A PROSPECTIVE RANDOMIZED COMPARATIVE STUDY OF LAPAROSCOPIC APPENDICECTOMY VERSUS OPEN APPENDICECTOMY IN HOSPITAL UNIVERSITI SAINS MALAYSIA.

BY

DR BHOMA ANAND PRAKASH. (MBBS)

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IV. LIST OF ABBREVIATIONS.

1	BMI	Body Mass Index
2	CT	Computerised Tomographic scan
3	HPE	Histopathological Examination
4	HUSM	Hospital Universiti Sains Malaysia
5	Kg	Kilogram
6	LA	Laparoscopic Appendicectomy
7	OA	Open Appendicectomy

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VII. ABSTRAK

Tajuk : Kajian Perbandingan Jangkaan Secara Rawak Apendisektomi Laparoskopi (LA) Dengan Apendisektomi Terbuka (OA) Di Hospital Universiti Sains Malaysia.

Latarbelakang : Sejak K. Semm menunjukkan demonstrasi apendektomi laparoskopi pada tahun 1983, pembedahan ini telah dilakukan di seluruh dunia walaupun ianya banyak dikritik. Apendektomi terbuka pula adalah satu prosedur rutin tetapi ia dengan pastinya telah dikaitkan dengan morbidity. Ianya boleh menyebabkan kesukaran untuk menuntukan kesahiatan yang tidak dapat di kenalpasti pada awalnya. Pada masa ini apendektomi laparoskopi telah menjadi satu prosedur pembedahan yang standard di Hospital Universiti Sains Malaysia, tetapi kajian jangkaan secara rawak untuk membandingkan berbagai parameter di antara apendektomi laparoskopi dan apendektomi terbuka adalah sangat kurang.

Objektif : Untuk membandingkan berbagai masa pembedahan, komplikasi dan hasil di antara apendektomi laparoskopi dan apendektomi terbuka di Hospital Universiti Sains Malaysia.

Rekabentuk : Kajian perbandingan jangkaan secara rawak.

Keputusan : Kajian ini berjalan daripada February 2006 hinga November 2006. Seramai 97 orang pesakit telah dipilih secara rawak. Seramai 53 orang pesakit telah menjalani apendektomi terbuka (OA) manakala 44 lagi telah menjalani apendektomi laparoskopi (LA). Seramai 54.6% pesakit adalah lelaki dan 45.4% pula adalah perempuan (P=0.2).

Median umur subjek dalam kumpulan apendektomi laparoskopi dan apendektomi terbuka pula adalah 18 tahun dan 20 tahun. Purata Indeks Jisim Badan (Body Mass Index / BMI) untuk kedua-dua kumpulan adalah sama ($22kg/m^2$). Pesakit dalam kumpulan apendektomi laparoskopi terpaksa menunggu lebih lama untuk menjalani apendektomi jika dibandingkan dengan kumpulan apendektomi terbuka iaitu 22 jam dibandingkan dengan 15.8 jam (P=0.04). Tiada perbezaan masa pembedahan untuk kedua-dua kumpulan iaitu 70.2 minit. Pesakit-pesakit dalam kumpulan apendektomi laparoskopi boleh mula mengambil diet yang normal dengan lebih awal iaitu 36.6 jam dibandingkan dengan 55.4 jam dalam kumpulan pesakit apendektomi terbuka (P=0.05), dan mereka dibenarkan pulang ke rumah sehari lebih awal jika dibandingkan dengan kumpulan apendektomi terbuka iaitu 2.4 hari dibandingkan dengan 3.6 hari (P=0.2). Lapan orang pesakit dari kumpulan yang menjalani apendektomi laparoskopi telah ditukarkan kepada apendektomi terbuka (18.1%). Apendisitis akut adalah penemuan intra-operatif yang paling paling tinggi iaitu (72.2%) diikuti oleh apendisitis yang bocor (20.6%). Dalam kajian ini, kadar keseluruhan apendektomi negatif ialah 3.1%. Kadar jangkitan pada luka dalam kumpulan apendektomi terbuka ialah 7.5% jika dibandingkan dengan 2.8% untuk kumpulan apendektomi laparoskopi.

Kesimpulan : Keputusan ujian rawak ini tidak menyokong konsep bahawa apendektomi laparoskopi adalah prosedur yang memerlukan masa yang panjang jika dibandingkan dengan apendektomi terbuka.. Oleh itu, persepsi apendektomi laparoskopi memerlukan masa yang panjang patut dielakkan. Pesakit-pesakit dalam kumpulan apendektomi laparoskopi mengalami proses pemulihan fungsi usus yang lebih cepat, jangkamasa tinggal di hospital selepas pembedahan yang lebih pendek dan kadar jangkitan luka yang rendah jika dibandingkan dengan apendektomi terbuka. Apendisitis yang bocor

dan bergangren juga boleh dirawat melalui kaedah apendektomi laparoskopi dan kajian ini menunjukkan ianya tidak kontraindikasi. Laparoskopi diagnostik patut dipertimbangkan untuk wanita dalam lingkungan umur reproduktif yang diagnosisnya tidak dapat kenalpasti.

VIII. ABSTRACT

Title: Prospective randomized comparative study of laparoscopic appendicectomy (LA) versus open appendicectomy (OA) in Hospital Universiti Sains Malaysia.

Background: Since the demonstration of laparoscopic appendicectomy by K. Semm in 1983, it is performed worldwide though criticized by many. Open appendicectomy is a brief procedure but is definitely associated with morbidity and can cause difficulty in uncertain diagnosis. Laparoscopic appendicectomy has been a standard surgical procedure performed in Hospital Universiti Sains Malaysia, but a prospective randomized study comparing various parameters in between LA and OA has not been done before.

Objectives: To compare various surgical times, complications and outcomes in between LA and OA in HUSM.

Design: Prospective randomized comparative study.

Results: This study was conducted in Hospital Universiti Sains Malaysia from February 2006 till November 2006. Total of 97 patients were randomized in the study. Amongst them, 53 patients underwent open appendicectomy (OA) and 44 patients underwent laparoscopic appendicectomy (LA). In the study, 54.6% patients were males and 45.4% were females (P = 0.2). The median age in LA and OA groups was 18 and 20 years respectively. The mean Body Mass Index (BMI) in both groups was same. ($22kg/m^2$) Patients in LA group had to wait longer for appendicectomy compared with OA group

and it was 22.2 hours versus 15.8 hours (P = 0.04). The operating time for laparoscopic appendicectomy group as well as for open appendicectomy group was similar (70.2 minutes). Patients in LA group tolerated normal diet significantly earlier (36.6 hours versus 55.4 hours, P = 0.05) and were discharged earlier compared to OA group (2.4 days versus 3.6 days, P=0.2). Eight patients in the laparoscopic group were converted to OA, intra-operatively (18.1%). Acute appendicitis was the commonest intra-operative finding (72.2%) followed by perforated appendicitis (20.6%). Wound infection rate in OA group was 7.5% compared to 2.8% in LA group. The overall negative appendicectomy rate was 3.1% in the study.

Conclusion: The results of this prospective randomized comparative study disapproves the concept that laparoscopic appendicectomy is a prolonged procedure, when compared to open appendicectomy. So the perception that laparoscopic appendicectomy is a prolonged procedure should be avoided. There is early return of bowel function, shorter post operative hospital stay, less pain and lower wound infection rate after laparoscopic appendicectomy when compared to open appendicectomy. Perforated and gangrenous appendicitis can also be handled by laparoscopic appendicectomy safely and are not the contraindications for laparoscopic appendicectomy. Diagnostic laparoscopy should be considered among females in reproductive age group with uncertain diagnosis.

1. INTRODUCTION

The role of laparoscopy in management of cholelithiasis is well established, but its impact on the management of acute appendicitis need to be objectively defined and compared to the conventional method (Cueto *et al.*, 2006, Vallina *et al.*, 1993). Advantages of laparoscopic appendicectomy over open appendicectomy were questioned as recovery from open appendicectomy was brief (Frazee *et al.*, 1994).

Laparoscopic appendicectomy was explored by many authors, who showed many significant benefits of the procedure such as early intake of normal diet, short post-operative hospital stay, reduced pain and earlier return to normal activity. Diagnostic accuracy of laparoscopic appendicectomy in female patients in reproductive age group was specially stressed in many studies and considered as a safe procedure (Marzouk *et al.*, 2003, Minne *et al.*, 1997, Wang *et al.*, 2006, Yagmurlu *et al.*, 2006).

On the other hand studies done, stressed the issue of cost involved in laparoscopic appendicectomy. Few authors were against laparoscopic appendicectomy (Vernon *et al.*, 2004), while others favoured it (Long *et al.*, 2001). Laparoscopic appendicectomy was associated with local interstitial infection due to carbon dioxide pneumoperitoneum and produced mesothelial damage, local thermal effects due to energized systems (Serour *et al.*, 2005). Early discharge after open appendicectomy was demonstrated and laparoscopy was not recommended for routine appendicectomy in men (Mutter *et al.*, 1996, Lord and Sloane, 1996).

Laparoscopic appendicectomy is performed as a routine procedure in Hospital Universiti Sains Malaysia, but the benefits need to be evaluated statistically. The

objective of this prospective randomized study was to compare laparoscopic appendicectomy with open appendicectomy, with respect to various parameters for determining the best method of treating patients with acute appendicitis.

2. LITTERATURE REVIEW

Evolution of endoscopies and laparoscopic surgery was gradual. The history of endoscopies dates back to 460 - 375 BC when Hippocrates in Greece made first reference of rectal speculum for examining hemorrhoids. This evolution went through Abulkasim (1012 – 1013 AD), an Arab who used mirror to reflect light, and Phillip Bozzini (1773-1890) who developed " Lichtleiter ", a light conductor made up of candle light and a tube as an endoscope, to avoid the problem of inadequate illumination during early endoscopies (Brett and Karen, 1998).

During subsequent development, Antoine Jean Desormeaux made the first cystoscope in 1853 and Nitze added a lens to it in 1877. The initial clinical use of laparoscope was made by Heinz Kalk who added 135 degree lens system to the scope and used them to diagnose liver and gallbladder diseases. The spring-loaded needle invented by Janos Veress to drain ascitis, fluid and air from chest was used to create pneumoperitoneum during laparoscopic surgery. Kurt Semm, the German gynaecologist invented the automatic insufflator for pneumoperitoneum and was the first to perform laparoscopic appendicectomy in 1983 (Brett and Karen, 1998).

Reiertsen and Trondsen (1994) in a randomized trial concluded that laparoscopic appendicectomy was at least as good as conventional appendicectomy and laparoscopy reduced the rate of misdiagnosis (Reiertsen and Trondsen, 1994). In a study, Tucker (2002), concluded that laparoscopic appendicectomy was a safe procedure with low morbidity and proven to be advantageous in obese patients, in patients with unusual position of appendix and had low a infection rate (Tucker *et al.*, 2002).

Chung (1999) in a meta-analysis stated that laparoscopic appendicectomy offered reduce post-operative pain, wound infection rate and faster convalescence but stated that it was a prolonged procedure (Chung *et al.*, 1999). Pederson A.G. (2001) in a randomized controlled trial demonstrated that laparoscopic appendicectomy had fewer wound infections rate, faster recovery, early return to work and improved cosmesis (Pedersen *et al.*, 2001).

A prospective randomized trial stated that laparoscopic and open appendicectomy are comparable in terms of complications, post-operative pain and hospitalization but open appendicectomy had shorter operative time, lesser charges for operating room and hospital. Laparoscopic appendicectomy did not offer any proved benefits compared with open approach for patients with acute appendicitis (Minne *et al.*, 1997).

2.1 PNEUMOPERITONEUM FOR LAPAROSCOPIC SURGERY

2.1.1 CREATION OF PNEUMOPERITONEUM

With the introduction of laparoscopic surgery and its widespread use and popularity in the 80's, surgeons and anaesthetist were more interested in the pathophysiological changes and complication of pneumoperitoneum. In view of surgeons performing more complex operation laparoscopically nowadays, the physiological changes when patient subjected to pneumoperitoneum were investigated (Schirmer *et al.*, 1992). Pneumoperitoneum for laparoscopic procedure is created by two methods:

- Close or "Veress" method

Described by Janos Veress of Hungary in 1938, this method consisted of creating pneumoperitoneum by using a Veress needle. The needle has a blunt tip and consist of a spring-loaded obturator that retracts once penetrated the fascia and peritoneum. The needle is inserted at the umbilicus and once entered the peritoneal cavity, proper insertion is confirmed by saline drop test whereby there is free flow of normal saline through the needle and no backflow on aspiration using a syringe. Another way to test the proper insertion of the needle is when connected to the insuffulator the pressure reading should be less than 5mmHg (Brett and Karen, 1998).

- Open or "Hasson" method

This technique comprise of direct sub-umbilical cut down and visualization of midline fascia. A small skin incision is given at the sub-umbilical level; dissection done in

cavity. The advantages of open method are minimal gas leak, low risk of bleeding and infection, reduce risk of infiltration of gas in the subcutaneous plane (Williamson and Kirk, 2002).

2.1.2 TYPES OF GASES FOR PNEUMOPERITONEUM

In the past ambient air was used which proved to be inconvenient because it was highly irritant to peritoneum. Air and oxygen present in air, put the patient at risk of embolism and the possibility of thermal lesion with electrocautery (Berci, 1998). Nitrous oxide had fewer case of arrhythmia as compared to carbon dioxide and its anaesthetic property reduced discomfort of abdominal distension during pneumoperitoneum. Despite the advantages, its use was obsolete because of its rapid and uncontrolled absorption into the blood stream causing cerebral oedema. Another disadvantage was inability to use nitrous oxide in case of colonic perforation where methane gas is released. Theoretically, methane in combination and an oxidizing agent like nitrous oxide with a spark from electrocautery can cause explosion. Helium, an inert gas, was also used in some procedures (Brett and Karen, 1998).

Carbon dioxide has become the gas of choice for pneumoperitoneum because it is readily available, inexpensive, easily absorbed into the bloodstream and patient had minimal risk of air embolism. The effect of carbon dioxide on blood pH can be measured by capnography and can be manipulated by anaesthetist at any given time by changing the ventilatory rate. It is not inflammable and electrocautery can be used safely (Chang and Rege, 2004).

2.1.3 INSUFFLATOR

In the beginning of the twentieth century, diagnostic laparoscopy was performed by introducing air into peritoneal cavity using a syringe. In current practice, high flow automatic insufflators are available that can pump gas at the rate of 15-20 litres/minute and allow a constant abdominal distension. The insufflator pressure is usually set to a maximum intra-abdominal pressure of 15 mmHg and a gas flow rate of 1-2 litres/minute for insertion of trocars. An intra-abdominal pressure of 8-12 mmHg is required to carry out surgical procedure to reduce cardio-pulmonary side effects to a minimum (Brett and Karen, 1998).

Gas leaks during the procedures can be diagnosed as sudden blurring of the visual field during the procedure, collapse of the abdominal wall and a drop of the intra-abdominal pressure seen on the insufflator's monitor. The leak is commonly found between skin incision and the trocar and can be closed with a purse string suture with silk. The other methods to prevent air leaks are by using a screw-type adaptors for the trocar sheath or a balloon tip trocar. At the end of the procedure, pneumoperitoneum is evacuated by opening one of the valves of the trocar and complete evacuation is ensured to avoid postoperative shoulder tip discomfort and abdominal distension. The trocars are removed under direct vision to avoid herniation of the omentum or intestine into the incision site, and at the same time bleeding along the tract can be noted (Najmaldin and Guillou, 1998, Cueto-Garcia and Vazquez-Frias, 2003).

2.1.4 PATHOPHYSIOLOGICAL EFFECTS OF PNEUMOPERITONEUM

Pathophysiological effects of pneumoperitoneum are a combination of mechanical effects of increased intra-abdominal pressure, chemical effects due to carbon dioxide, and changes in the body due to patient positioning (Holthausen *et al.*, 1999).

2.1.4(a) EFFECTS ON PULMONARY SYSTEM

Insufflation of peritoneal cavity with carbon dioxide increases intra-abdominal pressure and volume that impedes diaphragmatic excursions. Peak airway pressure is increased whereas vital capacity and lung compliance are reduced. Trendelenberg position given for better visualization of pelvis, cause a further upward displacement of diaphragm, hence compressing bibasilar lung segments and reduce functional residual capacity, increasing alveolar dead space (Brett and Karen, 1998).

Carbon dioxide (CO_2) absorbed from the peritoneal cavity can increase as much as 50% carbon dioxide to lungs compared with normal situation. In patients with lung disease, CO_2 exchange across alveoli is impaired can cause serum CO_2 level to rise and hence overload serum bicarbonate buffer system. Septicaemic patients with perforated appendicitis have a high metabolic and cellular respiratory rate, those with chronic obstructive airway disease with large ventilatory dead space and impaired regional blood flow as well as patients with poor cardiac output, are all at high risk of metabolic acidosis during laparoscopic surgery. Close monitoring of endotracheal CO_2 and pH is necessary during laparoscopic surgery (Chang and Rege, 2004).

Carbon dioxide is highly diffusible and soluble in blood, metabolised quickly through respiration and 100 ml/min can be injected directly into the blood stream without

significant metabolic changes. The anaesthetist is able to adjust the minute ventilation to clear the excess of carbon dioxide from the blood stream during procedure. Uncontrolled absorption of CO_2 through the peritoneum or the subcutaneous tissue can cause hypercarbia and acidosis therefore capnographic monitoring is essential during all laparoscopic procedures to avoid extreme changes in blood pH. Minute ventilation must be increased when the partial pressure of carbon dioxide is more than 40 mmHg (Brett and Karen, 1998, Cueto-Garcia and Vazquez-Frias, 2003). During laparoscopic surgery, post-operative pain may be less and less respiratory embarrassment compared to open surgery. Studies had shown smaller decrement in lung function tests in patients undergoing laparoscopic surgery compared with open surgery with lower incidence of atelectasis and improved oxygenation (Chang and Rege, 2004).

2.1.4(b) EFFECTS ON CARDIOVASCULAR SYSTEM

Pneumoperitoneum can cause either increase in preload and augment cardiac output or increase after load and reduce cardiac output and increase cardiac workload. The effects of pneumoperitoneum on cardiac output depend on the volume status, autonomic response, and cardiac reserve of the patient. These effects are well tolerated by normal individual (Brett and Karen, 1998).

Animal studies had shown that intra-peritoneal pressure of 40 mmHg results in 53% reduction in cardiac output in hypovolemic subjects, 17% reduction in normovolemics and 50% increase in hypervolemic subjects (Brett and Karen, 1998). Trans-oesophageal echocardiography had shown 45% increase in two-dimensional area of the ventricles in healthy women after 10 mmHg pressure increase (Chough and Andrus, 1998).

Pneumoperitoneum as well as Trendelenberg position cause increase in central venous pressure, cardiac work pressure and mean arterial pressure. Pneumoperitoneum, in

addition, causes increase in systemic vascular resistance and decrease in left ventricular stroke volume and cardiac index. Hypercarbia due to carbon dioxide causes vasodilatation and myocardial depression and can result in hypotension. In patients with poor cardiac function, pneumoperitoneum can cause significant reduction in cardiac output with increased systemic vascular resistance. Decompensation of the cardiac function does not return to normal immediately and these patients are at increased risk of myocardial infarction during and immediately after laparoscopic surgery (Sauerland, 2006).

2.1.4(c) EFFECTS ON RENAL SYSTEM

Effect of pneumoperitoneum on renal blood flow is dependent on volume status of the patient. Randomized studies have demonstrated decrease in urine output with pneumoperitoneum compared with open surgery or gasless laparoscopic surgery. Increase intra-abdominal pressure reduces renal cortical blood flow and reduces urine output. Vasoconstriction due to renin-angiotensin-aldosterone mechanism activated by pneumoperitoneum is also responsible for decrease urine output. It is complicated further by reduced cardiac output (Holthausen *et al.*, 1999).

2.1.4(d) EFFECTS ON GASTROINTESTINAL SYSTEM

Surgical trauma associated with laparoscopic surgery is less when compared to open surgery. There is less sympathetic activity and earlier return of bowel function. This is due to attenuation of elevation of inhibitory neurotransmitter substances in intrinsic gut nervous system. Increased intraabdominal pressure can also cause reduction in blood

supply to stomach, jejunum, colon and liver that may cause intestinal ischaemia in patients with pre-existing intestinal vascular disease (Chough and Andrus, 1998).

2.1.4(e) EFFECTS ON COAGULATION FUNCTION

Coagulation system is less activated by laparoscopic surgery with less reduction in Antithrombin III and protein C compared to open surgery. The increment in D-Dimer level is less. However, increase in intraabdominal pressure can cause venous stasis in lower extremity and increase risk of thrombosis. Pulmonary embolism post laparoscopic appendicectomy has been documented (Cox *et al.*, 1996).

2.1.4(f) HORMONAL CHANGES

Studies have demonstrated that there is a reduction in the level of β-endorphin and IL-6 in laparoscopic surgery as compared to open surgery. With laparoscopic surgery the serum cortisol, renin levels are unaffected. Experiments showed an increase in serum arginine and vasopressin with insufflation during pneumoperitoneum (Chough and Andrus, 1998)

2.1.4(g) EFFECTS ON IMMUNE SYSTEM

Laparoscopic surgery causes less immunosupression when compared to open surgery, assessed by delayed type of hypersensitivity reaction. C Reactive protein level is also significantly lower after laparoscopic surgery as compared to open surgery that suggest less operative trauma (Chough and Andrus 1998)

2.1.4(h) OTHER EFFECTS

Animal studies demonstrated a decrease in carotid blood flow and an increase in intracranial pressure following pneumoperitoneum, knowing this possibility suggest that diagnostic laparoscopy in patient with head injury can be detrimental (Brett and Karen, 1998).

2.1.5 GENERAL COMPLICATION OF PNEUMOPERITONEUM

Apart from specific systemic complication, there are also general complications associated with creation of pneumoperitoneum. During trocar insertion there can be injury to solid organs causing bleeding, vascular injury, perforation of bowels, injury to the urinary bladder or uterus. There can be port site hernia or wound infection. Gas insuffulation might cause pneumothorax, pneumomediatinum, gas embolism and subcutaneous emphysema (Kevin *et al.*, 2004).

2.1 APPENDICITIS

2.2.1 HISTORY

Although appendicitis has been a common problem for centuries, it was not until 19th century, that the appendix was recognised as an organ capable of causing disease. The first recorded appendicectomy was performed in 1736, by Claudius Amyand, surgeon to Westminster and St. George Hospital. He performed appendicectomy on an 11 years old boy who had right scrotal hernia with a fistula. The appendix was within the srotum and perforated by a pin. In 1755, Heister, while performing autopsy on the body of a criminal, recognized that appendix might be site for primary inflammation. Subsequently in 1824, Loyer-Villermany presented a paper titled "Observations of Use in Inflammatory Conditions of Caecal Appendix", at Royal Academy of Medicine in Paris. In his autopsy observations, he found that appendix was black and gangrenous while caecum was scarcely involved (Berci, 1998).

In 1827, Melier described several autopsy cases of acute appendicitis and pointed that appendix was the etiological factor responsible for the right lower quadrant inflammation but this theory was strongly opposed by Dupuytren, the most powerful and eminent surgeon at that time. The major set back in the progress of understanding appendicitis was in 1835, when Dupuytren developed the concept of inflammation arising in the cellular tissue surrounding the caecum as the cause of right lower quadrant pain, and Goldbeck coined the term " perityphlitis". Due to this concept the theory of 'appendix as the cause of right lower quadrant pain' by Melier did not get widespread acceptance (Kevin *et al.*, 2004).

During the same time, research continued in Britain and Germany. A number of publications was produced, stating appendix as a potential source of disease. In 1880,

Matterstock and With published papers clearly suggested the appendix as a significant cause of right iliac fossa inflammation. It was the turning point in 1886 when Reginald Fitz from Boston made a landmark contribution by discussing appendix as Primary cause of right lower quadrant inflammation and coined the term "Appendicitis". He also recommended early surgical treatment of the disease. During that time, with widespread availability of anaesthesia and aseptic techniques, Fitz recommendations was rapidly brought into practice but operative intervention was done well after the disease had established. The primary goal of the intervention was to drain the infection (Berci, 1998).

The credit for the first published account of appendicectomy went to Kronlein in 1886 despite the patient died two days later. In 1887, Morton of Philadelphia successfully diagnosed and excised acutely inflamed appendix within an abscess cavity.

Chester McBurney from New York, in 1889 described the migratory pain of acute appendicitis and demonstrated finger point localization of pain at a point over right iliac fossa, today known as McBurney's point. McBurney along with McArthur, in 1894, first described the muscle-splitting right lower quadrant incision for removal of inflamed appendix. Despite these marked success in treatment of appendicitis, the mortality associated with the treatment was high. With the beginning of antibiotic era, and discovery of penicillin, in 1940, the mortality rate for appendicitis dropped to less than 2% (Kevin *et al.*, 2004).

2.2.2 INCIDENCE

The incidence of acute appendicitis is variable in different studies conducted. Pieper and Kager estimated a yearly incidence of 1.33 cases per thousand of male population and 0.99 per thousand of female population (Pieper and Kager, 1982). Noer had reported a decline in the incidence of acute appendicitis from 1.3 per thousand to 0.5 per thousand over a period of 30 years (Noer, 1975). Burgess and Done in a study conducted over 15 years showed that there was more than 50% reduction in number of appendicectomies. Acute appendicitis was most frequently observed in North America, British Isles, Australia, New Zealand and among white South Africans. It is less common in Asia, Central Africa (Steele, 2002).

2.2.3 AETIOLOGY

The exact aetiology of acute appendicitis is unknown however, diet had significant influence on aetiology. It is more common in meat-eating white races and relatively rare in races habitually living on bulk cellulose diet, suggesting protective role of high fibre diet (Steele, 2002). Higher incidence of appendicitis in urban areas compared with rural areas are attributed to high incidence of enteric infections related to crowed living conditions (Ellis and Nathanson, 1997) Other rare causes of acute appendicitis are carcinoma caecum and parasitic infestation (O'Connell, 2000).

Nevertheless, the overall incidence of appendicitis is declining which coincides with improvement in domestic and food hygiene. In elderly patients, chronic use of non-steroidal anti-inflammatory drugs is associated with increased incidence of acute appendicitis. Acute appendicitis may have familial tendency explained by inherited malformations of the organ as well as incidence of large number of cases in the same family (Steele, 2002).

2.2.4 PATHOPHYSIOLOGY

Appendicitis is related to obstruction of the lumen due to lymphoid hyperplasia, faecolith or foreign body. This leads to bacterial overgrowth and continued mucous secretion causing distension and an increased intra-luminal pressure. With lymphatic and venous obstruction along with bacterial overgrowth and wall oedema, acute inflammatory response ensues. Necrosis of the appendiceal wall causes translocation of bacteria and ultimately appendix perforates and causing spillage of the contents into the peritoneal cavity. If this sequence of events occurs slowly, the appendix is contained by inflammatory response and omentum leading to localised peritonitis or appendicular mass and abscess formation. In an event when the body does not wall off this process, patient develops generalised peritonitis (Kevin *et al.*, 2004). In rare instances in elderly patients carcinoma caecum can block lumen of appenix producing acute appendicitis. Intestinal parasites can produce acute appendicitis similarly by blocking the lumen of appendix (O'Connell, 2000).

2.2.5 PATHOLOGY

Acute appendicitis is a non-specific infection. Since 1938, Altemeier had demonstrated polymicrobial nature of perforated appendicitis. The normal colonic flora consists of facultative, aerobic and anaerobic bacteria. These are *Escherichia coli, Viridans streptococci, Pseudomonas aeruginosa*, Group D streptococci, *Enterococcus* species. The anaerobic bacteria are *Bacteroides fragilis, Peptostreptococcus micros, Clostridium perfringes, Bilophila* species, *Lactobacillus* and *Fusobacterium* species. Routine peritoneal culture in patients with acute appendicitis is not recommended as the flora are generally known, and the results are not available for several days and mostly no change

in the treatment plan is done despite the culture results. Cultures are helpful in patients with persistent intra-abdominal infection or surgical site infection (Kevin *et al.*, 2004).

Acute appendicitis can be acute catarrhal appendicitis or acute obstructive appendicitis. Catarrhal appendicitis consists of mucosal and sub-mucosal inflammation. The mucosa is thickened, oedematous and reddened, with dark brownish infarcts and ulcerations. The appendix becomes swollen, turgid and the serosa looses its sheen. It is usually coated with fibrinous exudates. Conservative management during the acute inflammatory process may lead to adhesion formation and kinking of the appendix, subsequently there can be recurrent episodes of acute appendicitis of obstructive type (Ellis and Nathanson, 1997).

Acute appendicitis of obstructive type occurs when the lumen of appendix is occluded by faecolith or hyperplastic lymphoid tissue in acute catarrhal appendicitis. If the lumen of the appendix distal to the obstruction is empty, appendix distends with mucous and forms a mucocele. Proliferation of bacteria in stagnant mucous, along with the pressure atrophy of the mucosa causes translocation of the bacteria into the wall of the appendix. Subsequetly there is thrombosis of the blood vessels supplying appendix leading to infarction and gangrene of the appendix and ultimately appendix perforates (Ellis and Nathanson, 1997).

Overall, 20% patients with acute appendicitis have perforation at the time of operation and can be as high as 60% in extremes of ages (Steele. 2002). Risk factors for perforation of appendix are extremes of ages, immunosuppression, diabetes mellitus, obstruction with fecolith, free-lying pelvic appendix and previous abdominal surgerywhich limits the ability of greater omentum to wall off the spread of infection

(O'Connell, 2000). The general morbidity of 3.1% in case of acute appendicitis can rise to 47% in cases of perforated appendicitis (Cueto-Garcia and Vazquez-Frias, 2003). In histological grading, an appendix is normal when there is no mucosal abnormality. In mild acute appendicitis there is neutrophilic infiltration with mucosal ulceration with or without intra-luminal pus. Suppurative appendicitis there is transmural inflammation whereas in gangrenous appendicitis there is cellular necrosis with or without perforation (Kollias *et al.*, 1994).

2.2.6 DIAGNOSIS

Acute appendicitis is a clinical diagnosis and can be fairly accurate based on detailed history and correct physical examination aided by basic laboratory investigations.

2.2.6(a) CLINICAL DIAGNOSIS

Acute appendicitis presents with a typical history of periumbilical pain that can be constant aching or colicky in nature due to obstruction of the appendiceal lumen. The pain is explained on the embryological basis as appendix is derived from midgut and pain is produced by irritation of visceral peritoneum covering appendix. The periumbilical pain then shifts to right iliac fossa due to involvement of parietal peritoneum. However about 30% of the patients do not experience this shifting of the pain. Appendicitis is associated with anorexia, nausea vomiting and hyperpyrexia (Kevin *et al.*, 2004). Clinical examination at this point will show localized tenderness and rebound tenderness over right iliac fossa. In about 90% patients with acute perforated appendicitis, there is localized guarding due to spasm of abdominal muscles (Steele, 2002).

Clinical signs suggestive of acute appendicitis are finger-pointing test whereby patient points at the site of maximum tenderness, the McBurney's point. Rovsing's sign, psoas sign, obturator sign are other clinical signs associated with acute appendicitis (Steele, 2002). In Rovsing sign, the pain experienced over right iliac fossa by pressure over left iliac fossa can be due to displacement of viscera from left iliac fossa or due to distension of caecum due to bowel gas from left iliac fossa. About 20% patients with acute appendicitis may have diarrhoea especially with pelvic or retro-ileal appendicitis (Steele, 2002, Ellis and Nathanson, 1997). Rectal examination is helpful in determining presence or absence or pelvic mass or collection.

Examination of testes in male patients is essential to rule out testicular torsion or orchitis and the hernial orifices to rule out strangulated inguinal or femoral hernia. In female patients, history of missed period can give a clue towards the diagnosis of ectopic pregnancy (Steele, 2002).

2.2.6(b) LABORATORY DIAGNOSIS

The basic laboratory tests such as full blood count to confirm leucocytosis, urea and electrolytes analysis for assessment of hydration and electrolyte status is required. Urine analysis is helpful to rule out urinary tract infection or ureteric calculi. About 20% patients with acute appendicitis can have protenuria or pyuria although organisms are not found (Steele, 2002). Urinary pregnancy test is necessary to rule out ectopic pregnancy in childbearing age group patients. C reactive protein is not a clinically useful test as it is non-specific (Kevin *et al.*, 2004).

2.2.6(c) RADIOLOGICAL DIAGNOSIS

2.2.6(c)(i) ABDOMINAL X RAY

Abdominal x-ray is useful diagnostic tool in cases where possibility of ureteric calculi is present. It can also help in detecting faecolith and to rule out acute intestinal obstruction (O'Connell, 2000). 1% to 2% cases of perforated appendicitis can present as pneumoperitoneum seen on abdominal radiograph, nevertheless, it is not a mandatory investigation in diagnosing acute appendicitis (Kevin *et al.*, 2004).

2.2.6(c)(ii) ULTRASONOGRAPHY

This is non-invasive and readily available investigation when diagnosis of acute appendicitis is equivocal, especially in female patients to rule out other gynaecological causes of right iliac fossa pain such as ovarian cyst and ectopic pregnancy. Studies had demonstrated sensitivity of more than 85% and specificity of more than 90% in experienced hands. The sonographic criteria for acute appendicitis is a non-compressible appendix with more than 7mm antero-posterior diameter, presence of an appendicolith, interruption of continuity of echogenic submucosa, peri-appendiceal fluid or mass and localized paralytic ileus (Kevin *et al.*, 2004).

2.2.6(c)(iii) CT SCAN

CT scan has been reserved for the patients with equivocal history, physical and laboratory findings and in distinguishing those patients presenting late in their clinical course who may have developed phlegmon or abscess (Kevin *et al.*, 2004). The usual findings are abnormal appendix with peri-appendiceal inflammation. It is also useful when clinical findings suggest right lower quadrant mass. CT scan does not have role in routine diagnosis of acute appendicitis (Steele, 2002).

2.2.6(d) OTHER MODALITIES

Barium enema was used before availability of CT scan or high quality ultrasound to demonstrate non-filling appendix with indentation of caecum indicative of pericaecal inflammation. Nuclear medicine studies using radiolabelled white blood cells (Tc99mWBC) and immunoglobulin G (Tc 99 IgG) has been used occasionally. This technique relies on localization of WBC or IgG at the site of appendiceal inflammation. Diagnostic laparoscopy can be a useful tool in female patients within reproductive age group in whom diagnosis cannot be ruled out. (Kevin *et al.*, 2004).

Figure 2.2.6(c)(ii) shows the ultrasonographic feature of acute appendicitis with distended lumen and oedematous wall.

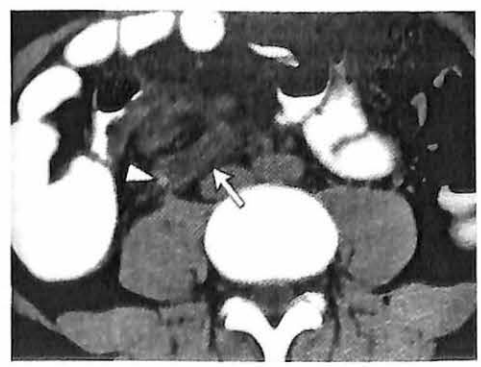

Figure 2.2.6(c)(iii) shows the CT scan of the abdomen demonstrating and oedematous thickened appendix (arrow) with obstructing appendicolith (arrowhead).

2.2.7 DIFFERENTIAL DIAGNOSIS

The differential diagnosis of acute appendicitis varies according to age and gender of patient. Differential diagnosis in children is gastroenteritis, mesenteric adenitis, Meckel's diverticulitis, intussusceptions, Henoch-Schonlein purpura, lobar pneumonia. In adults, the differential diagnosis can be regional enteritis, ureteric colic, perforated ulcer, testicular torsion, pancreatitis, or rectus sheath hematoma while in adult females, it can be mittleshmerz, salphingitis, pylonephritis, ectopic pregnancy, torsion or rupture of ovarian cyst, endometriosis. The differential diagnosis in elderly patients can be diverticulitis, intestinal obstruction, colonic carcinoma, torsion of appendix epiploicae, mesenteric infarction, aortic aneurysm (O'Connell, 2000).

2.2.8 TREATMENT MODALITIES

Treatment of the appendicitis depends on the stage of the disease as well as associated complications.

2.2.8(a) CONSERVATIVE MANAGEMENT

Acute appendicitis is the commonest emergency requiring surgical intervention. However, in certain situations, emergency appendicectomy is deferred until general condition of the patient is optimum for surgical intervention and anaesthesia. Moribund patients with advanced peritonitis, dehydration and electrolyte imbalance should undergo resuscitation before surgery is performed. These patients are observed on antibiotics, analgesics, intravenous fluids and nasogastric aspiration. Patients, in whom attack of acute appendicitis has resolved, can be planned for elective interval appendicectomy (Steele, 2002).

Patients with appendicular mass but without signs of generalized peritonitis can be observed closely with conservative management but should patient become pyrexial with increase in the size of the mass, surgical intervention is indicated (Kevin *et al.*, 2004). In unstable patients with large, unilocular abscess, ultrasound or CT guided percutaneous drainage of the abscess can be carried out. Rectal drainage of pelvic abscess in certain cases is also considered (Williamson and Kirk, 2002). After acute inflammatory state has subsided, elective appendicectomy should be performed after an interval of about 8 weeks to avoid the risk of recurrence of further episodes of appendicitis (Ellis and Nathanson, 1997).

2.2.8(b) SURGERY

Surgery is a definitive treatment for acute appendicitis. It can be open appendicectomy, laparoscopic appendicectomy or by laparotomy. Open appendicectomy is performed using Lanz incision in Hospital Universiti Sains Malaysia. Various randomized studies conducted could not show constant, uniform results, few studies favoured open method while other favoured laparoscopic appendicectomy (Steele, 2002).

3. AIMS OF THE STUDY

The specific objectives of the study were:

- To compare laparoscopic appendicectomy with open appendicectomy with respect to:
    - Operating time
    - Post operative pain
    - Post operative hospital stay
    - Time to tolerate normal diet
    - Wound infection rate
    - Complications
- To determine the rate and indication for conversion of laparoscopic appendicectomy to open appendicectomy.
- To determine the rate of negative appendicectomy.
- To determine the types of appendicitis managed by laparoscopic method.

The general objectives of the study were:

- To demonstrate demography, intraoperative diagnosis and histopathological diagnosis of presenting patients with acute appendicitis.