The Role of C-Reactive Protein in Diagnosis of Appendicitis

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Department of Medical Clinical Chemistry

Faculty of Medical Laboratory Sciences

University of Gezira

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> وقال: اعملوا فسيرة الله عملكم ورسوله ومؤمنو وسهرون عالم الغيب والشهادة فينصبكم بما كنتم تعملون.

صدق الله العظيم

سورة التوبة الآية (105)
To sprit of my mother ..

To my father …

To my husband ...

To my uncles ....

To my daughters ...

To my cousins ....

I dedicate this work...
First of all, I would like to show the deepest thanks and praise to the almighty Allah for giving me the strength and willingness to accomplish this work.

I thank supervisor Professor Omer Balla for the meticulous support and guidance throughout the conduction of the research.

Best regards to the nursing staff of the emergency room of Alahli Hospital.

I wish to express may thanks to all staff members in the laboratory of Alahli hospital.

All thanks are to every hand that made this work possible.
The Role of C-Reactive Protein In Diagnosis of Appendicitis

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Abstract

The human body contains thousands of different proteins in blood are known collectively as the plasma proteins, most are synthesize in the liver and move into the blood stream through the hepatic sinusoids and central veins of the liver. Plasma proteins circulate in the blood and between the blood and extra cellular tissue space. A common change in proteins concentration in disease result from the acute phase responds to tissue damage and to the presence of infecting organism. Appendix is acute disease that occur in human. This study has been done to determine the C-reactive protein level among patients with acute appendicitis presenting to Alahli Hospital in Abu Dhabi - UAE, during May to October 2015 are examined. The specimen’s was collected (as n = 90) patients. And 40 healthy volunteers in this study as control. The CRP and the TWBCs was measure with those patients using the NycoCard and Sysmex respectively. The main age of the study population was no affect on CRP concentration and their is was 66.7% males and 33.3 females. It was found that there was a significant elevation of CRP main concentration in the study population. But no significant elevation of the TWBCs above the normal value. Its conclude that CRP can be used to exclude that patients without acute appendicitis and its recommended to measure the CRP in patients presenting with symptoms of acute appendicitis. CRP can be used to exclude patients without acute inflammation of appendix.
قياس بروتين سي النشط في المرضى المصابون بالتهاب الزائدة الدودية

وعوضية عوض احمد محمد

ملخص الدراسة

يحتوي جسم الإنسان على آلاف أنواع البروتينات في الدم تعرف بالبلازما بروتين وتُصنَع في الكبد وتفرز في الدورة الدموية. التغييرات في تركيز البروتينات هو مؤشر لحدوث بعض الأمراض الحادة نتيجة تفاعل الأنسجة بالإصابة أو المايكروب. هذه البروتينات مثل بروتين سي النشط. التهاب الزائدة الدودية من الالتهابات الحادة التي تصيب الإنسان. أجريت هذه الدراسة لقياس مستوى بروتين التفاعل سي في مرضى وصفوا بأنهم مصابين بالتهاب الزائدة الدودية بعد عملية الفحص السريري. تم اختيار 90 مريضًا بتهاب الزائدة في المستشفى الأهلي في أبوظبي خلال شهر مايو لعام 2015. تم أخذ 90 عينة من المصابين (صغار + كبار) ثم أخذت 40 عينة من متطوعين أصحاء كعينات مرجعية قياس مستوي بروتين التفاعل سي في الدم بواسطة جهاز NycoCard READER11 وقياس كريات الدم البيضاء بجهاز Sysmex. وخلصت الدراسة إلى وجود علاقة قوية بين نسبة بروتين التفاعل سي والتهاب الزائدة الدودية عند المقارنة بالعينات المرجعية. أثبتت الدراسة أنه ليس هناك أي تأثير للعمر على مستوى بروتين التفاعل سي وان معدل ارتفاعه في التهاب الزائدة الدودية أعلى من معدل ارتفاع كريات الدم البيضاء. توصي هذه الدراسة بقياس مستوي سي النشط للمرضى الذين يعانون من علامات تشتبه التهاب الزائدة الدودية.
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## Abbreviation

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<td>APPs</td>
<td>Acute phase Protein</td>
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<td>APR</td>
<td>Acute phase Reaction</td>
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<td>CRP</td>
<td>C-reactive protein</td>
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<td>CT</td>
<td>Computed tomography</td>
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<td>RIF</td>
<td>Right iliac fossa</td>
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<td>WBCs</td>
<td>White blood cells</td>
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Chapter One

1.1 Introduction:
The human body contains thousands of different proteins in blood are known collectively as the plasma proteins, most are synthesize in the liver and move into the blood stream through the hepatic sinusoids and central veins of the liver. Plasma proteins circulate in the blood and between the blood and extra cellular tissue space.\(^{(1)}\)

A common change in proteins concentration in disease result from the acute phase reaction or response (APR). (The acute phase of an injury is the period of time in between when the injury is sustained, and the beginning of the sub- acute phase) which responds to tissue damage and to the presence of infecting organism or other foreign substance by a complex, interrelated series of cellular and humoral responses. These act together to initiate and control the inflammatory reaction and so to remove damaged tissue and foreign substance.\(^{(1)}\)

The proteins affected are known as acute phase proteins (APPs). Proteins such as: \(\alpha_1\) antitrypsin, \(\alpha_1\) acid glyco-protein, haptoglobin, ceruloplasmin, C\(_4\), C\(_3\) and C - reactive protein.

The concentration of some of these proteins increases (positive acute- phase proteins), such as CRP, fibrinogen, and plasma myeloid A, where as that of other decreases (negative acute phase proteins), such as albumin and transferrin. Plasma concentration of the individual APR proteins change at different rates after the initial insult, and are triggered by cytokines released at the site of injury.\(^{(1)}\)

In practice these changes are helpful in detection of inflammation, and sequential measurement of proteins such as CRP is useful in monitoring of the progress of the inflammation and or it’s response to treatment.
1.1.2 C-reactive protein

1.1.3 Definition

C-reactive protein was originally discovered by Tillett and Francis in 1930 as substance in the serum of patients with acute inflammation that reacted with the C-polysaccharide on the cell wall of streptococcus pneumoniae (5). In 1941 it was shown to be a protein and given the name CRP. It is one of the first acute phase proteins to become elevated in inflammatory disease. It is thought to bind to phospocholine, thus initiating recognition and phagocytosis of damaged cells, it consists of five identical subunits and is synthesized primarily by the liver. (2)

1.1.4 CRP Genetics and Biochemistry

The CRP gene is located in the first chromosome (1q 21-q23). CRP is a 224 residue protein with a monomer molar mass of 25106 Da. The protein is an annular pentameric disc in shape. Proteins with this type of configuration are known as pentarikins, native CRP is a bit different as it has 10-subunits making two pentameric discs, with an overall molecular mass of 251060 Da. (9)

1.1.5 Function of CRP

CRP is a member of the class of acute phase reactant as its levels rise dramatically during inflammatory processes occurring in the body. This increment is due to arise in the plasma concentration of IL-6, which is produced predominantly by macrophages as well as adipocytes, in the presence of Ca$^{2+}$, CRP binds not only the polysaccharides present in many bacteria, fungi, and protozoa parasites but also binds to phosphorycholine, phosphatidyicholines such as lecithin, and polyanions, such as nucleic acid. In the absence of Ca$^{2+}$, CRP binds polycations, such as histone. (2)

CRP is thought to assist in complement binding to foreign and damaged cells and enhance phagocytosis by macrophages (5).

CRP also is able to recognize potentially toxic autogenous substances released from damaged tissue, bind them, and then detoxify them or clear them from the blood, (2) it also plays an important role against infections.
CRP rise up to 50,000 fold in acute inflammation, such as infection. It rises above normal limits with in 6 hours, and peaks at 48 hours, its half life is constant, and its level is mainly determined by the rate of production (and hence the severity of the precipitating cause). (5)

1.1.6 Clinical significance

CRP long has been recognized as one of the most sensitive acute phase protein. It is concentration in plasma usually rises dramatically after the following conditions

* Stress.
* Trauma.
* Infection.
* Inflammation.
* Surgery.
* Neoplastic proliferation.

The increase begins within 6 to 12 hours of the onset of any of these disorders, and the concentration may reach 2000 times the normal.

Determination of CRP is clinically useful for

* Screening for organic disease
* Assessment of the activity of inflammatory disease
* Detection of inter current infections in systemic lupus Erythematous (SLE)
* Management of neonatal septicemia and meningitis

(When collection of specimen for bacteriological investigation may be difficult)(2)

Cord blood normally has low CRP concentrations (1 to 35 mg/dL) but with intrauterine infection, concentrations may be as high as 26,000 mg/dL. Concentrations in infancy normally rise for a few days after vaginal delivery, fall to very low concentration, and then gradually rise over several weeks to adult concentrations. (2)
1.1.7 Appendix

1.1.8 Definition
Appendix is a narrow tubular pouch that is attached to the intestines.

1.1.9 Function of appendix
The biological purpose of appendix has mystified scientists for some time. There have been cases of people who have been found, usually on laparotomy to have congenital absence of an appendix, there have been no reports of impaired immune or gastrointestinal function in these people.
One potential purpose put for by Darwin, was that the appendix was used for digesting leaves as primates, overtime, we have eaten fewer vegetables and have evolved, over million of years, for this organ to be smaller to make room for our to stomach.\(^{(10)}\)

1.1.10 Immune use
Loren G. Martin, a professor of physiology at Oklahoma state university, argues that the appendix has a function in fetuses and adults, Endocrine cell have been found in appendix of the week old fetuses that contribute to biological control (homeostatic mechanism). In adults, Martin argues that the appendix act as lymphatic organ, as being rich in infection. Fighting lymphoid cell, that it may play role in immune system, expose the body to antigen in order that it can produce the antibody.

1.1.11 Maintaining gut normal flora
William parker, Rand, Bollinger and colleagues at Duke University, propose that the appendix serves as a safe heaven for useful bacteria when illness flushes those bacteria from the rest of intestine. \(^{(10)}\)

1.1.12 Appendix Disease (Appendicitis)
When appendix is blocked, it becomes inflamed and results in the condition known as appendicitis, if the blockage continues; the inflamed tissue becomes infected with bacteria and begins to die from lack of blood supply, which finally results in the appendix bursting. Appendicitis is a common condition that affects 6% of population, it most commonly occurs among those 10- 30 years of age. And recognize in male more than female. \(^{(1)}\)
The pain often being in the center of the abdomen where the lining of the stomach is irritated then moves lower right as the condition develops. This makes the diagnosis difficult in the early stages.

1.1.13 What is acute appendicitis?
Acute appendicitis is a rapidly progressing inflammation of a small part of the large intestine called the appendix. The appendix is a pouch-like structure located in the lower right quadrant of the abdomen near the area where the small intestine joins the large intestine. The exact function of the appendix is not known.

Acute appendicitis is a common and serious condition that requires immediate surgery for treatment. In acute appendicitis, the appendix swells and begins to fill with rapidly growing bacteria and pus. This results in the hallmark symptoms of acute appendicitis including pain in the right lower area of the abdomen and fever. However, not all people with acute appendicitis will experience typical symptoms.

Acute appendicitis is a medical emergency that generally requires prompt removal of the appendix to prevent life-threatening complications, such as ruptured appendix and peritonitis (infection of the membrane that lines your inner abdomen).

1.1.14 Appendicitis Causes
There are no clear causes of appendicitis. Fecal material has been thought to be one possible obstructing object.

1.1.15 Pathogenesis
Appendicle inflammation is associated with obstruction in 50% to 80% of cases, usually in form of fecalith and, less commonly, a gallstone, tumor, or ball of worms (oxyuriasis vermicularis). With continued secretion of mucinous fluid, the build-up of intraluminal pressure presumably is sufficient to cause collapse of the draining veins. Obstruction and ischemic injury then favors bacterial proliferation with additional inflammatory edema and exudation, further embarrassing the blood supply. A significant minority of inflamed appendices have no demonstrable luminal obstruction, and the pathogenesis of the inflammation remains unknown.

1.1.16 Pathological features
Macroscopically: an acutely inflamed appendix is markedly swollen and intensely congested: the peritoneal surface is invariably rough end and may be covered by yellow plaques of fibrinous
exudates. In unusually sever case the appendix may be green or black in color- gangrenous appendicitis. \(^{(8)}\)

Histologically, there is mucosal ulceration with focal or extensive neutrophil infiltration in all the main layers of the appendicular wall and including the Serosa. There is often frank abscess, formation. \(^{(8)}\)

### 1.1.17 Clinical features

Acute appendicitis is either the easiest or the most difficult. of abdominal diagnosis, the classic case is marked by, mild per umbilical discomfort, followed by anorexia, nausea, and vomiting, soon associated with right lower quadrant, which in the course of hours is transformed in to a deep constant pain in the right lower quadrant, fever and leukocytosis appear early in the course. Large numbers of cause are not classic. The condition can be remarkably silent, and these include the following disorders:

- Mesenteric lymphadenitis after a viral systemic infection.
- Gastroenteritis with mesenteric adenitis
- Pelvic inflammatory disease.
- Rupture of an ovarian follicle at the time of ovulation.
- Ectopic pregnancy. \(^{(1)}\)

Pain increases when pressure is put on the area (called the McBurney’s point), and the area becomes even more painful and tender when the pressure is released (rebound tenderness).

### 1.1.18 Complications

Most serious is rupture of the appendix which may lead to acute generalize peritonitis or to per appendicular abscess formation, if the site of rupture becomes sealed off by the blanketing action of the omentum.

Thrombosis of the mesoappendicular in value in the inflammatory process may lead to gangrenous appendicitis, some fibrous thickening of the appendix.

Especially in the sub mucosa, may lead to luminal stenosis and muslin accumulation, one form of mucocele may take place and produce local perpendicular mucin accumulation and inflammation, the condition known as pseudomyxom peritoneal. \(^{(8)}\)

### 1.1.19 Diagnosis of appendicitis

In general, the investigations are including:

- Leucocyte count: a mild polymorph leukocytosis is the rule.
- CT is increasingly being used to evaluate atypical presentation of appendicitis and its complication.
- Ultra sound of the RIF, in experienced hands, may be diagnostic. (4)

But it is mainly clinical and laboratory diagnosis cannot confirm it unless the appendectomy and histological examination were done.

1.2 Rationale:
Acute abdominal pain is one of the commonest presentations. There is wide differential diagnosis for this presentation ranging from myocardial infraction to ectopic pregnancy and including acute appendicitis. Most of this diagnoses can be verified by blood tests or radiological test but there is no diagnostic test for acute appendicitis other than the clinical features and surgery followed by the histopathology.

The need of the simple test arises to diagnose or even exclude acute appendicitis so as to decrease the incidence of unnecessary surgery with its accompanying morbidity and mortality and wasting of the health system resources.

CRP and TWBCs are inflammatory makers which are suggested to help in exclusion of acute appendicitis.

1.3 Objectives:
1.3.1 General Objective:
To assess the value of serum CRP level in patients with acute appendicitis.

1.3.2 Specific objective:
To correlate the concentration of the CRP to the diagnosis of acute appendicitis.
To correlate the level of serum CRP to the TWBCs in patients with acute appendicitis.
Chapter Two

2.1 Leukocyte count, C-reactive protein, alpha-1 acid glycoprotein and erythrocyte sedimentation rate in acute appendicitis

The diagnosis of acute appendicitis is clinical, but in some cases, it can present unusual symptoms. The diagnostic difficulties still lead surgeons to unnecessary laboratories, which reach rates from 15% to 40%. Laboratory exams, then, may become important to complement appendicitis diagnosis. The leucocyte count seems to be the most important value, but measurement of acute phase proteins, specially, the C-reactive protein, is object of several studies.\(^{(11)}\)

Appendectomy is one of the commonest procedures in surgery. In spite of various investigations used to improve the accuracy of diagnosis, the rate of normal appendices removed is still about 15-30%. Many studies have investigated the role of C-reactive protein (CRP) in acute appendicitis, but with conflicting results.\(^{(13)}\)

Leukocyte count, C-reactive protein, alpha-1 acid glycoprotein and erythrocyte sedimentation rate in acute appendicitis were measured in the study involving 63 patients submitted to appendectomies for acute appendicitis suspicion, in “Hospital das Clinical”, Federal University of Uberlândia, MG, Brazil.

The leucocyte count was altered in 74.6% of the cases and C-reactive protein elevation was observed in 88.9%. The alfa-1acid glycoprotein and the erythrocyte sedimentation rate were predominantly normal. The C-reactive protein was augmented in more than 80% of the cases in all ages. Leucocyte count and C-reactive protein were altered in 80% of the patients with the limit of 24 hours from the beginning of symptoms. With clinical evolution time superior than 24 hours, the leucocyte count was altered in 69.7% of the cases, whereas C-reactive protein was in 97% Sensitivity and specificity of the leucocyte count were 88.7% and 20% for the C-reactive protein, the values were, respectively, 88 9% and 10%. C-reactive protein presented more sensible in cases with more than 24 hours of evaluation (96.9%), although with no specificity. The Alfa-lacid glycoprotein and erythrocyte sedimentation rate presented low sensitivity and specificity.
The leucocyte count and the C-reactive protein were significantly altered in acute appendicitis cases, independent from gender or age interval. The leucocyte count and, mainly, the C-reactive protein must be considered in individuals with more than 24 hours of clinical evolution. Augmented values, as a matter of fact, should never substitute the doctor's clinical examination, but complement it. The erythrocyte sedimentation rate and the alfa-1 acid glycoprotein do not contribute to acute appendicitis diagnosis.\(^{(12)}\)

### 2.2 Predictive value of white blood cell count and C-reactive protein in children with appendicitis

Few studies have addressed the predictive value of white blood cells (WBCs) and C-reactive protein (CRP) at different cutoff values in appendicitis. The purpose was to determine the cutoff values for WBC and CRP at different periods during clinical evolution of appendicitis and to establish their use for the diagnosis of appendicitis and differentiation of simple from perforated appendicitis.

198 patients were operated on for appendicitis, which were further divided into 4 subgroups according to the time from the onset of symptoms to diagnosis. Receiver operating characteristic curves were constructed for CRP and WBCs the best cutoff points were used to calculate the sensitivity and specificity to discriminate patients with and without appendicitis and patients with simple and perforated appendicitis.

White blood cell and CRP individually and together had a high sensitivity to differentiate patients with and without appendicitis. The specificity of WBCs and CRP taken individually and together to differentiate patients with appendicitis was high, but the sensitivity was low.

White blood cell and CRP could be used to support the clinical diagnosis of appendicitis, and, depending on the time from the onset of symptoms to diagnosis, to differentiate patients with and without appendicitis and discriminate simple from perforated appendicitis.\(^{(13)}\)

### 2.3 CRP in acute appendicitis-is it a necessary investigation?

In a prospective, double blind study, blood for the measurement of serum C-reactive protein was collected pre-operatively from 192 children before going to the operating theatre for appendectomy. The histopathology was grouped into positive (acute appendicitis) and negative (normal appendix) and this was correlated with CRP values.
CRP was normal in 14 out of 33 negative explorations (normal appendix on histopathology). The specificity and sensitivity of serum CRP was 42% and 91% respectively. The predictive value of a positive (raised CRP) and negative (normal CRP) test is 88% and 48% respectively. It was concluded that neither raised nor normal CRP value is helpful in the diagnosis of acute appendicitis. CRP is not a good tool for helping the surgeon makes the diagnosis of appendicitis and it should not be measured in suspected appendicitis.\textsuperscript{(14)}

### 2.4 Predictive value of C-reactive protein at different cutoff levels in acute appendicitis.

was examined. Determining the different cutoff values of C-reactive protein on the basis of how long the patient’s symptoms were present can be used to early predict acute appendicitis. It was analyzed retrospectively from 2001 to 2004 the hospital records of 568 patients who underwent appendectomies for suspected appendicitis. Receiver operating characteristic analysis has shown that CRP measurement can increase the diagnostic accuracy in acute appendicitis. The cutoff values of CRP concentration taken as the first, second, and third days after onset of symptoms that distinguish acute appendicitis from other acute abdominal diseases were 1.5, 4.0, and 10.5 mg/dL, respectively; the values that distinguish perforated appendicitis from other acute abdominal diseases were 3.3 mg/dL (first day). 8.5 mg/dL (second day), and 12.0 mg/dL (third day).The different cutoff values of CRP concentration may serve as a useful predictive parameter in the early diagnosis of acute appendicitis on the first 3 days after the onset of symptoms.\textsuperscript{(15)}

### 2.5 The role of white cell count and C-reactive protein in the diagnosis of acute appendicitis

Despite recent advances in diagnostic medicine, the diagnosis of appendicitis is still doubtful in a number of cases. Majority of the clinicians rely on their clinical examination strengthened by the laboratory tests. This study was carried out to find out the specificity and sensitivity of white cell count (WBCs) and C - reactive protein (CRP) in diagnosing appendicitis in patients presenting with right iliac fossa pain.

A total of 259 patients were included in this study that presented in the hospital with acute right iliac fossa pain and later on operated and had appendectomy. The histopathology data was collected to find out the frequency of negative appendectomy. According to the histopathology reports these patients were grouped into three sub-groups as normal appendix, inflamed appendix
or perforated/gangrenous appendix. A record was kept of the WBCs and CRP levels of these patients on admission.

A total of 259 patients were included in this study and out of them 37 had a normal appendix giving an overall negative appendectomy rate of 14.3%. Out of these 11 were male and 26 were female, male to female ratio being 1:2:3. The age range was 12-73 with a median age of 24. Among the 222 patients who had appendicitis, 96 had a ruptured perforated appendix and 126 had an inflamed appendix. Overall the WBCs was elevated in 185 patients and CRP was elevated in 168 cases. The cutoff value for white cell count was $11 \times 10^6$/L. The C-reactive protein levels were calculated by immunoturbidimetric test and the cut off value was taken as 1.7 mg/dl. The sensitivity and specificity of WBCs in this study was 83% and 62.1% and that for CRP was 75.6% and 83.7%.

Both the inflammatory markers i.e. WBCs and C-reactive protein can be helpful in the diagnosis, when measured together as this increases their positive predictive value.\(^{(15)}\)
Chapter Three

3 Materials and methods

3.1 Study design
This is the cross sectional analytical study.

3.2 Study duration
The study was performed during the period between May and October 2015.

3.3 Study areas
The study was conducted in Al Alahli Hospital Abu Dhabi-UAE.

3.4 Study population
Ninety patients diagnosed clinically by the surgeon as acute appendicitis and on whom appendectomy was done. 40 healthy individuals matching in age and sex were included as controls.

3.5 Data collections
A questionnaire was used to collect needed information from population.

3.6 Exclusion criteria:
Any inflammation or acute illness other than acute appendicitis.

3.7 Ethical considerations
Permission for this study was obtained from local authorities. The objectives were explained to all individuals participating in the study and informed consent was taken from the study population.

3.8 Sample collection
Venous blood were collected in plain containers 2.5 ml, allowed to clot and immediately centrifuged, at 3000R/M for 5 minutes. Separated serum was stored until analyzed at 25°C. EDTA container for WBCs count.

3.9 Reagent sof CRP
Kit contents:
- Test device: plastic device containing a membrane coated with monoclonal anti-CRP antibodies.
- R₁/ dilution liquid, borate buffer (phg.0) and detergents.
- R₂/ conjugate: solution containing monoclonal anti-CRP antibodies labeled with ultra-small gold particles.
- R₃ / washing solution: phosphate buffered NaCl solution (PH7.4) and detergents. (see appendix)

3.10 Principle
The following techniques used for measuring serum or plasma CRP. Nycocard CRP single test is solid phase, sandwich- formatted immunometric assay it was used to measure the concentration of CRP in mg/dL.
In the test well of the device there is a membrane coated with immobilized CRP-specific monoclonal antibodies.
A diluted sample is applied to the test device. When the sample flows through the membrane, the C-reactive proteins are captured by the antibodies. CRP trapped on the membrane will then bind the gold- antibody conjugate added, in a sandwich- type reaction; unbound conjugate is removed from the membrane by the washing solution. PAPERLYE underneath the membrane absorbs excess liquid. In the presence of a pathological level of CRP in the sample, the membrane appears red-brown with color intensity proportional to the CRP concentration of the sample. The color intensity is measured quantitatively with the Nycocard READER 11 serial No. 61844. (see appendix)

3.11 Procedure
- Sample was Diluted.
- 5 µL capillary with patient sample or control, and drop the capillary in to the tube with R₁/ dilution liquid.
- 50 µL diluted sample or diluted control to the test device. Allowed the sample to soak in to the membrane (approx. 30 seconds).
- One drop R₂ / conjugated to the test device, allow the reagent to the soak in to the membrane (approx. 30 seconds).
- One drop R₃/washing solution to the STD/ test device allowed reagent to the soak into the membrane (approx. 20 seconds).
- The result with in 5 minutes using the Nycocard, READER. (see appendix)

3.12 Principle of sysmex
The sysmex KX-21N serial No. (B7853) is an automatic multi parameter blood cell counter for in vitro diagnostic use.
Which have employs three detector blocks and two kinds of reagents for blood analysis.
The WBCs count was measure by the WBCs detector block using direct current detection method.
The result was displayed in LCD. \(^{(16)}\)

3.13 Method of sysmex
50 \(\mu\)l of the sample was taken by needle (420 mm width-355 mm depth) and the result displayed on LCD screen within 50 second

3.14 Calculation:
Calculation was done by the instrument (Nycocard READER) digitally and expressed by mg/L as international units with the 10 mg/dL cutoff value.

3.15 Data processing and analysis:
Data was analyzed by the computer program of SPSS.

3.16 Quality control:
The quality control program applied by two commercial control material one normal and another pathological were run with each batch.
Chapter Four

4. Result

Table (4.1) show age of the cases in study population 43.3% of patient between 10 – 20 years, 26.7% between 21 – 30 years and 30% between 31 – 40 years.

Table (4.2) show mean of age in cases and control in study population. Mean of age in cases is 24 years and control 25 years.

Table (4.3) show gender of the cases. Were is males is representing about 66.7% of the study population. And the females about 33.3% of study population.

Table (4.4) show mean of CRP (mg/dL) in cases and controls in study population. Mean of CRP in cases is 16.9% mg/dL and control is 2.5 mg/dL.

Table (4.5) show mean of TWBCs (Cu/mml) in cases and control in study population. Mean of TWBCs in cases is 12330 cu/mml and control is 5420 cu/mml.

**Table (4.1) show age distribution of the study population**

<table>
<thead>
<tr>
<th>Age</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 – 20</td>
<td>39</td>
<td>43.3</td>
</tr>
<tr>
<td>21 – 30</td>
<td>24</td>
<td>26.7</td>
</tr>
<tr>
<td>31 – 40</td>
<td>27</td>
<td>30.0</td>
</tr>
<tr>
<td>Total</td>
<td>90</td>
<td>100.0</td>
</tr>
</tbody>
</table>
Fig. (4.1) show age distribution of the cases in study population

Table (4.2) show mean of age in cases and controls in the study population

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cases</td>
<td>90</td>
<td>24</td>
<td>8</td>
</tr>
<tr>
<td>Control</td>
<td>40</td>
<td>25</td>
<td>7</td>
</tr>
</tbody>
</table>
Fig. (4.2) show mean of age in cases and control in study population

Table (4.3) show gender distribution of the cases in study population

<table>
<thead>
<tr>
<th>Gender</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>60</td>
<td>66.7</td>
</tr>
<tr>
<td>Female</td>
<td>30</td>
<td>33.3</td>
</tr>
<tr>
<td>Total</td>
<td>90</td>
<td>100.0</td>
</tr>
</tbody>
</table>
Fig. (4.3) show gender distribution of the cases in study population

Fig. (4.4) show mean of CRP (mg/dL) in cases and controls in study population

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>P.V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cases</td>
<td>90</td>
<td>17</td>
<td>6</td>
<td>0.01</td>
</tr>
<tr>
<td>Control</td>
<td>40</td>
<td>3</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>
* P. value less than 0.05 is significant.

Fig. (4.4) show mean of CRP (mg/dL) in cases and controls in study population

Fig. (4.5) show mean of TWBCs (Cu/mml) in cases and control in study population

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>P.V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cases</td>
<td>90</td>
<td>12330</td>
<td>13</td>
<td>0.6</td>
</tr>
<tr>
<td>Control</td>
<td>40</td>
<td>5420</td>
<td>11</td>
<td></td>
</tr>
</tbody>
</table>

* P. value more than 0.5 . by conventional criteria this difference is consider to be extremely no significant.
Fig. (4.5) show mean of TWBCs (Cu/mml) in cases and control in study population

4.1 Discussion:

The present study was designed to assess the concentration of C-reactive in proteins diagnosed with acute appendicitis and its relation with the WBCs. This is study was conducted in Alahli Hospital Abu Dhabi-UAE. Evaluation was obtained through performing CRP test and TWBCs on the venous blood samples of 90 patients and 40 healthy controls.

This study found that the age has no apparent effect on the C-reactive protein concentration according to table (4.1), (4.2).

According to tables (4.4), (4.5) it is found that CRP is significantly elevated in patients in appendicitis and was no significant in TWBs in the study population. This agrees with the study of Wu, Lin, Chang, Chang, Huang. And Khan, Dave, Irshad.
Chapter Five

5. Conclusion and Recommendations

5.1 Conclusion:
This study concluded that:
1. The age has no apparent effect upon the C-reactive protein concentration.
2. There was significant elevation of CRP in patients with acute appendicitis.
3. There was no significant elevation of TWBCs above the normal level in patients with acute appendicitis.
4. The CRP is more accurate in the diagnoses of appendicitis than TWBC

5.1 Recommendations:
1. CRP can be used to exclude patients without acute inflammation of appendix.
2. Larger studies can be used to evaluate the role of the CRP in exclusion of cases without acute appendicitis and evaluation of patients undergoing appendectomy by histopathology.
References

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Department of Emergency Medicine, Changhua Christian Hospital, Changhua, Taiwan.
NK: natural killer; eNOS: endothelial nitric oxide synthase; iNOS: inducible nitric oxide synthase; COX: cyclo-oxygenase.
Acute appendicitis
Acute appendicitis (Histological)
Acute appendicitis