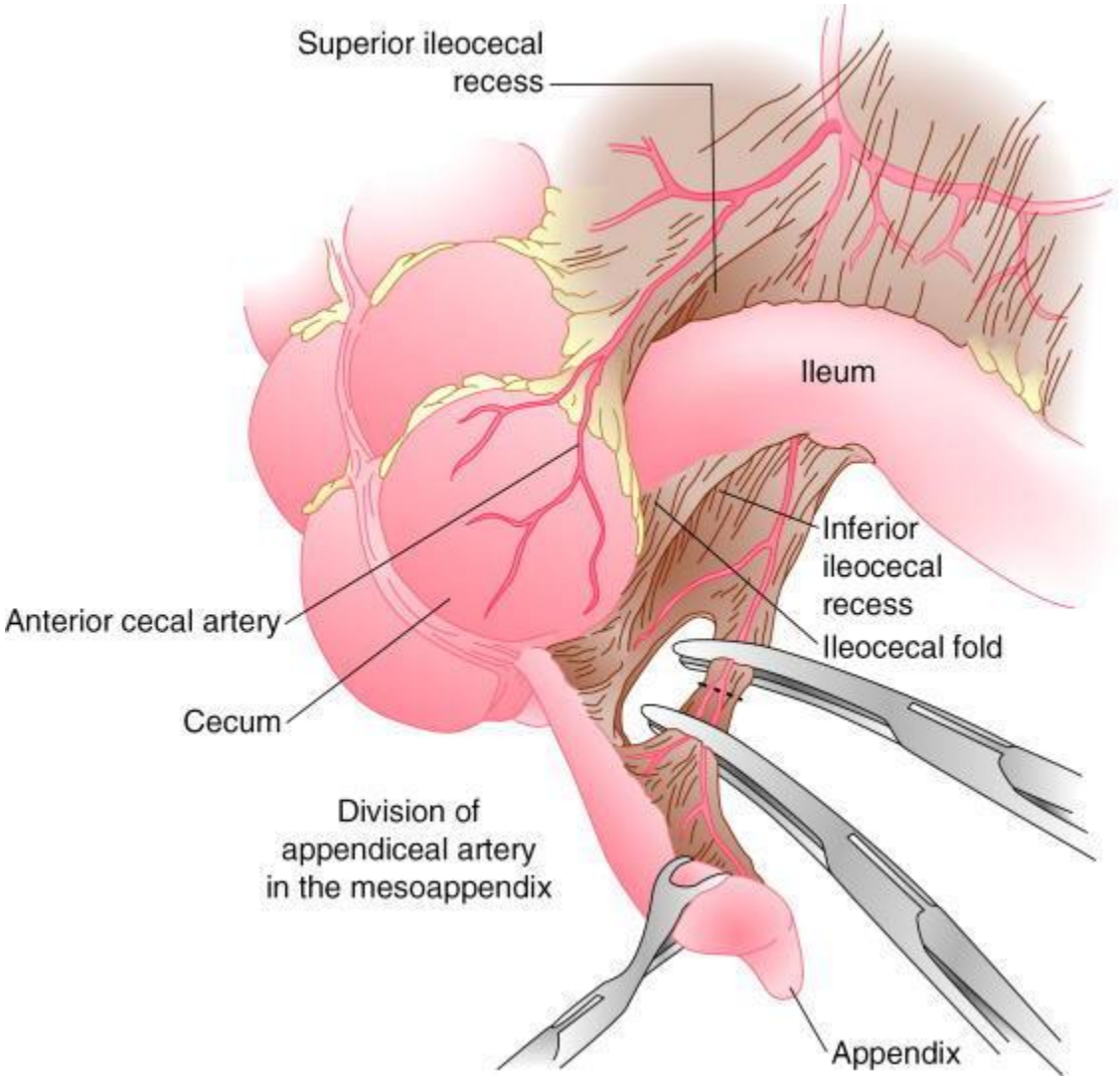

Figure 2: ligation of appendicular artery[10]

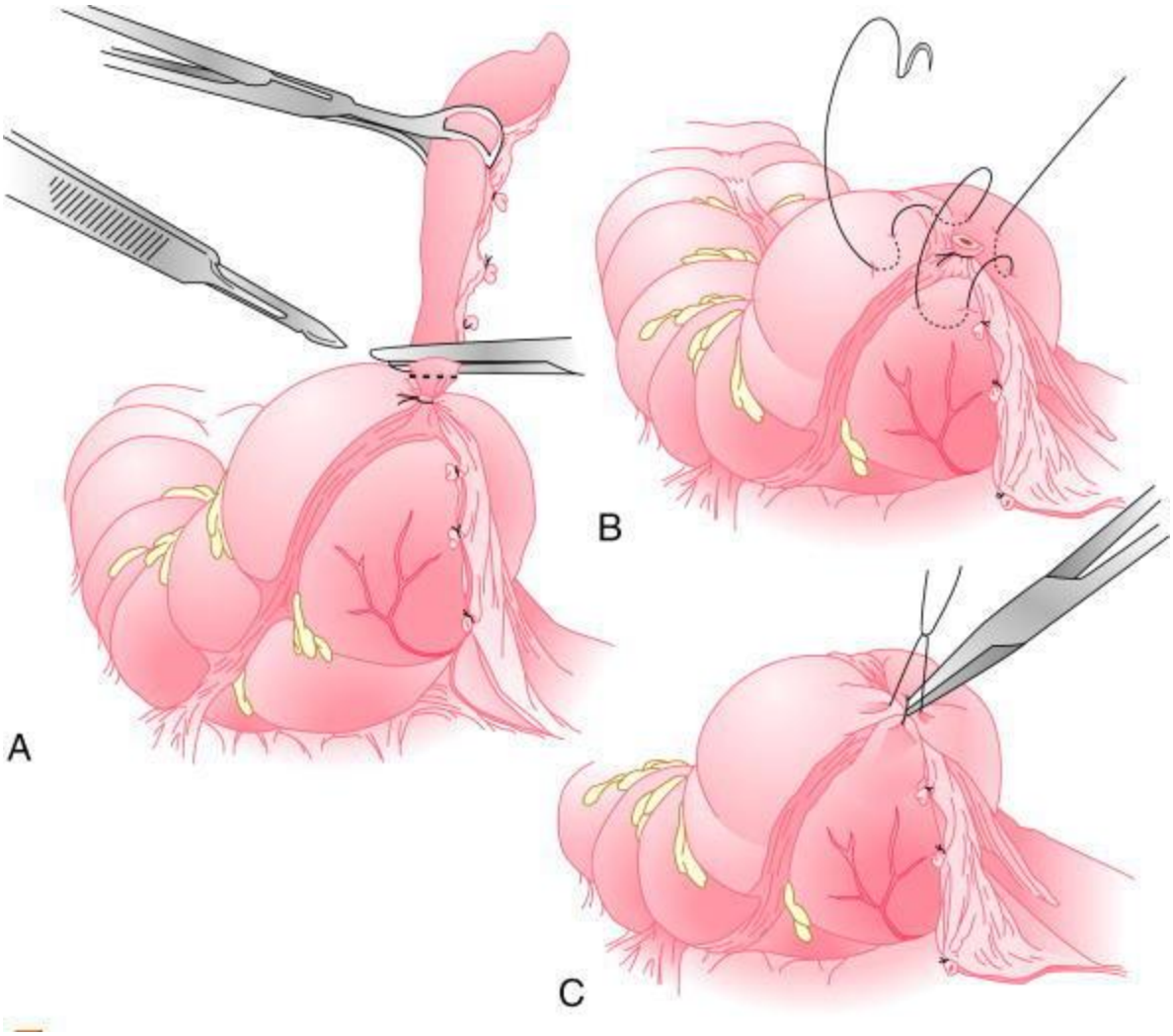

Figure 3: **A** ligating appendiceal stump **B and C** burying appendiceal stump[10]

3.13 COMPLICATIONS OF APPENDICECTOMY

Mortality rate after appendicectomy is less than 1%. The rate tends to be higher if the appendix was perforated before surgery. The morbidity also parallels the mortality rate, around 5% in simple appendicitis but can be as high as 45% in perforated appendix.[16] Elderly patients also have a higher morbidity and mortality from appendicectomy. Hemorrhage from a slipped ligature can occur in the early postoperative period. The most common early post operative complication is surgical site infection. It occurs in up to 4% of all appendicectomies.[50]If the infection is superficial, removal of sutures, adequate drainage and dressings will solve the problem. Intraabdominal abscesses can

occur in appendiceal fossa; pouch of Douglas, the subhepatic space and between loops of intestine. Abscess in the pouch of Douglas can be drained transrectally. Imaging guided drainage can be done for other intraabdominal abscesses. Pulmonary embolism also accounts for some early post operative deaths. Superficial infections are less likely with the laparoscopic technique than with the open appendicectomy. Intraabdominal abscesses however are less with the open appendicectomy than with the laparoscopic appendicectomy. [10 35 47]

Late complications are usually a sequel of early complications. Incisional hernias can form as a result of wound infection which predisposes to wound dehiscence and finally incisional hernia. Intraabdominal abscesses can also predispose to postoperative intestinal obstruction and fifty percent of these obstructions occur in the first postoperative year.[44] 46 Intra-abdominal abscess may be due to retained fecolith after laparoscopic appendicectomy.[20] The incidence of inguinal hernias is three times more common in patients with a history of appendicectomy.[19] Portal pyaemia, intrahepatic abscess and septicaemia are the other complications of appendicitis.

4 MATERIALS AND METHODS

Authority to do the study was obtained from the Joint Parirenyatwa Group of Hospitals and College of Health Sciences Research Ethics Committee (JREC). Permission was also obtained from the clinical directors of Parirenyatwa Group of Hospitals and Harare Central Hospital. This is a prospective observational cross-sectional study to determine the negative appendicectomy rate in our set up among patients undergoing surgery for acute appendicitis.

All patients (n=206) undergoing appendicectomy from June 2012 to May 2013 were included in the study. The investigator followed up all patients taken to theatre for appendicectomy. The decision to operate was taken by the operating surgeon based on overall clinical judgment and not the Alvarado score alone. The investigator did not influence the management of the patient. Data collection sheets were used to capture data from the patient's notes. The following information pertinent to the study was also captured: ultrasound scan results; the operative findings; the type of surgery performed (open or laparoscopic surgery); and the gross appearance of the appendix as described by the operating surgeon. The Alvarado score was calculated from the collected data. Histology results from the removed appendices were followed up by the investigator. The negative appendicectomy rate was then calculated.

4.1 INCLUSION CRITERIA

All patients who had an appendicectomy done at Parirenyatwa Group of Hospitals and Harare Central Hospital were included in the study.

4.2 EXCLUSION CRITERIA

The following patients were excluded from the study:

- children under 5 years
- incidental appendicectomy
- patients undergoing interval appendicectomy

- patients with a mass in the right iliac fossa

4.3 SAMPLE SIZE DETERMINATION

Sample size was determined assuming a negative appendicectomy rate of 15% in the population of patients with a diagnosis of acute appendicitis who underwent appendicectomy at 95% confidence level and a precision of 5%: the minimum sample size was calculated using Dobson's formula:

$$n = \frac{z^2 p(1-p)}{d^2}$$

$$= \frac{1.96^2 \times 0.15(1-0.15)}{0.05^2}$$

$$= 196$$

Thus, the minimum sample size calculated was 196 participants

4.4 DATA COLLECTION

The data was prospectively collected using structured data collection forms as shown in Figure 9.

4.5 STATISTICAL ANALYSIS

Data was analyzed using Epi-info v3.5.3 and Stata v10.1. Frequencies and charts were generated for descriptive statistics. Data was summarized using frequency tables. For categorical data frequency tables, pie charts and histograms were used. Quantitative data was summarized using means and standard deviations. Sensitivity tests were done to compare ultrasound scan and histology. Sensitivity results were reported together with their 95% confidence intervals.

Tests for association were conducted using the Chi-squared test. A p value of 0.05 was considered significant.

5 RESULTS

Two hundred and six patients who had appendicectomies from June 2012 to May 2013 were included in the study. Ninety five patients (46.1%) were from Harare Central Hospital while 111 patients (53.9%) were from Parirenyatwa Group of Hospitals.

5.1 AGE AND SEX DISTRIBUTION

One hundred and forty seven patients (71.4%) were males and fifty nine patients (28.6%) were females (Figure 4). The mean age was 28 years (SD 12.8). Figure 5 shows the age distribution.

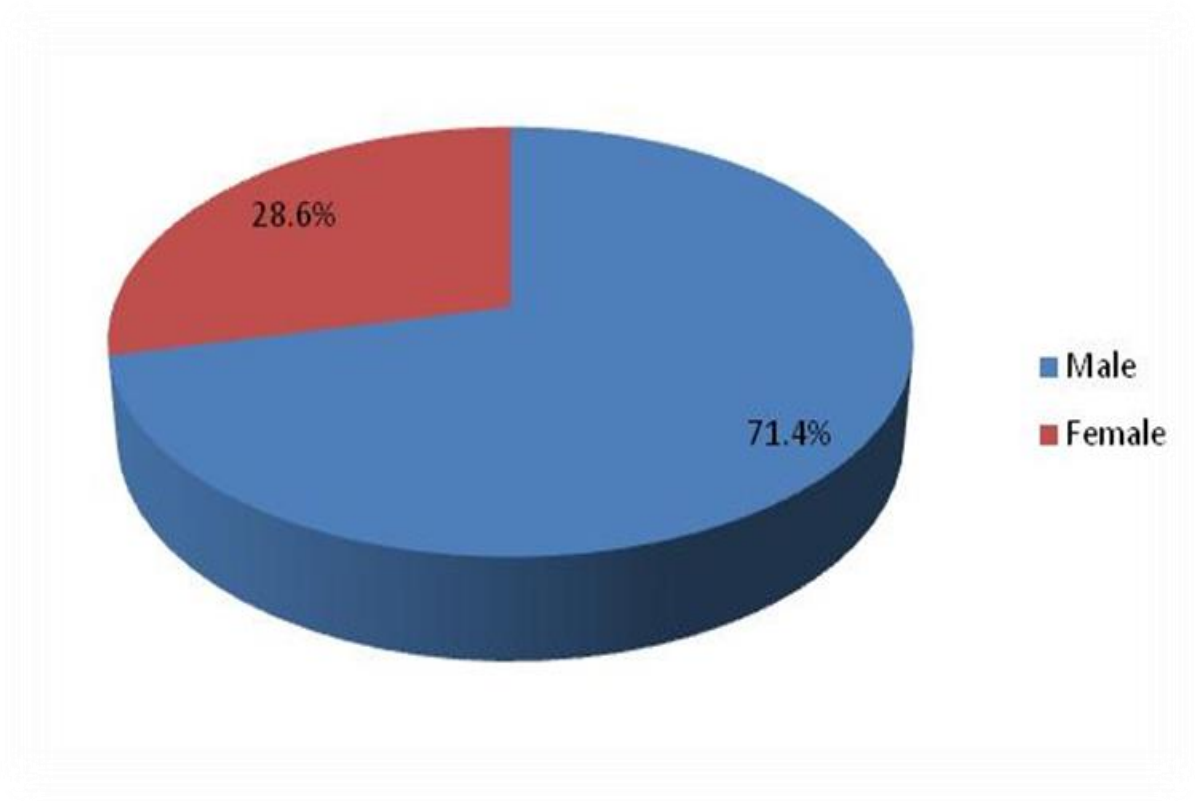

Figure 4: Sex distribution

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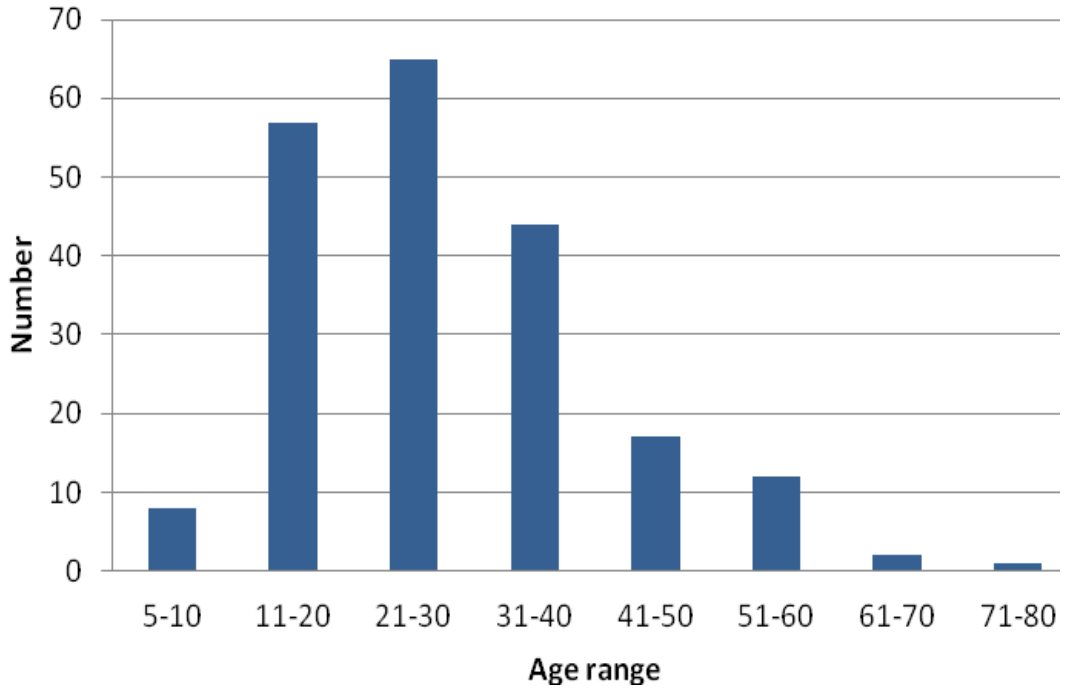

Figure 5: Age distribution

5.2 CLINICAL FEATURES

One hundred and sixty four patients (79.6%) had migrating abdominal pain. One hundred and sixty four patients (79.6%) had nausea with or without vomiting. Anorexia was recorded in 145 patients (70.4%) (Table 2). The most common finding on physical examination was right lower quadrant tenderness in 204 patients (99.0%). Ninety five patients (46.1%) had an elevated temperature. One hundred and eighteen patients (57.3%) had leucocytosis. Left sided shift was noted in one hundred and thirty three patients. Of the 88 patients without leucocytosis, 37 (42%) had left sided shift.

Table 2: Clinical features

PARAMETERS	YES		NO	
	NUMBER	PERCENTAGE	NUMBER	PERCENTAGE
RLQ Tenderness	204	99.0%	2	1.0%
Migrating Abdominal Pain	164	79.6%	40	20.4%
Rebound Tenderness	173	84.0%	33	16.0%
Nausea/ Vomiting	164	79.6%	42	20.4%
Anorexia	145	70.4%	61	29.6%
Left Shift	133	64.6%	73	35.4%
Leucocytosis	118	57.3%	88	42.7%
Elevated Temperature	95	46.1%	111	53.9%

5.3 ALVARADO SCORE

Alvarado scores for every patient were calculated from the notes. A total score of less than five was recorded in 7.8%. None of the patients had an Alvarado score of less than 3 amongst those taken for appendicectomy. Forty nine patients (23.8%) had an Alvarado score of 5 to 6. One hundred and forty one patients (68.4%) had an Alvarado score of 7 to 10.(Figure 6)

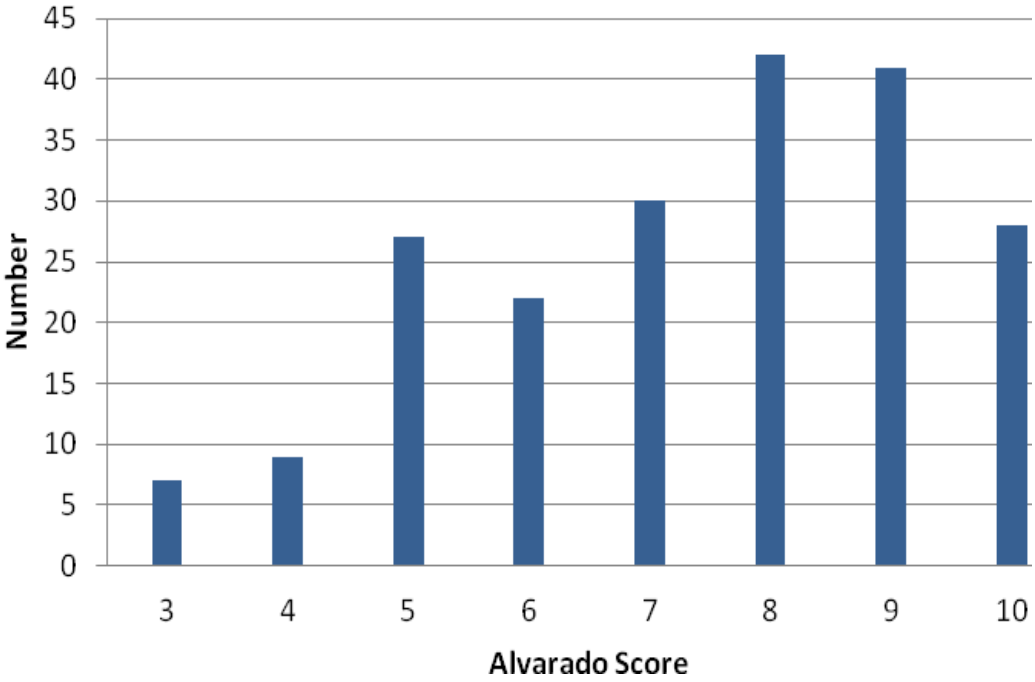

Figure 6: Alvarado score

5.4 INVESTIGATIONS

All the patients had full blood count, but only 42 had an abdominal ultrasound scan.

5.4.1 FULL BLOOD COUNT

The average haemoglobin for the patients going to theatre was 13.3g/dl (SD 2.05). (Figure 7) There were 9 patients with haemoglobin of less than 10g/dl. Eight out of nine of these patients were found to have perforated appendix intraoperatively. White cell count was elevated in 118 patients (57.3%). (Table 2)

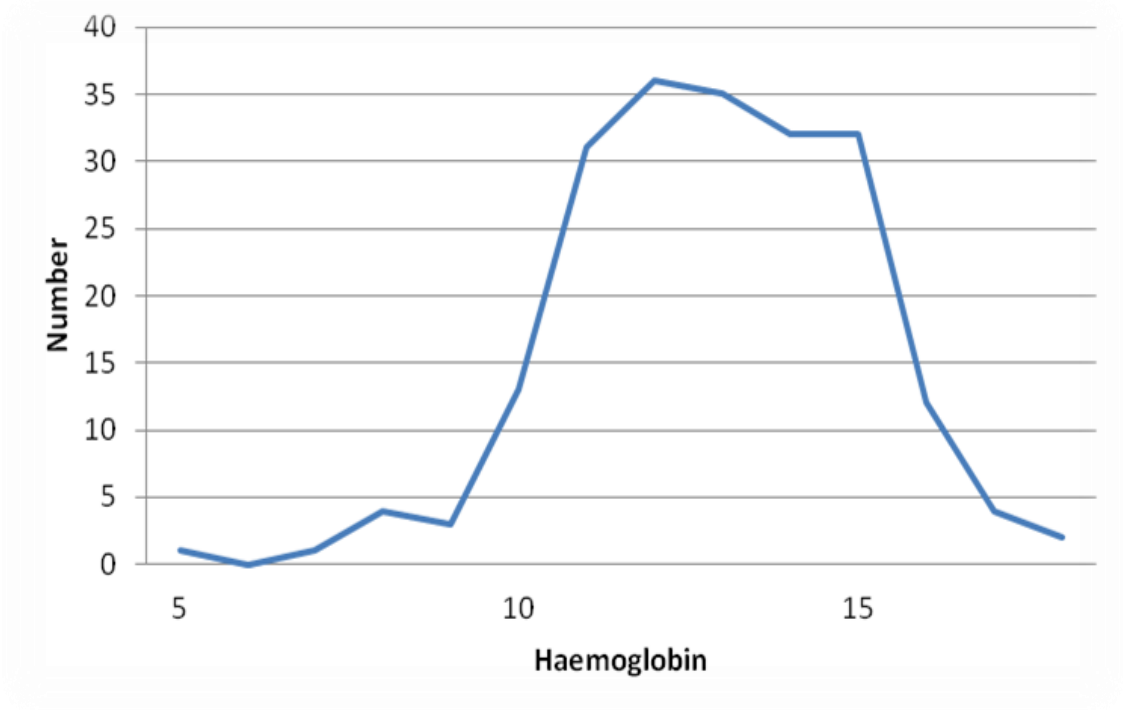

Figure 7: Haemoglobin level

5.4.2 ULTRASOUND SCAN

Forty two patients had ultrasound scan done. Nineteen of the patients were female (i.e. 32.2% of female patients) while 23 of the patients were male (i.e. 15.8% of male patients). Ultrasound scan was suggestive of appendicitis in 27 patients (64.3%) and ruled out appendicitis in 6 patients (14.3%). In 9 patients (21.4%) ultrasound scan was indeterminate. Using Odds ratio women were 2.6 times more likely to have an ultrasound scan than males. The Chi-squared test showed a significant association between use of ultrasound scan and female sex, p value 0.008. There was no correlation between the Alvarado score and ultrasound scan findings, p value 0.095 (Table 4).

Table 3: Relationship between Alvarado score and ultrasound scan

ALVARADO SCORE	ULTRASOUND DONE	
	YES	NO
3	3	4
4	1	8
5	7	20
6	4	17
7	7	23
8	7	35
9	7	34
10	6	22

(p=0.522)

Table 4: Relationship between Alvarado score and ultrasound scan findings

ALVARADO SCORE	ULTRASOUND SCAN FINDINGS		
	Unlikely	Indeterminate	Suggestive
3	1	0	2
4	0	0	1
5	2	3	2
6	0	2	2
7	0	1	6
8	0	1	6
9	0	2	5
10	3	0	3

(p=0.095)

5.5 TREATMENT

5.5.1 ANALGESIA

All the patients were given analgesia. The commonly used analgesia was an opioid (pethidine/meperidine). Analgesia in form of opioid was continued for twenty four hours post operatively after which the patient would be started on oral analgesia. Non steroidal anti-inflammatory drugs were the commonly prescribed oral analgesia.

5.5 .2 INTRAVENOUS FLUIDS

All the teams would start their patients on intravenous fluids once the diagnosis of appendicitis was made. The commonly used was Ringer's lactate.

5.5.3 ANTIBIOTIC USE

All the patients were given intravenous antibiotics. Antibiotic usage was divided into three groups. (Table 5) Prophylactic antibiotic was defined as one dose of antibiotics that was given just before induction of anasthesia. Prolonged prophylactic antibiotic was defined as antibiotics given up to 72hours post operatively. The treatment group would get antibiotics for at least five days. The majority of patients (75.2%) got a five to seven day course of antibiotics which would fall in the treatment group. Ceftriaxone and metronidazole in combination were the commonly used antibiotics.

Table 5: Antibiotic use

ANTIBIOTICS ADMIN	Frequency	Percent
Prophylactic	7	3.4%
Prolonged Prophylactic	44	21.4%
Treatment	155	75.2%

Table 6 shows the relationship between antibiotic usage and intraoperative findings of the surgeon. Every patient who had perforated (n=73) appendix got at least three days of antibiotics. All the patients with generalised peritonitis (n=26) got the full course of antibiotics.

Table 6: Relationship between antibiotic usage and intraoperative findings

	INTRAOPERATIVE FINDINGS				
ANTIBIOTICS ADMIN	**NORMAL**	**INFLAMED**	**GANGRENOUS**	**PERFORATED (LOCALISED PERITONITIS)**	**PERFORATED (GENERALISED PERITONITIS)**
Prophylactic	1	6	0	0	0
Prolonged prophylactic	6	34	0	4	0
Treatment	6	68	12	43	26

5.6 TIME FROM PRESENTATION TO OPERATION

The majority of the patients (55.3%) were operated on the day of admission and 38.3% were operated on the following day. (Table 7)

Table 7: Time from presentation to operation in days

Days before operation	Frequency	Percent
0	114	55.3%
1	79	38.3%
2	5	2.4%
3	4	1.9%
4	1	0.5%
6	2	1.0%
7	1	0.5%

5.7 SURGICAL APPROACH

Majority of patients (95.1%) had open appendicectomy while only 4.5% (10 patients) had laparoscopic appendicectomy. All the ten patients who had laparoscopic appendicectomy had an Alvarado score of at least seven. Of those patients who had open appendicectomy, transverse incision was done in 142 patients (73.6%). A lower midline incision was done in 51 patients (26.4%). Most of the lower midline incisions (70.6%) were done for perforated appendix.

5.8 INTRAOPERATIVE FINDINGS

Table 8 shows the intraoperative findings. The majority of the appendices, (n=108) were found to be inflamed during the operation. The appendix was found to be normal in 13 patients (i.e. 8 females and 5 males).

Table 8: Intraoperative findings

INTRAOPERATIVE FINDINGS	Frequency	Percent
NORMAL	13	6.3%
INFLAMED	108	52.4%
GANGRENOUS	12	6.3%
PERFORATED (LOCALISED PERITONITIS)	47	22.8%
PERFORATED (GENERALISED PERITONITIS)	26	12.6%

5.10 HISTOLOGY RESULTS

Out of a total of 206 patients entered in the study, histology results were available for 158 patients. The overall negative appendicectomy rate was 16.5%. (Table 9) The negative appendicectomy rate for Parirenyatwa Group of Hospitals was 19.0% and that for Harare Central Hospital was 12.1% (p=0.257). The negative appendicectomy rate for males was 13.3% while that for females was 24.4% (p=0.087). The negative appendicectomy rate for open appendicectomy was 17.1% and all the 10 laparoscopic appendicectomies had appendicitis on histopathological examination. There were12 patients (7.6%) who were found to have schistosomiasis, eleven of them had appendicitis and one had submucosal fibrosis only. Submucosal fibrosis was found in

11 patients. (Table10) Fecoliths were found in 7 cases and in two of the cases the appendix was found to be normal. In one case the histology revealed Non –Hodgkin's lymphoma. In one other case the histology revealed reactive lymphoid hyperplasia. Three pathologists reported on the specimens, individually.

Table 9: Histology results

Histology	Frequency	Percent
Normal	26	16.5%
acute appendicitis	20	12.7%
suppurative appendicitis	50	31.6%
gangrenous appendix	25	15.8%
acute ruptured appendicitis	37	23.4%

Table 10: Other pathologies

OTHER PATHOLOGIES	Frequency	Percent
non Hodgkin's lymphoma	1	3.85%
periappendicitis	2	7.69%
schistosomiasis	11	42.31%
submucosal fibrosis	12	46.15%
Total	26	100.00%

5.11 ULTRASOUND SCAN VERSUS HISTOLOGY RESULTS

Of the patients who had ultrasound scan done (n=42), 31 patients had histology results. Table 11 below shows the relationship between ultrasound findings and histology results. Sensitivity of ultrasound was 89.5% (CI 66.9% to 98.7%) with a positive predictive value of 77.3% (CI 54.6% to 92.2%).

Table 11: Relationship between ultrasound scan and histology results

	ULTRASOUND SCAN		
HISTOLOGY	APPENDICITS UNLIKELY	INDETERMINATE	SUGGESTIVE OF APPENDICITIS
Normal	2	2	5
acute appendicitis	0	1	3
suppurative appendicitis	2	0	7
gangrenous appendix	0	0	3
acute ruptured appendicitis	0	2	4

5.12 INTRAOPERATIVE FINDINGS COMPARED WITH HISTOLOGY RESULTS

Table 12 shows the relationship between intraoperative findings by the surgeon and histology results. Intraoperative findings by the surgeon had a sensitivity of 97.0% (CI 92.4% to 99.2%) and a positive predictive value of 87.1% (80.6% to 92%). The specificity of the surgeon in diagnosing appendicitis intraoperatively was 26.9% (CI 11.6% to 47.8%) with a negative predictive value of 63.6% (CI 30.8% to 89.1%).

Table 12: Intraoperative findings compared with histology results

HISTOLOGY	INTRAOPERATIVE FINDINGS				
	Normal	Inflamed	Gangrenous	Perforated (localised)	Perforated (generalised)
Normal	7	19	0	0	0
acute appendicitis	3	16	0	0	1
suppurative appendicitis	1	27	3	13	6
gangrenous appendix	0	13	3	7	2
acute ruptured appendicitis	0	6	0	18	13

5.13 ALVARADO SCORE COMPARED TO HISTOLOGY RESULTS

Table 13 shows the relationship between the Alvarado score and the histology results. There were only 11 patients who had an Alvarado score of seven and above who had a histologically normal appendix. Alvarado score (≥7) had a sensitivity of 95.3% (CI 89.4% to 98.5%) and a positive predictive value of 90.3% (CI 83.2% to 95%). The negative appendicectomy rate for an Alvarado score of four or less was 54.5%.

Table 13: Alvarado score compared with histology results

HISTOLOGY	ALVARADO SCORE							
	3	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Normal	4	2	7	2	4	4	3	0
acute appendicitis	1	1	3	2	5	2	4	2
suppurative appendicitis	1	1	3	5	7	9	14	10
gangrenous appendix	0	0	2	2	2	8	6	5
acute ruptured appendicitis	0	1	2	6	7	6	7	8

6 DISCUSSION

The mean age for the study was 28 years (SD 12.8). This is comparable with other studies that were done on appendicitis which showed a mean age of 22.7 years to 30.6 years.[11 14 15 44 59 60]Appendicitis was common in the second and third decades of life as shown in other studies.[45]The highest number of appendicitis cases was in the third decade of life. In our study, appendicitis was rarely diagnosed after the sixth decade. This is in agreement with the findings of other authors.[2 8 41 43]Appendicitis was more common in males than females as was reported in other studies.[11]

Most patients (n=114) were operated on the day of presentation and 79 patients were operated on the next day. One of the patients was operated on day seven. This was a female patient who was initially managed for pelvic inflammatory disease before being referred to general surgeons for appendicectomy. She was found to have a perforated appendix intraoperatively. Only one out of the eight patients who had delayed operation was found to have a perforated appendix intraoperatively. Two of the patients had ultrasound scan results which were negative and that could have led to the delay in operation. Two other patients presented to physicians with diarhoea and anaemia. They were initially managed as typhoid before being referred to general surgeons. One of the patients was operated on day 4 and was found to have a fecolith and the appendix was reported as normal.

There was generally an overtreatment of patients with antibiotics in this study. There were six patients that were found to have a normal appendix intraoperatively but they were given antibiotics for 5 days. Sixty eight patients were given a 5 day course of antibiotics despite being found to have an inflamed appendix without perforation. Only 3.4% percent of patients were given prophylactic antibiotics. The overuse of antibiotics calls for a clear antibiotic policy in our practice.

The commonest clinical feature was right lower quadrant tenderness (99%) which is consistent with what Alvarado found in his study.[11] Leucocytosis was present in 57.3% of cases despite having two points in the Alvarado score. A high percentage of patients

with rebound tenderness might point towards late presentation in our patients (84.0% versus 55.0% that was found by Alvarado).

The sensitivity of the Alvarado score was 95.3% which is comparable with other studies which were done. [12 15 45] The specificity of the Alvarado score could not be calculated in this study since the study was only focusing on the patients who had appendicectomy and did not capture the patients who were sent home after observation without going to theatre. The positive predictive value of the Alvarado score greater or equal to seven in our study was 90.3% which is comparable with other studies which report a positive predictive value of 83.79% to 86.9%. [15 27]

Ultrasonography can be used with a high sensitivity and specificity to diagnose appendicitis.[47]In our study 31 patients had both ultrasound scan and histology results. The sensitivity of ultrasound scan in our study was 89.5% with a positive predictive value of 77.2%. This is comparable to other studies which showed a sensitivity of 82%[24] and 94.7% [17]The specificity of the ultrasound scan could not be calculated in this study. The study did not capture the patients with suspected appendicitis and discharged because of a negative ultrasound scan result. There was no correlation between Alvarado score and ultrasound scan findings, p value 0.095. One of the possible reasons is a small sample size (n=42) of patients who had ultrasound scan. There were 3 patients with an Alvarado score of 10 who had a negative ultrasound scan result. All the 3 patients were found to have a perforated appendix intraoperatively. Perforated appendix is recognized as one of the causes of a false negative in graded compression ultrasonography for diagnosing acute appendicitis. [10 18 43]

The overall negative appendicectomy rate was 16.5% for the two hospitals. This is comparable with other studies which showed a negative appendicectomy rate of 18.5% to 22.9%.[5 15 24 27] Negative appendicectomy rate of 15% to 30% was generally accepted in clinical practice.[15 17 19 22 44]The negative appendicectomy rate at the two University Teaching Hospitals in Harare falls in the generally accepted range. Recent literature however now quotes negative appendicectomy rates of less than 10%.[23]The negative

appendicectomy rate for Parirenyatwa Group of Hospitals was 19.0% and that for Harare Central Hospital was 12.1%. The negative appendicectomy rate for males was 13.3% and that for females was 24.4%. The finding of a higher negative appendicectomy rate in women than men is consistent with other studies.[2 10 14 26 47] The negative appendicectomy rate for Parirenyatwa Group of Hospitals was higher than that for Harare Central Hospital. Harare Central Hospital did not have general surgical registrars for the first half of the study and all the firms were being run by consultants and that might explain a low negative appendicectomy rate at Harare Central Hospital.

Histology results revealed a higher rate of acute suppurative appendicitis than that of acute appendicitis (30.8% versus 13.3%) Most articles however show a higher rate of acute appendicitis as opposed to suppurative appendicitis. [2 26]The reasons for a higher rate of suppurative appendicitis in our study is not clear. One of the possible reasons might be late presentation.

The rate of perforated appendicitis has remained constant over the decades. It is reported to be between 13.2% and 41.9%.[25]The rate of perforated appendicitis in our study was 23.4%, which falls within the reported range. [6 47]The rate of perforated appendicitis is now believed to be due to patient delay in presentation than due to in-hospital observation whilst the diagnosis is being verified.[7 17 18 47 48] In developing countries this statement has to be validated since patients can present early in remote clinics and managed as gastritis or other diagnosis. The patients are then referred when their clinical condition gets worse or if they do not show any clinical improvement.

Histology results for 158 patients were available for analysis. The other results could not be found in the laboratory. For Harare Central Hospital histology results were found for 58 patients (i.e. 61.1% of patients from Harare Central Hospital) and Parirenyatwa Group of Hospitals 100 patients (i.e. 90.1% of patients from Parirenyatwa Group of Hospitals). At Harare Central Hospital relatives of patients were given the samples to take to the laboratory where they had to pay cash for the services. It is probable that either the relatives did not understand the importance of sending the specimen for histology or that the relatives could not afford the fees for the examination. At

Parirenyatwa Group of Hospitals there is a histopathology laboratory at the hospital unlike at Harare Central Hospital.

Ten patients (4.9%) had their appendix removed laparoscopically. Five of these patients were done at Harare Central Hospital and 5 of these were done at Parirenyatwa Group of Hospitals. Laparoscopic equipment at the two hospitals has to be used during the day and with the supervision of a consultant. Most cases of acute appendicitis are attended during the night and for those cases that presented during the day it was difficult to get the consultants to come and to organize the laparoscopic equipment to be brought to the theatre. Because of logistical problems and shortage of theatre time most surgical firms would opt for open appendicectomy which is thought to be faster and can be done easily by the surgical registrars. This unfortunately might result in low utilization of laparoscopy at the two teaching hospitals in Harare. All the ten laparoscopic appendicectomies were done by consultants. All the laparascopic cases were carried to completion, no cases were converted.

The surgeon was able to make an intraoperative diagnosis of appendicitis with a sensitivity of 97% and a positive predictive value of 87.1%. However the chance of ruling out appendicitis intraoperatively was very low (specificity of 26.9%). This supports the general position of removing the appendix even if it looks normal once you have taken the patient to theatre. [22 25] Other causes of right iliac fossa pain have to be sought if the appendix appears normal intraoperatively. There were 20 cases which were found to be perforated intraoperatively and histology reported as suppurative appendicitis and one of them as acute appendicitis. Reasons for this observation are not clear.

7 CONCLUSION

Negative appendicectomy rate (16.5%) at the two University Teaching Hospitals in Harare is relatively high when compared with modern trends. Alvarado score had a high sensitivity (95.3%) and predictive value (90.3%). Ultrasound scan had a high sensitivity (89.5%) and a relatively low predictive value (77.2%) in diagnosing acute appendicitis. Regular use of these assessment modalities should contribute substantially to reduction in the negative appendicectomy rate in our practice.

The negative appendicectomy rate for males was 13.3% whilst that for females was 24.4%. Using Odds ratio, women were 2.6 times more likely to have an ultrasound scan done for diagnosing acute appendicitis than males.

8 LIMITATIONS

The study had no funding and as a result we did not manage to get all the histology results as some patients could not afford to pay for the histopathological examination of the appendiceal specimen. This might have skewed our results

Ultrasound scan usage was limited in this study, probably because patients could not afford to pay for the investigation.

The study did not capture the patients who were suspected to have appendicitis but sent home after reassurance or an ultrasound scan done.

There were no set criteria for diagnosing appendicitis amongst the three pathologists who were examining the appendiceal specimens.

9 RECOMMENDATIONS

- Surgical firms at the two University Teaching Hospitals in Harare should be encouraged to use the Alvarado score actively in diagnosing acute appendicitis.
- To make ultrasound scan readily available for diagnosis of acute appendicitis and at a cheaper price so that patients can afford.
- There is need for a clear antibiotic policy in the treatment of patients with appendicitis.
- Encourage laparoscopic appendicectomy and to re-visit some of the regulations concerning laparoscopic equipment use.
- Follow up study to evaluate the negative appendicectomy rate whilst actively adhering to the Alvarado score and evaluate if the negative appendicectomy can be reduced.
- Criteria for ordering ultrasound scan in diagnosing acute appendicitis should be clearly spelt out.

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DATA COLLECTION FORM

NAME OF HOSPITAL 1. Parirenyatwa 2. Harare Central Hospital

AGE _____SEX 1. Male 2. Female

HOSPITAL NUMBER_____

DATE OFADMISSION_____/_____/_____

DATE OF OPERATION_____/_____/_____

ALVARADO SCORE (tick below):

		SCORE	**TICK**	**VALUE**
SYMPTOMS	MIGRATING ABDOMINAL PAIN	1		
	NAUSEA/VOMITING	1		
	ANOREXIA	1		
SIGNS	RLQ TENDERNESS	2		
	REBOUND TENDERNESS	1		
	ELEVATED TEMPERATURE	1		
LAB FINDINGS	LEUKOCYTOSIS	2		
	LEFT SHIFT	1		
		TOTAL SCORE		
	Haemoglobin (value only)			

ULTRA SOUND SCAN YES ☐ NO ☐

RESULTS: 1. Suggestive of appendicitis
2. Appendicitis unlikely
3. Indeterminant

TREATMENT

1. Intravenous Fluids
2. Analgesia
3. Antibiotics 3.1 prophylactic
3.2 prolonged prophylactic
3.3 treatment

PROCEDURE

1. Open appendectomy
2. Laparascopic appendectomy

INTRAOPERATIVE FINDINGS

1) Normal
2) Inflamed
3) Gangrenous
4) Perforated (localised)
5) Perforated (generalised)

HISTOLOGY RESULTS:

1. Normal
2. Acute appendicitis
3. Suppurative appendicitis
4. Gangrenous appendix
5. Acute ruptured appendicitis
6. Other_____