Aus der Chirurgische Klinik des DRK Kliniken Berlin Westend
Akademische Lehrkrankenhaus Charité Universitätsmedizin Berlin

Dissertation

Experience with laparoscopic appendectomy as routine operation to manage patients with appendicitis: special attention to the role of laparoscopic appendectomy in training for resident surgeons

Zur Erlangung des akademischen Grades

Doctor medicinae (Dr.med.)

Vorgelegt der Medizinischen Fakultät Charité-Universitätsmedizin Berlin

Von

Maged Header

aus: Kairo, Ägypten

Gutachter: 1. Prof. Dr. med. E. Kraas

2. Prof. Dr. med. H. Weidemann

3. Priv.-Doz. Dr. med. R. Pfitzmann

Datum der Promotion : 30.01.2009.

Index

1. Goals of the study

Conventional appendectomy has become the standard surgical treatment for acute appendicitis since its introduction more than a century ago. Since its initial description by the German gynaecologist Kurt Semm[1] in 1983, laparoscopic appendectomy has struggled to prove its superiority over the conventional technique. This is in contrast to laparoscopic cholecystectomy, which promptly became the gold standard for gallstone disease despite little scientific challenge.[2] The rationale underlying this lack of acceptance is multifactorial.

To answer questions on superiority and safety of laparoscopic appendectomy compared to the conventional appendectomy, this study was performed focusing, in the first part, on the laparoscopic appendectomy technique as a routine operation to manage all cases of appendicitis. The results of all cases of laparoscopic appendectomy in the period of the study were revised and analysed.

Patients with suspected acute appendicitis are routinely managed laparoscopically at Westend Hospital, Berlin, where this study was conducted. In the first part of the study, the results of all patients with completed laparoscopic appendectomy were presented and analysed. Because of the small number of conventional appendectomy cases, 76 patients in the period of the study, these results were critically reviewed and compared with literature which discuses conventional procedures to manage patients with suspected acute appendicitis.

Two additional points were discussed. Firstly, three different methods of appendiceal stump closure were compared and analysed, in regard to safety and securing of closure. The cost and benefits of each method are also compared.

Secondly, the role and the use of drains in laparoscopic appendectomies were discussed. We compare cases in which drains were used and with those where drains were not used. Two different drains were discussed and analysed (Easy-Flow drain and Robinson drain).

The second part of this study discusses the question of whether the laparoscopic appendectomy is suitable as a training operation for resident surgeons. Traditional surgical training in the field of conventional surgical procedure has relied on procedures such as the appendectomy to teach and develop basic surgical skills for surgeons in the first years of surgical training. In the field of laparoscopic surgery, the role of laparoscopic cholecystectomy as a training operation for resident surgeons is well known.[3] Although the laparoscopic appendectomy as a diagnostic and therapeutic modality is potentially superior to conventional surgery, its role in surgical training in the field of laparoscopic surgery is unclear.[4] In the second part of this study we compare the outcome of the laparoscopic appendectomies performed by resident surgeons with those performed by consultant surgeons. In this study there were 11 consultant surgeons who operated on 697 patients and 18 resident surgeons who operated on 653 patients who underwent laparoscopic appendectomies.

The results of this study were compared with the current literature and discussed.

2. Introduction

2.1. Historical background

That the appendix lay hidden in the right lower abdominal quadrant has been known for millennia, its function and role in disease however has remained obscure. Egyptians, 2000 years before the Christian era, noted the presence of the appendix and during post-mortem preservation referred to it as the “worm” of the bowel. The appendix, along with other viscera, was preserved during the ritual process of mummification.[5]

The appendix vermiformis as an anatomical structure was first described in 1521 by Jacopo Berengario da Carpi, (ca. 1470-1530) professor of anatomy at Bologna. In 1554 the French physician Jean Fernel (1497-1558) reported the first case of perforative appendicitis at autopsy .[6]

A classical post-mortem description is owed to Lorenz Heister (1683-1758), professor of medicine and also a practising surgeon at the universities of Altdorf-Nürnberg and Helmstedt in Germany (1712). Heister was the first to study the pathology of appendicitis (1711). [7]

The 19th century pathological concept is based on the notion ´perityphilitis´, i.e. inflammation of the cecum (typhlon, blind). The cecum rather than the appendix was considered as the site of the disease; this is easily explained by advanced stages of inflammation which were observed in autopsies. According to the concepts of pathogenesis a number of therapeutic measures were taken. Baron Guillaume Dupuytren (1777-1835) supposed an ‘idiopathic inflammation of the cellular tissue’ in the fossa iliaca and thus recommended an antiphlogistic therapy and bleeding with leeches. Surgical treatment was reserved for patients with fulminate abscess.[8]

The condition now called ‘appendicitis’ became a surgical problem once it was obvious that the starting point of the disease is the appendix vermiformis. The first to clearly recognize this was Harvard University’s pathologist Reginald Heber Fitz (1843-1913) who communicated his finding at the first meeting of the Association of American Physicians in 1886. In his paper, Fitz pointed out that the frequent abscesses in the right iliac fossa were not due to typhilitis, perityphilitis or epityphlitis but to perforation of the vermiform appendix. Hence he gave the condition the name ‘appendicitis’ so as to avoid the possibility of misunderstanding and to localize the disease in its usual place of origin.[9]

2.2. Epidemiology of appendicitis

The appendectomy for acute appendicitis is one of the most frequently performed surgical procedures in the Western world. A great deal has been written on appendicitis since it was described by Fitz more than 100 years ago, but the epidemiology and the aetiology of this disease remain poorly understood.

An analysis of the national hospital discharge survey data in USA allowed the calculation of approximately 250,000 appendectomies per year in patients that had a discharge diagnosis of acute appendicitis.[10] Based on public health routine data, a study on the incidence of appendectomies was carried out in Germany. The result of 130 appendectomies per 100,000 inhabitants per year comes very close to the findings made in England and Wales.[11] The crude incidence of acute appendicitis was 100-110/100,000 population per year. This number may be representative for the whole Western world. Approximately 7 percent of the population will have appendicitis in their lifetime.[12] A Californian study, including more than 100.000 cases of surgically treated acute appendicitis, exhibited incidence rates in blacks and a defined Asian/other group one half or less of the rates for whites and Hispanics.[13] Differences in socioeconomic status could be an explanation for the racial/ethnic differences observed.[14] Several authors have proposed that dietary fiber plays an important role in the cause of acute appendicitis. In Asian and African countries, the incidence is probably lower because of the dietary habits of the inhabitants of these geographic areas.[15]

The overall incidence of appendicitis has decreased by about 15% in the time period from 1970 to 1984 in the USA.[16] This trend was more pronounced in the populations at highest risk. Decreasing rates of acute appendicitis have been reported in the Western world,[17] and increasing rates in developing countries.[18] The reason therefore is still not clear. The changing incidence has been attributed to dietary changes, improvement in socioeconomic status and hygienic standards, the increased use of antibiotics, and a better developed health care system.[19]

Persons of any age may be affected, with highest incidence occurring during the second and third decades of life. Appendicitis occurs more frequently in males than in females, with a male-to-female ratio of (1.7:1).[20] The incidence of acute appendicitis was found to be season-dependent. The peak of the incidence is during the summer months and the lowest incidence is during the winter.[21]

2.3. Surgery for appendicitis

The first appendectomy was performed at St. George's Hospital, London, in 1736 by Claudius Amyand. The acutely inflamed appendix, perforated by a pin, and surrounding omentum was removed through a scrotal wound while dealing with a faecal fistula in a chronic scrotal hernia. The patient was 11-year-old boy and he recovered.[22]

On May 4, 1901, Frederick Treves was knighted by King Edward VII, on whom he performed an appendectomy in June 1902. The king desperately needed an appendix operation but strongly opposed going into hospital. 'I have a coronation on hand,' he protested. But Treves was adamant: 'It will be a funeral, if you don't have the operation.' Treves won, and the king lived. Treves found a large abscess, opened it, washed out the cavity and packed it with gauze. No attempt was made to find the appendix. The royal case history illustrates conservative, temporizing and primarily internal treatment of appendicitis with surgery as last resort when an abscess was clearly ascertained.[23]

After the clear statements and orderly conclusions drawn by Fitz, he gave the condition the name 'appendicitis' rather than typhilitis, perityphilitis or epityphlitis. He localized the disease in its usual place of origin and aroused the interest of the medical profession in this disease. The work of leading American surgeons made appendicitis in the US, earlier than elsewhere, a disease that clearly requires surgical treatment.[24]

Charles McBurney (1845-1913) was one of the surgeons pioneering the diagnostics and operative treatment of appendicitis. McBurney's classic report on early operative interference in cases of appendicitis was presented before the New York Surgical Society in 1889. In it he described the area of greatest abdominal pain in this disease process, now known as McBurney's point. Five years later, he set forth in another paper the incision that he used in cases of appendicitis, now called McBurney's incision.[25]

The US surgeon John Benjamin Murphy introduced and popularised early removal of the appendix in all cases of suspected appendicitis. In 1889 Murphy established a pattern of early symptoms for appendicitis and strongly urged immediate removal of the appendix when this pattern appeared. Although Murphy's program first met with incredulity and derision from his colleagues, his more than 200 successful appendectomies over the next several years provided ample evidence to make the operation common medical practice.[26]

2.4. Laparoscopy and appendicitis

Reducing the size of incisions has been a dream of surgeons for years. Hippocrates described a rectoscope in 400 BC. Albukasim, an 11th century Arab doctor, developed a speculum illuminated by a set of light reflectors. These early systems had limited applications because the heat produced by candles and other artificial light sources was transmitted to the instruments and could result in burns.[27]

“I asked myself, how do organs react to the introduction of air? To find this out, I devised a method to use an endoscope on an unopened abdominal cavity (Koelioskopie) in the following way." George Kelling, of Dresden, coined the term "coelioskope" to describe the technique that used a cystoscope to examine the abdominal cavity of dogs. Dr. Kelling reported these results at the German Biological and Medical Society Meeting in Hamburg, in September 1901.[28]

The first laparoscopy on a human was performed in 1911 by the Swedish doctor Hans Christian Jacobeus. Von Ott inspected the abdominal cavity of a pregnant woman.[29]

Up to the 1970s, laparoscopy was mainly used by gynaecologists and gastroenterologists for diagnostic purposes. Therapeutic laparoscopy was introduced by gynaecologists in the early 1970s. Rapid technical advances in miniaturized surgical tools, fibre optics, and video systems enabled new developments in minimally invasive surgery; these methods greatly reduced post-operative complications so that laparoscopy and other types of minimally invasive surgery became widely used by surgeons around the world.[30]

In the young female the cause of lower abdominal pain is often of gynaecological origin. Gynaecologists perform diagnostic laparoscopy frequently. On 13 September 1980 the gynaecologist Professor Kurt Semm performed the world's first laparoscopic appendectomy at the University of Kiel in Germany.[31]

Increasing interest in laparoscopy among general surgeons developed only after the French gynaecologist Mouret performed in 1987 the first acknowledged laparoscopic cholecystectomy by means of four trocars.[32] Götz et al.[33] applied laparoscopic appendectomy procedure in 1987. They pointed to the most important potential benefit, a lower incidence of long-term complications such as adhesive intestinal obstruction, which was reported to be high among patients with conventional appendectomy and conventional abdominal surgery.[34]

3. Patients and methods

3.1. Selection of patients

This is a retrospective study, which includes all patients that underwent an appendectomy during the time period between first of January 1999 and the end of June 2006 at the DRK-Kliniken-Westend in Berlin. During these seven and a half years, 1473 patients underwent an appendectomy surgery for suspected appendicitis. At this hospital the laparoscopic technique is routinely used to manage all patients with acute appendicitis. Out of 1473 operated appendectomy procedures, 1397 (94.85%) were started as laparoscopic appendectomies. The remaining 76 patients (5.15%) were operated on conventionally from the start. Forty-seven out of 1397 patients (3.4%) were converted to conventional technique.

3.2. Technique of laparoscopic appendectomy

The patient after endotracheal intubation and anaesthesia is positioned in supine position, legs together with the right arm alongside of the body and the left arm at an angle.

The surgeon stands on the left side of the patient and the assistant on the right side of the operating surgeon. The scrub nurse stands on the right side of the patient, the laparoscopic tower and the monitor facing the surgeon.

After Veress needle insertion, the abdomen is inflated with CO_2 up to an abdominal pressure of 12 mm Hg. Three trocars in triangular formation are used. One 10 mm optic trocar in the umbilical region for a 30 degree laparoscope (preferred for all laparoscopic procedures). Diagnostic abdominal survey is then carried out. After that, the two other trocars are introduced under direct vision. One 10 mm trocar in the left lower quadrant and a 5 mm trocar in right lower quadrant.

Identification and mobilization of the appendix is performed after moving the operating table to Trendelenburg position and inclining it to the left side. The mesoappendix can either be transacted close to the base of the appendix by mono- or bipolar current, Endo-loops, stitches, clips, or a stapling device (Endo-GIA). The dissection of the mesoappendix is continued until the base of the appendix has been completely freed.

The appendix can either be transacted using two or three Endo-Loops, a stapling device, a stitch or clips. Removal of the appendix depends on its size and the grade of inflammation. Endobag is used usually if the appendix is thick, too inflamed or perforated. The appendix is placed within the bag and removed. If the appendix is thin and not perforated, it can be directly extracted via a 10-12 mm trocar. Following the removal of the appendix, the base of the transaction margin is carefully examined and haemostasis is secured. The appendiceal stump is not routinely inverted with a Z-stitch. However, in case of bleeding, an unsecured resection margin or severe inflammation, a Z-stitch is tied intracorporally.

Drains into the right lower quadrant or space of Douglas are not routinely placed. In case of difficult situations such as perforation, abscess formation or severe bleeding, an Easy-Flow or Robinson drain is inserted.

When the pneumoperitoneum is evacuated and the trocars removed, the larger fascial incisions (>5 mm) are closed with interrupted absorbable sutures. The skin incisions are then closed.

3.3. Data collection and processing of data

For all patients included in this study, 30 anonymized items were extracted from the patient chart and recorded in Microsoft Excel sheet.

These items were:

• Patient data: Name, birth date, gender, age at operation, hospital record number.
• Clinical diagnose at admission and ASA classification of the patient.
• Day of operation, time of operation, operative technique.
• Method of appendiceal stump closure, drain or no-drain and type of drain.
• Operating time in minutes and name of operating surgeon.
• Other pathology found during the operation and other procedure in the same sitting.
• Intraoperative and postoperative complications.
• Histopathological results.
• Pre- and postoperative hospital stay.
• Readmission and reoperation.
• Conversion and causes of conversion to conventional appendectomy.
• Mortality.

3.4. Statistics

The statistical analysis in this work was done with support and assistance from the Institut für Medizinische Statistik des Universitätsklinikums Charite` Benjamin Franklin.

This work presents the experience with management of appendicitis in the DRK-Kliniken-Westend, Berlin. The data was collected retrospectively and processed through different statistical analysis processes.

For statistical evaluations of the data presented in this work and the results obtained in this study, the statistical Package for the Social Sciences (SPSS) version 11 was used.

To summarize information about the averages and variances of variables, and also to summarize the data with an underlying continuous distribution, descriptive statistics was applied including the mean, the minimum, the maximum and the standard deviation.

The frequencies procedure was used for interpreting categorical data and for investigating the numbers of cases that fall into various categories.

The relationship between categorical variables was studied with the aid of the crosstabs procedure.

For qualitative data, the Chi-square test for independence was used in situations where there were two categorical variables. In case where there were 5 or less values, Fisher's exact test was used.

In quantitative data, non-parametric tests were used. Mann-Whitney-U-Test and Student's t test were used for comparing mean values of two sets of numbers and for assessing whether two samples of observations come from the same distribution. The independent-sample t test was used to compare two groups' score on the same variable. The paired-sample t test was used to compare the means of two variables within a single group.

In all statistical processes a probability of < 0.05 was accepted as significant.

4. Results

4.1 Results concerning laparoscopic appendectomy as routine operation for handling acute appendicitis

4.1.1 Patients completed laparoscopically

4.1.1.1 Different techniques and number of patients in total and over the period of the study

Between January 1999 and July 2006, a total of 1473 patients in DRK-Kliniken-Westend in Berlin underwent an appendectomy surgery. The gender distribution of these patients was 833 females (56.6%) and 640 males (43.4%) [Figure 1].

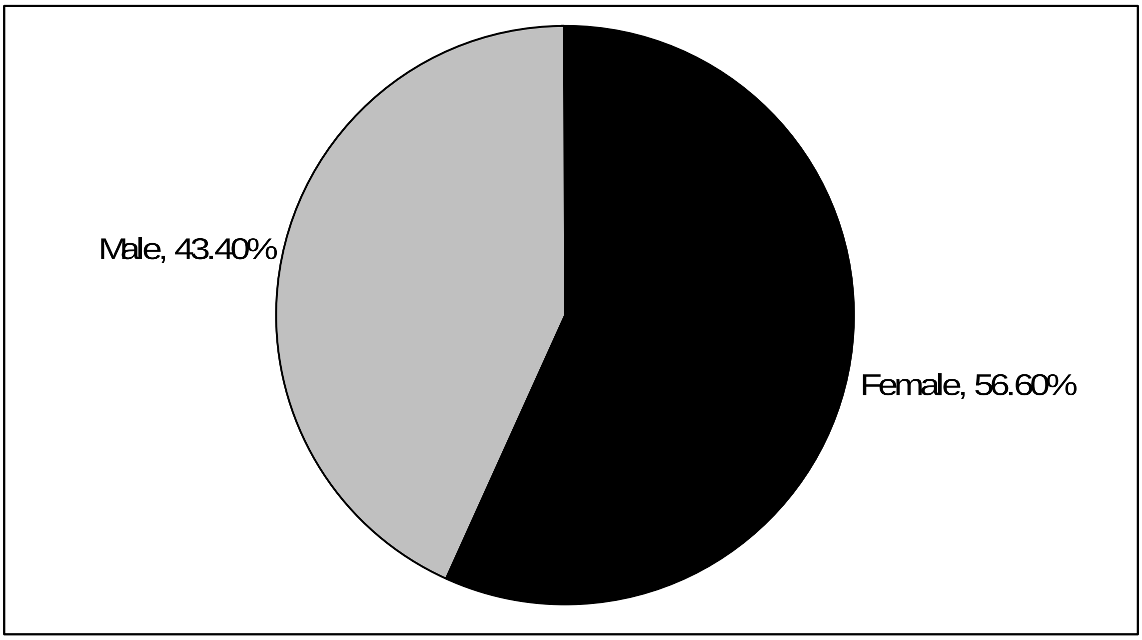

Figure 1: Gender distribution of the patients

From the total of 1473 patients, there were 76 patients (5.2%) operated on primarily by conventional technique and 1397 patients (94.8%) started as laparoscopic surgery. From the latter number of patients, 1350 (96.6%) were completed laparoscopies and 47 (3.4%) were converted to conventional technique [Figure 2].

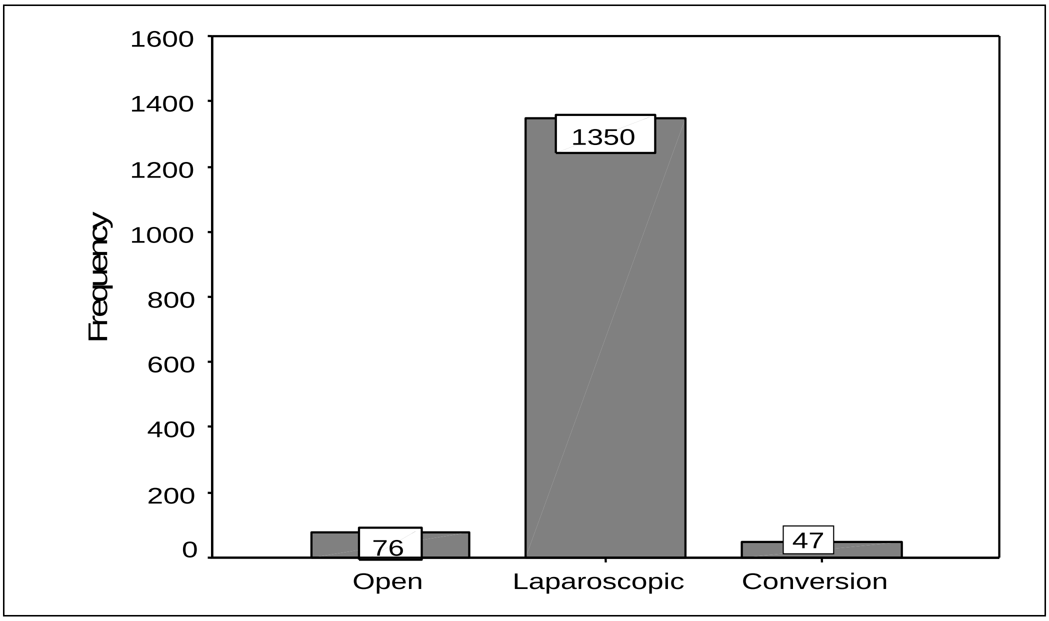

Figure 2: Number of patients with different technique

From 1999 to 2006 there was a decrease in the number of conventional appendectomies [Figure 3]. 33 patients out of a total 130 patients had a conventional appendectomy in 1999. In the first half of 2006, there was only one patient operated on by conventional appendectomy. There was also a decrease in the number of conversion cases and an increase in the number of laparoscopic procedures over the years. In 1999 there were 3 conversion patients out of 97 patients, and in 2006 there was one patient with conversion from the total number of 112 patients till the end of June 2006 [Table 1].

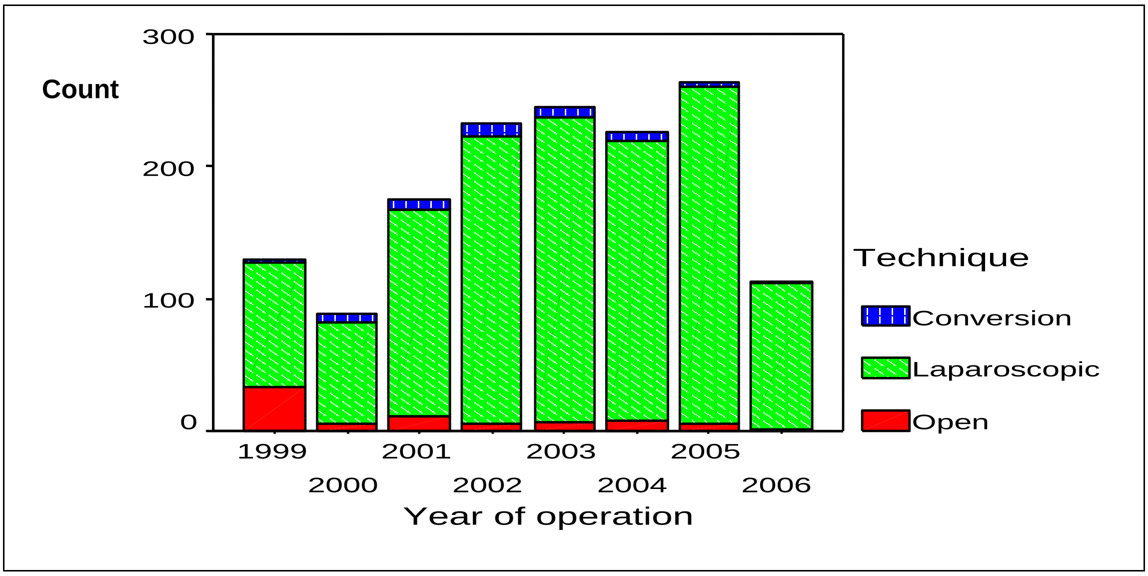

Figure 3: Number of patients with different techniques over the years of the study

Years	Technique			Total
	Open	Laparoscopic	Conversion	
1999	33	94	3	130
2000	5	77	7	89
2001	11	156	8	175
2002	6	216	10	232
2003	7	230	8	245
2004	8	211	7	226
2005	5	255	3	263
2006	1	111	1	113
Total	76	1350	47	1473

Table 1: Number of patients with different techniques over the years of the study

4.1.1.2 Patients' numbers, age and gender distribution

The total number of cases which completed as laparoscopic appendectomy in this study was 1350 cases. From this number 776 cases (57.5%) were female and 574 cases (42.5%) were male [Figure 4].

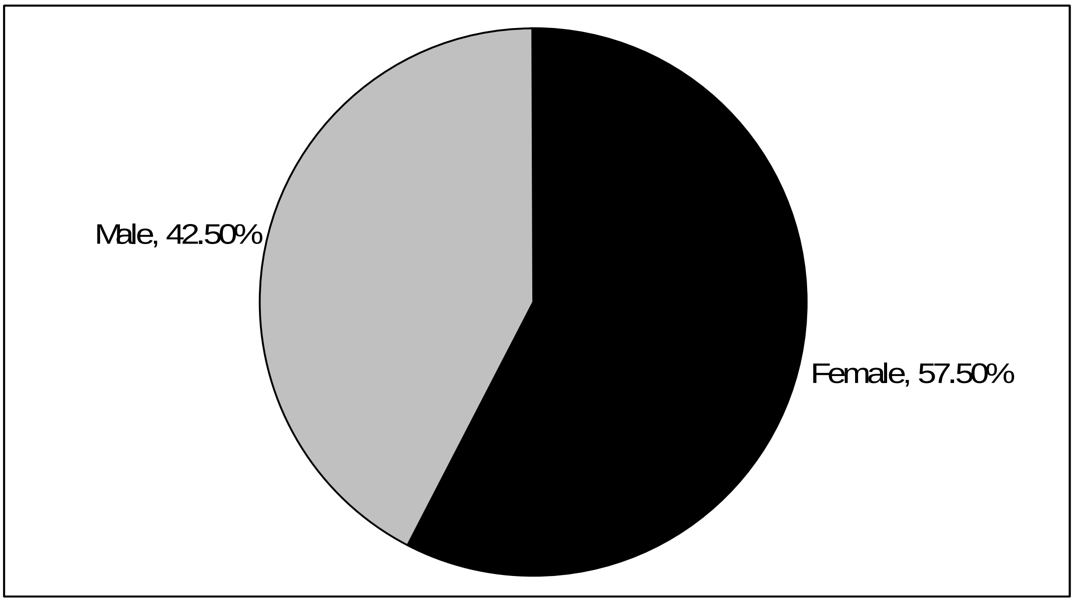

Figure 4: Male and female patients with completed laparoscopic technique

The youngest patient in this study was 5 years old. The oldest patient was 90 years old. The mean age was 30 years. The standard deviation was 16.9 years. For female patients, the youngest patient was 5 years old and the oldest patient was 90 years old.

The mean age was 29 years. The standard deviation was 16.8 years. Regarding male cases, the youngest patient was 6 years old, and the oldest patient was 88 years. The mean age was 31 years and the standard deviation was 16.8 years.

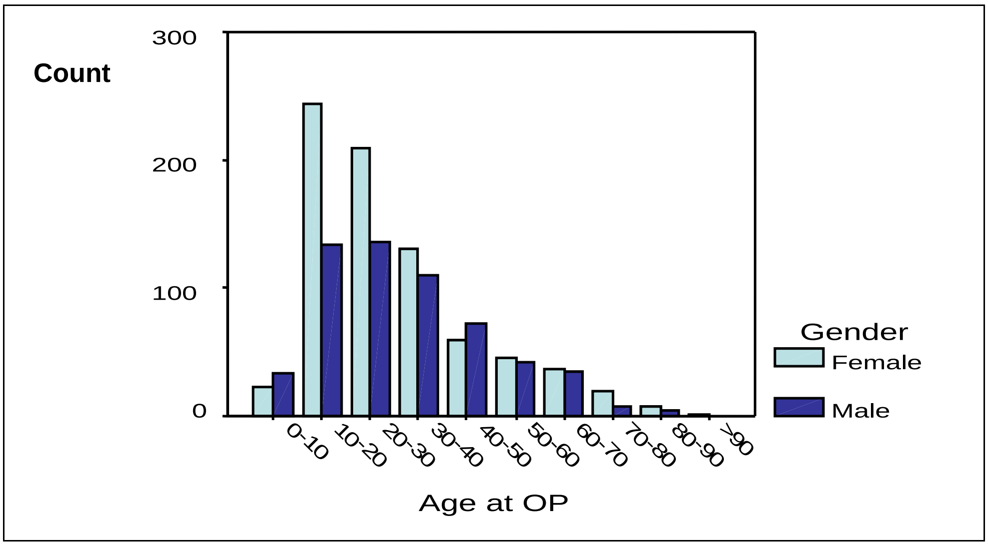

Figure 5: The distribution of patients' gender in the different age groups

The highest numbers of patients with laparoscopic appendectomy were in age groups 10-20 years and 20-30 years. More than half of the patients were between the age of 10 and 30 years. After the age of 30 years the number of cases decreases with increases in the age of patients. In the children group (patients less than 10 years old), there were 56 patients (4.1%). Regarding the gender distribution, there were more females than males in all age groups except in the children age group, and in the age group 40-50 years [Figure 5] [Table 2].

Age of the patients	Gender		Total
	Female	Male	
0-10	23	33	56
10-20	244	134	378
20-30	209	136	345
30-40	131	110	241
40-50	59	72	131
50-60	45	42	87
60-70	37	35	72
70-80	19	8	27
80-90	8	4	12
>90	1		1
Total	776	574	1350

Table 2: Number of patients in relation to gender and age

4.1.1.3 Patients with previous abdominal operations

Analysing the data of 144 patients who had a previous abdominal operation in these 1350 patients with completed laparoscopic surgery, the following was observed. There were 1206 patients (89.3%) with no previous abdominal surgery. There were 83 patients (6.1%) who had previous conventional abdominal surgery, 65 patients (4.8%) had previous conventional lower abdominal surgery, and 18 patients (1.3%) had previous conventional upper abdominal surgery. There were 60 patients (4.5%) who had previous laparoscopic surgery, 46 patients (3.4%) had laparoscopic lower abdominal surgery, and 13 patients (1%) had laparoscopic upper abdominal surgery. One patient had a diagnostic laparoscopy procedure (0.1%).
There was one patient (0.1%) who had more than one surgery. She was 77 years old at the time of appendectomy in 2001. At the age of 47 years, she had undergone abdominal hysterectomy surgery, and at the age of 70 years she had laparoscopic cholecystectomy surgery [Table 3].

Previous abdominal operation	Frequency (percent)
No operation	1206 (89.3 %)
Open upper abdominal	18 (1.3 %)
Open lower abdominal	65 (4.8 %)
Lap. upper abdominal	13 (1 %)
Lap. lower abdominal	46 (3.4 %)
Diagnostic lap.	1 (0.1%)
More than one operation	1 (0.1%)
Total	1350 (100 %)

Table 3: Number of patients with and without previous abdominal operation

4.1.1.4 Histopathology of laparoscopic cases

A review of the histopathological results for patients who had a laparoscopic appendectomy [Figure 6], showed that there were 617 patients (45.7%) who had acute ulcerative phlegmonous inflammation without perforation of the appendix. 115 patients (8.5%) had acute ulcerative phlegmonous inflammation with perforation of the appendix. There were 357 patients (26.4%) with acute catarrhal inflammation. The presence of chronic inflammation was found in 254 patients (18.8%). There were 7 patients (0.5%) with neoplastic changes, 6 of which were with carcinoid changes and one patient with adenocarcinoma of the appendix. No significant differences were noted in operating time between patients with chronic appendicitis and acute appendicitis without perforation (P=0.490). Patients with perforation had a statistically longer operating time compared to other patients (P<0.001).

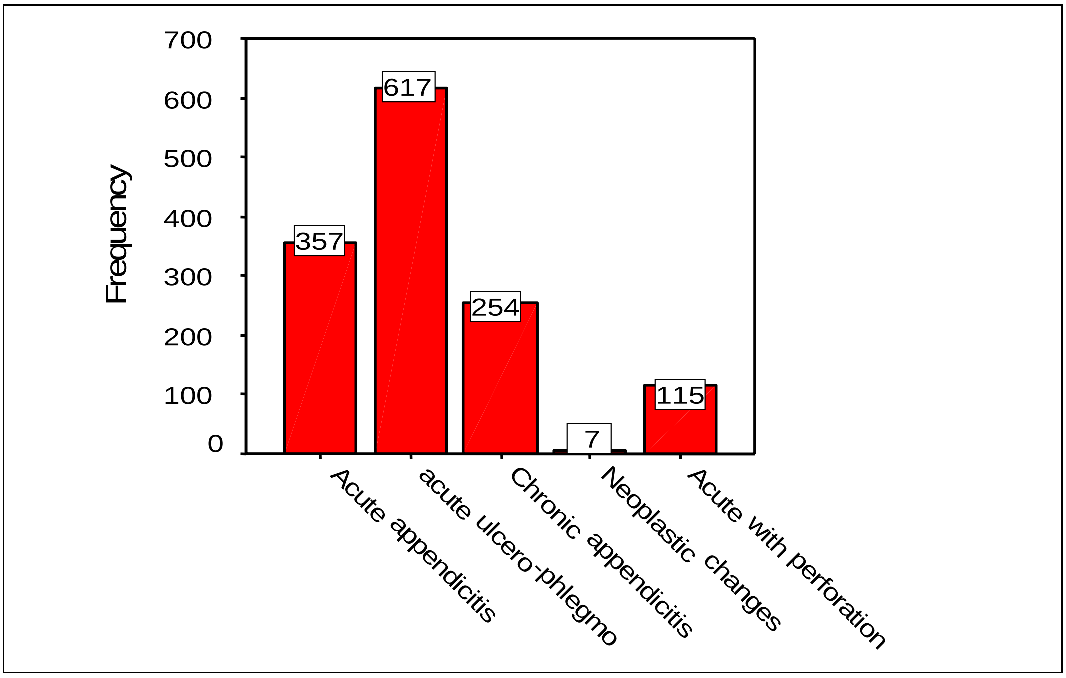

Figure 6: Different pathological results for laparoscopic appendectomy patients

4.1.1.5 Operating time for different techniques

The minimum operating time for the laparoscopic surgery (1350 patients) was 15 minutes and the maximum was 180 minutes. The mean was 47 minutes and the standard deviation was 19 minutes. For the cases with conversion (47 patients), the minimum operating time was 35 minutes and the maximum was 165 minutes. The mean operating time was 87 minutes, and the standard deviation was 31 minutes. The operating time for conversion patients was significantly longer than laparoscopically treated patients (P<0.001).

For conventional surgery, (76 patients), the minimum was 15 minutes and the maximum 105 minutes. The mean operating time was 44 minutes and the standard deviation was 18 minutes. There was no significant difference between operating time for laparoscopic and conventional procedures (P=0.223).

Year of operation	N	Mean	Minimum (minutes)	Maximum (minutes)	Standard Deviation
1999	94	47.82	20	110	19.380
2000	77	42.79	20	90	16.110
2001	156	44.04	20	115	17.958
2002	216	52.20	15	170	21.378
2003	230	46.27	15	140	18.273
2004	211	45.69	15	150	17.012
2005	255	47.28	15	180	21.457
2006	111	46.26	20	110	18.097
Total	1350	46.97	15	180	19.296

Table 4: Comparing the operating time for laparoscopic appendectomy patients over the years of the study

An Examination of the operating time over the years of the study showed the following results [Table 4]. The minimum operating time over the years of the study ranged between 15 and 20 minutes. The maximum operating time ranged between 90 and 180 minutes. Comparing the mean operating time of individual years of the study there was little change. There was no statistically significant difference between the operating time in the first year (1999) compared with the last year of the study (2006) (P=0.349).

4.1.1.6 Intraoperative complications

Among the 76 patients who had conventional appendectomy surgery, there was no patient with intraoperative complications. Regarding the patients who underwent attempted laparoscopies, there were 4 patients (0.28%) with intraoperative complications from a total of 1397 [Table 5]. All 4 patients were males, two of these patients had small intestinal injuries and the other two had caecal wall injuries. In two patients, iatrogenic injuries were discovered at the time of surgery and a conversion was made immediately to deal with the injury. In the other two patients, the injuries were discovered during the postoperative stay and required explorative laparotomy later.

	Gender	Complication	Procedure
Patient 1(1999)	Male(20y)	small intestinal injury	Laparotomy
Patient 2(2000)	Male(10y)	small intestinal injury	Conversion to conventional appendectomy
Patient 3(2003)	Male(17y)	ascending colon injury	Laparotomy
Patient 4(2004)	Male(32y)	ascending colon injury	Conversion to conventional appendectomy

Table 5: Patients with intraoperative complications

4.1.1.7 Postoperative complications

Out of 1350 patients with laparoscopic appendectomies, there were 1271 patients (94.15%) without any recorded postoperative complications and 79 patients (5.85%) with postoperative complications [Table 6]. Out of 47 patients with conversion to conventional procedure, there were 40 patients (85.1%) without postoperative complications and 7 patients (14.9%) with postoperative complications. Regarding the conventional appendectomy patients (76 patients), there were 70 patients (92.1%) without postoperative complications and 6 patients (7.9%) with postoperative complications.

Technique	Postoperative complications					Total
	No complication	Minor complications	Major complications	General complications	Others	
Open	70	1	3	1	1	76
Laparoscopic	1271	24	37	9	9	1350
Conversion	40	2	1	4		47
Total	1381	27	41	14	10	1473

Table 6: Postoperative complications in relation to different techniques

79 patients out of laparoscopically completed appendectomy patients (1350 patients) had a record of postoperative complications. There were 24 patients (30.3%) with minor postoperative complications. 14 patients had local wound complications. There were 7 patients with intraabdominal seroma which required only conservative management. Three patients had trocar site hernias in the left lower abdomen. All three patients had

the hernia in the site of 13 mm trocar. There were 37 patients (46.8%) with major postoperative complications. 23 patients had intraabdominal abscess formation. 12 patients required relaparoscopy and lavage, six patients required an explorative laparotomy and five patients were managed conservatively. Out of seven patients with intraabdominal bleeding, six patients required relaparoscopy and lavage and one patient was managed by explorative laparotomy. Five patients had postoperative paralytic ileus, two of whom required relaparoscopy and adhesiolysis while the other three patients were managed conservatively. Stump abscess was reported in two patients postoperatively, one was treated with relaparoscopy and the other one with explorative laparotomy. Nine patients (11.4%) were reported with general postoperative complications. Six patients suffered pulmonary complications. Two patients suffered cardiac complications, and one patient had urinary complications. All these patients were managed conservatively. Nine patients (11.4%) were reported with other complications, six patients with gastroenteritis and two patients with peptic ulcer. All these eight patients were managed conservatively. One patient with difficult drain removal required relaparoscopy. It was an Easy-Flow drain [Table 7].

The first year of the study (1999) showed a postoperative complication rate of 9.6%, which is the highest rate compared to all other years in this study. The postoperative complication rate decreased in 2000 (7.8%) and continued to decrease in 2001 (4.5%) [Table 8].

In 2002, the postoperative complication rate was 5.5% and in the following year increased to 9.1%, which is close to the rate in the first year of the study. The postoperative complication rate decreased again in 2004 to 4.7% and in 2005 3.5%, which is the lowest rate during the study period. The year 2006 in this study only represents the first half of the year until the end of June 2006. The postoperative complication rate in that period was 4.5%. The postoperative complication rate decreased significantly in the last year of the study compared to the first year of the study (P=0.037).

	Total number of Patients	Management		
		Conservative	Operative	Relaparoscopy
Minor complications	**24**	**11**	**13**	
Wound infection	**14**	**4**	**10**	
Trocarsite hernia	**3**		**3**	
Intra-abdominal seroma	**7**	**7**		
Major complications	**37**	**8**	**8**	**21**
Intra-abdominal abscess	**23**	**5**	**6**	**12**
Intra-abdominal bleeding	**7**		**1**	**6**
Stump abscess	**2**		**1**	**1**
Paralytic ileus	**5**	**3**		**2**
General complications	**9**	**9**		
Cardiac complications	**2**	**2**		
Pulmonary complications	**6**	**6**		
Urinary tract complications	**1**	**1**		
Others	**9**	**8**		**1**
Gastroenteritis	**6**	**6**		
Peptic ulcer	**2**	**2**		
Difficult drain removal	**1**			**1**
Total number	**79**	**36**	**21**	**22**

Table 7: Postoperative complications in cases completed as laparoscopic procedure

	1999	2000	2001	2002	2003	2004	2005	2006
Number of patients	94	77	156	216	230	211	255	111
Patients with postoperative complications	9	6	7	12	21	10	9	5
Percentage	9.6%	7.8%	4.5%	5.5%	9.1%	4.7%	3.5%	4.5%

Table 8: Number of patients with postoperative complications over the years of the study

Out of 79 patients with postoperative complications, there were 37 patients with major postoperative complications. From this number of patients with major postoperative complications, there were 17 patients with acute ulcerative phlegmonous inflammation of the appendix, 13 patients with acute ulcerative perforated appendix, 6 patients had appendix with acute catarrhal inflammation, and one patient had chronically inflamed appendix [Figure 7].

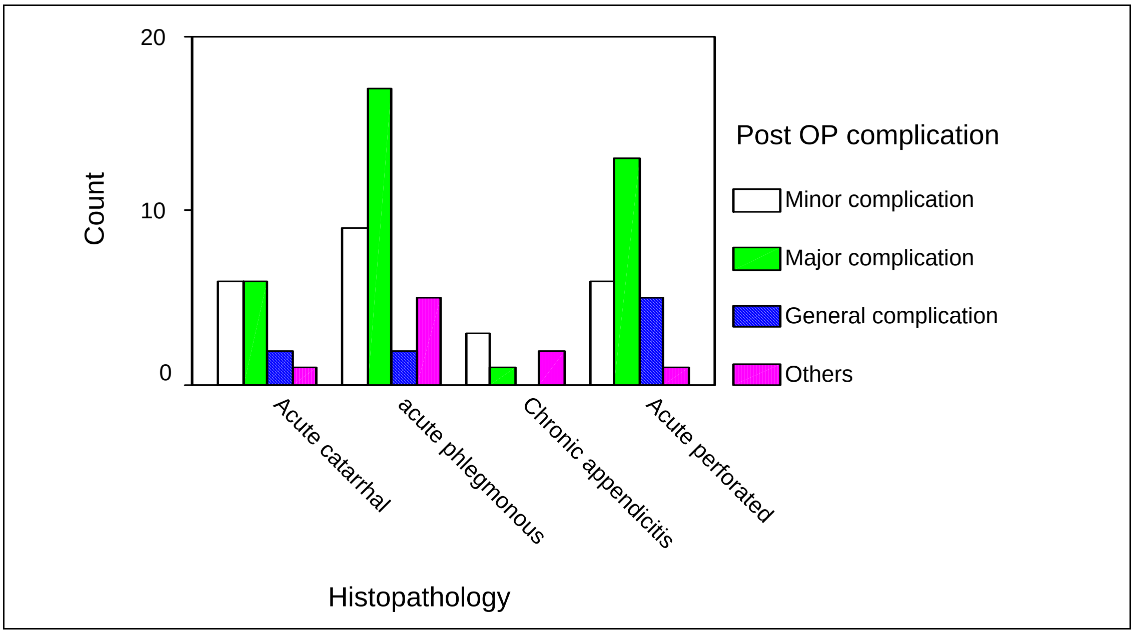

Figure 7: Postoperative complications in relation to the histopathological finding for laparoscopic appendectomy patients

Minor postoperative complications were shown in 24 patients. Nine patients had an acute ulcerative appendicitis without perforation and 6 patients had an perforated appendix. An acute catarrhal inflamed appendix was found in 6 patients and in another 3 patients the appendix was chronically inflamed. General postoperative complications of other systems of the body, like cardiac, pulmonary and urinary complications, were found in 9 patients. Seven patients had an acute ulcerative appendix, 5 of which were perforated. Two more patients had an acute catarrhal inflamed appendix. Nine patients had other postoperative gastrointestinal complications, like gastroenteritis or peptic ulcer. The histopathological findings in 6 patients were acute ulcerative phlegmonous appendicitis, in 5 of which without perforation and in the other patient with perforation. Two patients had a chronic inflammatory histopathological picture and one patient had an acute catarrhal inflammation. There is a significantly higher number of patients with post operative complications with perforated appendicitis than nonperforated appendix patients ($p<0.001$).

4.1.1.8 Postoperative hospital stay

The minimum postoperative stay for laparoscopic patients was one day and the maximum was 23 days. The mean postoperative stay was 3.6 days and the standard deviation was 2.5 days. Comparing the minimum, maximum and the mean postoperative hospital stay over the years of the study, the following results were noticed [Table 9]: the minimum stay was one day through all years of the study; the maximum postoperative stay varied over the years between 12 and 23 days. The mean postoperative stay tended to be higher in the first years of the study, ranging from 4.9 days in 1999 to 3 days in 2006. The hospital stay is significantly shorter in the last year of the study compared to the first year of the study (P<0.001).

Year of operation	Number of patients	Mean (days)	Minimum (days)	Maximum (days)	Standard deviation
1999	94	4.9	1	14	2.1
2000	77	5	1	22	3.1
2001	156	4	1	23	2.8
2002	216	3.7	1	19	2.5
2003	230	3.5	1	21	2.7
2004	211	3	1	21	2.1
2005	255	3.2	1	17	2
2006	111	3	1	12	1.8
Total	1350	3.6	1	23	2.5

Table 9: Comparing the post operative hospital stay for laparoscopic appendectomy patients along the years of the study

Analysing the data and correlation between the histopathological finding and the postoperative hospital stay the following was observed [Table 10]. More than half of the patients with acute ulcerative perforated appendicitis had a postoperative hospital stay of more than one week. 62 % of the patients with acute ulcerative phlegmonous inflammation had a postoperative hospital stay of 3 days or less. About 65 % of patients with acute catarrhal inflammation of the appendix had a postoperative hospital stay 3 days or less. Around 72 % of the patients with chronic inflammatory findings had a postoperative hospital stay of 3 days or less. Patients who had chronically inflamed appendix had shorter postoperative hospital stays than patients who had acutely inflamed appendix (P<0.001). Comparing patients with acute appendicitis, patients with acutely inflamed perforated appendix had significantly longer postoperative hospital stay compared with patients who had acute nonperforated appendix (P<0.001).

Postoperative stay		Histopathology					Total
		Acute appendicitis	Acute ulcero-phlegmonose	Chronic appendicitis	Malignant changes	Acute perforated appendicitis	
One day	Count	25	34	42		2	103
	% within post OP stay	24.3%	33.0%	40.8%		1.9%	100%
	% within histopathology	7.0%	5.5%	16.5%		1.7%	7.6%
Two days	Count	120	167	83	2	2	374
	% within post OP stay	32.1%	44.7%	22.2%	0.5%	0.5%	100%
	% within histopathology	33.6%	27.1%	32.7%	28.6%	1.7%	27.7%
Three days	Count	91	190	61		10	352
	% within post OP stay	25.9%	54.0%	17.3%		2.8%	100%
	% within histopathology	25.5%	30.8%	24.0%		8.7%	26.1%
Four days	Count	60	124	32	2	16	234
	% within post OP stay	25.6%	53.0%	13.7%	0.9%	6.8%	100%
	% within histopathology	16.8%	20.1%	12.6%	28.6%	13.9%	17.3%
Five days	Count	29	56	10		14	109
	% within post OP stay	26.6%	51.4%	9.2%		12.8%	100%
	% within histopathology	8.1%	9.1%	3.9%		12.2%	8.1%
Six days	Count	11	19	9		15	54
	% within post OP stay	20.4%	35.2%	16.7%		27.8%	100%
	% within histopathology	3.1%	3.1%	3.5%		13.0%	4.0%
One-two weeks	Count	19	25	15	3	49	111
	% within post OP stay	17.1%	22.5%	13.5%	2.7%	44.1%	100%
	% within histopathology	5.3%	4.1%	5.9%	42.9%	42.6%	8.2%
Two-three weeks	Count	2	2	2		5	11
	% within post OP stay	18.2%	18.2%	18.2%		45.5%	100%
	% within histopathology	0.6%	0.3%	0.8%		4.3%	0.8%
>3 weeks	Count					2	2
	% within post OP stay					100%	100%
	% within histopathology					1.7%	0.1%
Total	Count	357	617	254	7	115	1350
	% within post OP stay	26.4%	45.7%	18.8%	0.5%	8.5%	100%

Table 10: Correlation between the histopathological finding and the postoperative hospital stay

4.1.1.9 Reoperation after laparoscopic appendectomy

Forty nine patients (3.6%) from a total number of 1350 who had a laparoscopic appendectomy required reoperative intervention, while 1301 patients (96.4%) did not require reoperative intervention. The 49 patients with reoperative intervention were 25 females and 24 males. There was no statistical difference between the two groups (P=216). Relaparoscopy was the most commonly used procedure in these patients [Figure 8]. Twenty eight patients (57.1%) underwent relaparoscopy for diagnostic or therapeutic reasons. Ten patients (20.4%) had reintervention for local wound management of a postoperative wound infection. Eight patients (16.3%) required more invasive measures in the form of explorative laparotomy. One patient had a severe postoperative pulmonary infection and required tracheotomy. One patient who had an adenocarcinoma of the appendix as histopathological finding underwent a right hemicolectomy. Another patient was discovered to have a calculus gall bladder and underwent laparoscopic cholecystectomy during the same hospital stay.

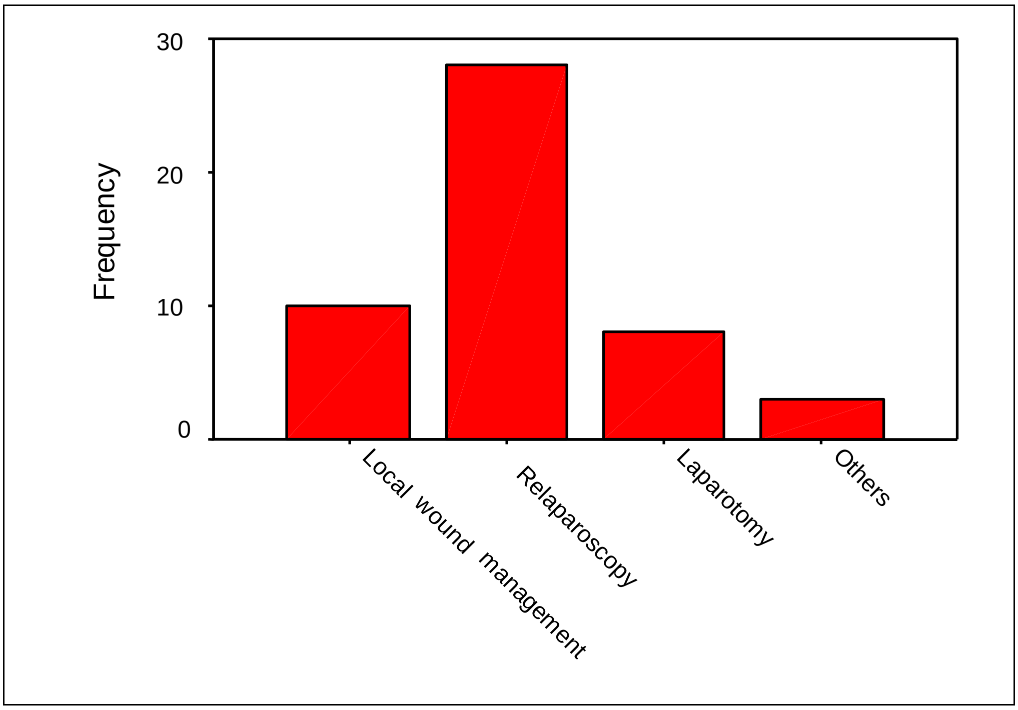

Figure 8: Different methods of reintervention for the 49 patients (3.6%) with reintervention

In 1999, 6 patients (6.4%) out of 94 required reintervention. Two patients underwent a relaparoscopy, two patients had a laparotomy and another two patients underwent local wound management. In 2000, five patients (6.5%) out of 77 required reintervention. One patient underwent relaparoscopy and two patients had laparotomies. One patient underwent a tracheotomy for severe post operative pulmonary infection and another patient had laparoscopic cholecystectomy for cholecystitis. In 2001 there were no patients who required reintervention. In 2002, 7 patients out of 209 (3.2%) required reintervention. 5 patients underwent relaparoscopies and one patient required laparotomy. The other patient required local wound management. In 2003, 18 patients (7.8%) required reintervention from a total 212 patients. 11 patients underwent relaparoscopy, 4 patients received local wound management, and 2 patients had laparotomies. One patient received a right hemicolectomy due to histopathological findings of adenocarcinoma of the appendix. In 2004, 7 patients (3.3%) out of 204 required reintervention. Five had relaparoscopy, one patient had local wound management and one patient had laparotomy. In 2005, there were 4 patients (1.5%) with reintervention out of 251, and all these patients received a relaparoscopy. In the last year of the study, which covered the first 6 months of 2006, there were 2 patients (1.8%) who required reintervention out of a total of 111 patients. These 2 patients had local wound infection and were managed by local interventions [Table11]. There was a significant decrease in the number of patients requiring reoperation in the last year of the study compared with the year 1999 (P=0.027).

Year of operation			Reoperation					
			No reoperation	Local wound management	Relaparo-scopy	Laparotomy	Others	Total
	1999	Count	88	2	2	2		94
		% within the year of operation	93.6%	2.1%	2.1%	2.1%		100%
	2000	Count	72		1	2	2	77
		% within the year of operation	93.5%		1.3%	2.6%	2.6%	100%
	2001	Count	156					156
		% within the year of operation	100%					100%
	2002	Count	209	1	5	1		216
		% within the year of operation	96.8%	0.5%	2.3%	0.5%		100%
	2003	Count	212	4	11	2	1	230
		% within the year of operation	92.2%	1.7%	4.8%	0.9%	0.4%	100%
	2004	Count	204	1	5	1		211
		% within the year of operation	96.7%	0.5%	2.4%	0.5%		100%
	2005	Count	251		4			255
		% within the year of operation	98.4%		1.6%			100%
	2006	Count	109	2				111
		% within the year of operation	98.2%	1.8%				100%
Total		Count	1301	10	28	8	3	1350
			96.4%	0.7%	2.1%	0.6%	0.2%	100%

Table11: Correlation between reintervention for the patients with laparoscopic appendectomy for individual years of the study

Out of the 49 patients with reintervention and reoperation, 19 patients (38.8%) were with acute ulcerative phlegmonous inflammation of the appendix. 11 patients underwent relaparoscopy, 4 required local wound management and 4 required a laparotomy [Table12].

There were 13 patients (26.5%) with a perforated appendix who required reintervention. Seven patients underwent relaparoscopy and 3 required local wound management. In one patient a laparotomy was required. Out of 9 patients (18.4%) with acute catarrhal appendicitis and reintervention, 6 patients required relaparoscopy, one patient had local wound management and 2 patients required a laparotomy. Seven patients (14.3%) with chronic histopathological findings required reintervention. Four of them underwent relaparoscopy. Two patients received a laparotomy and one patient required wound management. One patient, who was diagnosed with an adenocarcinoma of the appendix, received a laparotomy and right hemicolectomy. Relaparoscopy was the most common procedure used for reintervention in laparoscopic appendectomy patients [Table 12]. It was used in 28 patients (57.1%) from a total of 49 patients requiring reintervention. Local wound management was used for 10 patients (20.4%) and a laparotomy was required for 8 patients (16.3%). There is no significant difference in reoperation between patients with chronic and those with acute nonperforated appendicitis (P=0.517). The number of reoperations for patients with perforated appendicitis was significantly larger compared to patients with chronic appendicitis (P<0.005). Patients with acutely inflamed appendix with perforation were associated with a significantly larger number of reoperative interventions compared to patients without perforation (P<0.001).

Histopathology			Reoperation				Total
			Local wound management	Relaparo-scopy	Laparotomy	Others	
	Acute appendicitis	Count	1	6	2		9
		% within histopathology	11.1%	66.7%	22.2%		100%
	acute ulcero-phlegmonose	Count	4	11	4		19
		% within histopathology	21.1%	57.9%	21.1%		100%
	Chronic appendicitis	Count	2	4		1	7
		% within histopathology	28.6%	57.1%		14.3%	100%
	Malignant changes	Count			1		1
		% within histopathology			100%		100%
	Acute perforated appendicitis	Count	3	7	1	2	13
		% within histopathology	23.1%	53.8%	7.7%	15.4%	100%
Total		Count	10	28	8	3	49
		% within histopathology	20.4%	57.1%	16.3%	6.1%	100%

Table12: Correlation between reoperation and the histopathological finding in patients with laparoscopic appendectomy

4.1.1.10 Mortality

During the time of the study from January 1, 1999 to June 30, 2006 there was no mortality reported following laparoscopic appendectomy. There were also no reported cases of mortality in the 47 patients who required conversion to conventional appendectomy.

4.1.2 Methods of stump closure in laparoscopic cases

4.1.2.1 Different methods of stump closure

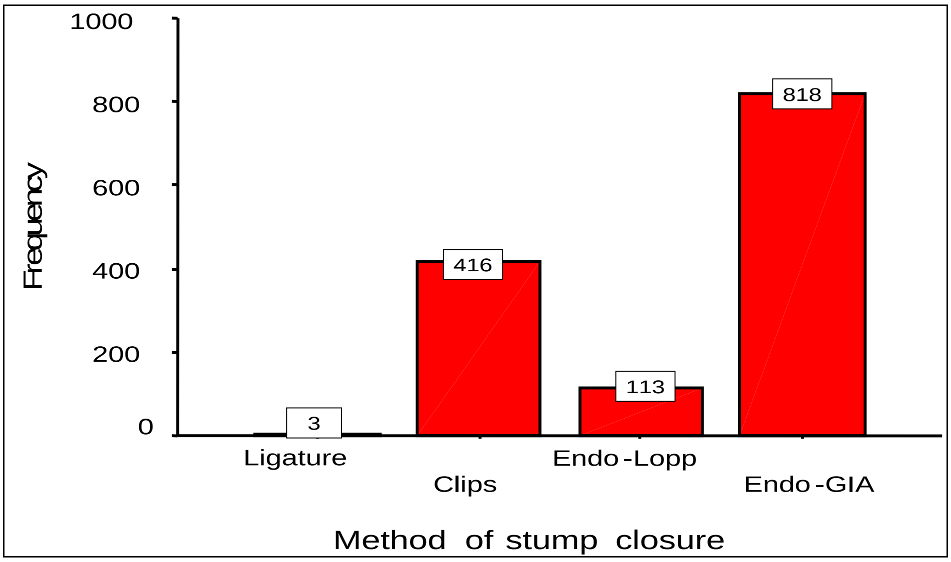

Figure 9: Frequency of different methods of stump closures

The most frequent method for stump closure was Endo-GIA. It was used in 818 patients (60.6%) out of a total number of 1350 completed laparoscopic appendectomy patients. The second most common method for stump closure was Endo-Clips; it was used in 416 patients (30.8%). Endo-Loop was used in 113 patients (8.4%). In three patients (0.2%) intracorporally knotting technique was used [Figure 9].

4.1.2.2 Methods of stump closure with reference to the year of operation

During the first two years of the study (1999 and 2000), the Endo-GIA was the only method used to close the appendiceal stump in laparoscopic appendectomy [Table 13]. From the start of 2001 three different methods were used. During 2001 and 2002, the most frequent method for stump closure was Endo-GIA. Endo-Clips were the second most common method. The less frequently used method was Endo-Loop. In 2003 Endo-Clips were used most frequently (48.3%), followed by Endo-GIA (43.0%). The Endo-Loop method was used in 20 patients (8.7%). In 2004 the Endo-GIA was used more frequently to close the appendiceal stump (58.3%).The second more common method was Endo-Clip (29.4%). Endo-Loop was used less commonly (12.3%). The same distribution was found in 2005. Endo-GIA was used most frequently (45.9%). Endo-Clip was the second most commonly used method (37.6%) and the least common method was Endo-Loop (15.7%). In the first half of year 2006, Endo-clip was used in 54 patients (48.6%), and Endo-GIA in 49 patients (44.1%). Endo-Loop was used in 8 patients (7.2%).The extra-corporeal knotting technique was used in 3 patients during the study: one patient in 2002 and two patients in 2005.

Year of operation			Method of stump closure				Total
			Ligature	Clips	Endo-Loop	Endo-GIA	
	1999	Count				94	94
		% within the year of operation				100%	100%
	2000	Count				77	77
		% within the year of operation				100%	100%
	2001	Count		21	13	122	156
		% within the year of operation		13.5%	8.3%	78.2%	100%
	2002	Count	1	72	6	137	216
		% within the year of operation	0.5%	33.3%	2.8%	63.4%	100%
	2003	Count		111	20	99	230
		% within the year of operation		48.3%	8.7%	43.0%	100%
	2004	Count		62	26	123	211
		% within the year of operation		29.4%	12.3%	58.3%	100%
	2005	Count	2	96	40	117	255
		% within the year of operation	0.8%	37.6%	15.7%	45.9%	100%
	2006	Count		54	8	49	111
		% within the year of operation		48.6%	7.2%	44.1%	100%
Total		Count	3	416	113	818	1350
			0.2%	30.8%	8.4%	60.6%	100%

Table 13: Frequency of different methods of appendiceal stump closure over the years of the study

4.1.2.3 Operating time in relation to method of stump closure

Comparing the operating time for the three different commonly used methods for appendicial stump closure [Table 14], it was observed that for the Endo-GIA, which was the most frequently used method, the minimum was 10 minutes, the maximum was 150 minutes and the mean was 46.2 minutes. These numbers were close to the numbers for the second most commonly used method, the Endo-Clips. The minimum was 15 minutes, the maximum was 170 minutes and the mean was 46.3 minutes. For the Endo-Loop, the least common method for stump closure, the minimum was 20 minutes and the maximum was 180 minutes. The mean operating time was 53.2 minutes, a little longer than the other two methods. The Endo-Loop method has a significantly longer operating time compared with the clips (P<0.001), and also compared with the staplers (P<0.001). No significant differences were noted between clips and staplers in operating times (P=0.939).

Method	Number of patients	Minimum (minutes)	Maximum (minutes)	Mean (minutes)	Standard Deviation (minutes)
Ligature	3	75	95	86.7	10.4
Endo-Clips	416	15	170	46.3	18.9
Endo-Loop	113	20	180	53.2	22.9
Endo-GIA	818	10	150	46.2	18.8

Table 14: Comparing the operating time for different methods of stump closure

4.1.2.4 Histopathology in relation to method of stump closure

Histopathology			Method of stump closure				Total
			Ligature	Clips	Endo-Loop	Endo-GIA	
	Acute appendicitis	Count		125	34	198	357
		% within histopathology		35.0%	9.5%	55.5%	100%
	Acute ulcero-phlegmonose	Count	2	158	51	406	617
		% within histopathology	0.3%	25.6%	8.3%	65.8%	100%
	Chronic appendicitis	Count		105	14	135	254
		% within histopathology		41.3%	5.5%	53.1%	100%
	Malignant changes	Count		3		4	7
		% within histopathology		42.9%		57.1%	100%
	Acute perforated appendicitis	Count	1	25	14	75	115
		% within histopathology	0.9%	21.7%	12.2%	65.2%	100%
Total		Count	3	416	113	818	1350
			0.2%	30.8%	8.4%	60.6%	100%

Table 15: Number of patients with different histopathological findings in relation to method of stump closure

The Endo-GIA method of stump closure was used most frequently in all stages of appendicitis. In acute catarrhal inflammation it was used in 198 patients (55%). In chronic appendicitis, it was used in 135 patients (53.1%). Also in complicated histopathological findings the Endo-GIA was used more frequently than other methods. In acute ulcerative and necrotic appendicitis the Endo-GIA was used in 406 patients (65.8%). In perforated gangrenous appendicitis it was used in 75 patients (65.2%).The second most frequently used method, Endo-Clip, was used in 125 patients (35%) with acute catarrhal appendicitis and about 105 patients (41.3%) with chronic appendicitis. In acute ulcerative necrotic appendicitis, Endo-Clips were used as a method for stump closure in 158 patients (25.6%). Endo-Clip was also used for 25 patients (21.7%) with perforated gangrenous appendicitis.

The Endo-Loop method was used for 34 patients (9.5%) with acute catarrhal appendicitis, and in 14 patients (5.5%) with chronic appendicitis. The Endo-Loop was also used in 51 patients (8.3%) with acute ulcerative necrotic and in 14 patients (12.2%) with perforated gangrenous appendicitis [Table 15].

4.1.2.5 Operative complication in relation to method of stump closure

Postoperative complications			Method of stump closure				Total
			Ligature	Clips	Endo-Loop	Endo-GIA	
	No postoperative complication	Count	3	395	109	764	1271
		% within post OP complications	0.2%	31.1%	8.6%	60.1%	100%
	Minor complications	Count		7	1	16	24
		% within post OP complications		29.2%	4.2%	66.7%	100%
	Major complications	Count		8	3	26	37
		% within post OP complications		21.6%	8.1%	70.3%	100%
	General complications	Count		3		6	9
		% within post OP complications		33.3%		66.7%	100%
	Others	Count		3		6	9
		% within post OP complications		33.3%		66.7%	100%
Total		Count	3	416	113	818	1350
			0.2%	30.8%	8.4%	60.6%	100%

Table 16: Frequency of postoperative complications in relation to the method of stump closure

From the total number of 1350 laparoscopic appendectomy patients, 1271 (94.15%) were without postoperative complications and 79 patients (5.85%) with postoperative complications. Minor complications included local wound complications, wound haematoma, wound infection and wound abscess. General complications included pulmonary, cardiac and urinary system complications. Other complications comprised gastrointestinal complications, gastroenteritis or peptic ulcer disease. Major postoperative complications included paralytic ileus, postoperative intraabdominal bleeding, intraabdominal collections, or intraabdominal septic complications and abscesses.

An analysis of the relationship between the method of stump closure and the major postoperative complications revealed that [Table 16] from the total number of 37 patients with major postoperative complications, there were 26 patients (70.3%) with Endo-GIA, 8 patients (21.6%) with clips and 3 patients (8.1%) with Endo-Loop.

A comparison of the number of patients with major postoperative complications with the methods of stump closure showed that, from 818 patients with Endo-GIA, 26 patients (3.18%) had major postoperative complications. Out of 416 patients with clips 8 patients (1.9%) had major postoperative complications. Regarding the Endo-Loop, out of 113 patients there were 3 patients (2.6%) with major postoperative complications. Comparing the three methods regarding the number of cases with major post operative complications, there was no statistically significant differences between clips and staplers (P=0.203), between clips and Endo-Loop (P=0.629), or between stapler and Endo-Loop (P=0.764).

4.1.2.6 Postoperative hospital stay in relation to stump closure methods

Method of stump closure	Number of patients	Minimum (in days)	Maximum (in days)	Mean (in days)	Standard Deviation
Ligature	3	4	7	5.7	1.5
Lapro-Clips	416	1	20	3.2	2.3
Endo-Loop	113	1	21	3.4	2.3
Endo-GIA	818	1	23	3.9	2.6

Table 17: Postoperative hospital stay for patients with various methods of stump closure

Studying the length of the postoperative hospital stays for patients of different methods of stump closure revealed that all three groups of patients (Clips, Endo-Loop and Endo-GIA) had the same minimum hospital stay of one day [Table 17]. For the Endo-GIA patients, the maximum stay was 23 days and the mean was 3.9 days. Regarding the Endo-Clips method, the maximum stay was 20 days and the mean was 3.2 days. With the Endo-Loop method, the maximum stay was 21 days and the mean was 3.4 days. Regarding the postoperative hospital stays, there were statistically significant shorter postoperative hospital stays for patients with Clips compared to patients with Endo-GIA (P<0.001). Patients with Endo-GIA had statistically significant longer post operative hospital stays compared to patients with Endo-Loop (P=0.050). Patients with Clips had shorter postoperative hospital stays compared to patients with Endo-Loop (P=0.031).

4.1.2.7 Reoperation in relation to methods of stump closure

Reoperation			Method of stump closure				Total
			Ligature	Clips	Endo-Loop	Endo-GIA	
	No reoperation	Count	3	402	110	786	1301
		% within reoperation	0.2%	30.9%	8.5%	60.4%	100%
	Local wound management	Count		3		7	10
		% within reoperation		30.0%		70.0%	100%
	Relaparoscopy	Count		9	3	16	28
		% within reoperation		32.1%	10.7%	57.1%	100%
	Laparotomy	Count		1		7	8
		% within reoperation		12.5%		87.5%	100%
	Others	Count		1		2	3
		% within reoperation		33.3%		66.7%	100%
Total		Count	3	416	113	818	1350
			0.2%	30.8%	8.4%	60.6%	100%

Table 18: Patients with reoperation in relation to method of stump closure

Out of 818 patients with Endo-GIA used for appendiceal stump closure, 32 patients (3.9%) had reintervention [Table 18]. From these 32 patients, 16 (2 %) underwent relaparoscopy and 7 (0.9%) had laparotomies. In 416 patients with Endo-Clips, there were 14 patients (3.4%) with reintervention, 9 cases (2.2 %) with relaparoscopy and one case (0.2%) with laparotomy. Out of 113 Patients with Endo-Loop, there were 3 patients (2.7%) who needed reintervention; all 3 patients received a relaparoscopy. No significant differences were noted in reoperation numbers between patients with clips and Endo-Loops (P=0.491) and between clips and staplers (P=0.380). Comparing post operative stays for staplers and Endo-Loops patients, there were no statistically significant differences (P=0.368).

4.1.3 Drains in laparoscopic appendectomy

4.1.3.1 Numbers of patients with and without of drains

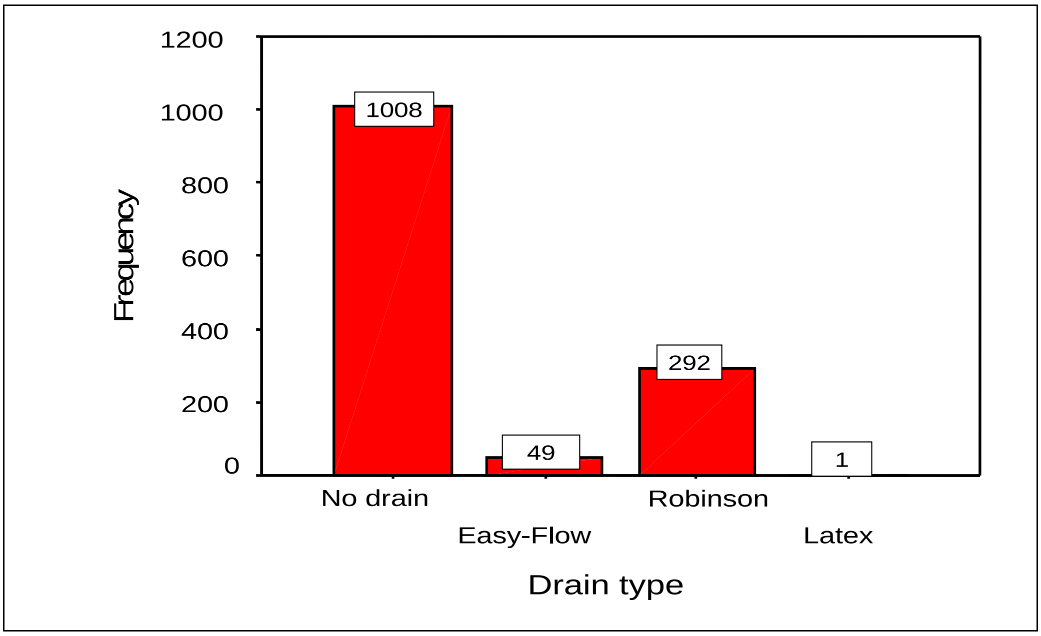

Figure 10: Number of patients in relation to drain used and the type of drain

Out of a total number of 1350 patients who completed as laparoscopic appendectomy procedure, 1008 patients (74.7%) did not require drains, and 342 patients (25.3%) required drains.

In patients where a drain was required, the largest number of patients, 292 patients (85.4%) received a Robinson drain. For 49 patients (14.3%) an Easy-Flow drain was used. In one patient (0.3%) a latex drain was used [Figure 10].

4.1.3.2 Histopathology in relation to drain used

For patients where no drain was required, there were 322 patients (31.9%) with acute appendicitis without necrosis or perforation. 447 patients (44.3%) were with high grade acute inflammation with necrosis. There were 229 (22.7%) chronic appendicitis patients. There were 7 patients (0.7%) with perforated appendix and 3 patients (0.3%) with neoplastic changes.

In patients where a drain was used [Table 19], there were 35 (10%) with acute appendicitis without necrosis or perforation. One hundred and seventy patients (49.7%)

had a high grade acute inflammation with necrosis. Twenty five patients (7.3%) had a chronically inflamed appendix. 108 patients (31.5%) had a perforated appendix and 4 patients (1.1 %%) had neoplastic changes. There is a statistically significant higher number of patients with perforated and gangrenous appendicitis among the patients where a drain was used compared to patients without a drain (P<0.001).

In 292 patients with a Robinson drain, there were 146 (50%) with necrotic appendicitis and 90 (30.8%) with a perforation. Thirty one patients (10.6%) had acute catarrhal inflammation and 21 patients (7.2%) had a picture of chronic inflammation. In 4 patients (1.4 %) there were neoplastic changes.

Out of 49 patients with the Easy-Flow drain, 24 (49%) had necrotic and high grade acute inflammation of the appendix without perforation, and 17 patients (34.6%) had perforated appendix. Four patients (8.2%) had catarrhal inflammation of the appendix, and another 4 patients (8.2%) had a chronic inflammation of the appendix.

Drain type			Histopathology					
			Acute appendicitis	acute ulcero-phlegmonose	Chronic appendicitis	Malignant changes	Acute perforated appendicitis	Total
	No drain	Count	322	447	229	3	7	1008
		% within drain type	31.9%	44.3%	22.7%	0.3%	0.7%	100%
		% within histopathology	90.2%	72.4%	90.2%	42.9%	6.1%	74.7%
	Easy-Flow	Count	4	24	4		17	49
		% within drain type	8.2%	49.0%	8.2%		34.7%	100%
		% within histopathology	1.1%	3.9%	1.6%		14.8%	3.6%
	Robinson	Count	31	146	21	4	90	292
		% within drain type	10.6%	50.0%	7.2%	1.4%	30.8%	100%
		% within histopathology	8.7%	23.7%	8.3%	57.1%	78.3%	21.6%
	Latex	Count					1	1
		% within drain type					100%	100%
		% within histopathology					0.9%	0.1%
Total		Count	357	617	254	7	115	1350
			26.4%	45.7%	18.8%	0.5%	8.5%	100%

Table 19: The histopathological results for patients with and without drain

4.1.3.3 Intraoperative complications in relation to drains

There were 4 patients with intraoperative complications. In two patients complications were detected at the time of the ongoing operation and the operation was converted to conventional procedure. In these two patients, one had small bowel injury and a Latex drain was used. The other patient had ascending colon injury and a Robinson drain was used.

In the other two patients, complications were discovered later in the postoperative period. Both patients were operated upon and a Robinson drain was used for each patient.

4.1.3.4 Postoperative complications in relation to drains

Drain type			Postoperative complications					Total
			No complications	Minor complications	Major complications	General complications	Others	
	No drain	Count	973	16	12	4	3	1008
		% within drain type	96.5%	1.6%	1.2%	0.4%	0.3%	100%
	Easy-Flow	Count	39	1	6	1	2	49
		% within drain type	79.6%	2%	12.2%	2%	4.1%	100%
	Robinson	Count	258	7	19	4	4	292
		% within drain type	88.4%	2.4%	6.5%	1.4%	1.4%	100%
	Latex	Count	1					1
		% within drain type	100%					100%
Total		Count	1271	24	37	9	9	1350
			94.1%	1.8%	2.7%	0.7%	0.7%	100%

Table 20: Postoperative complications in relation to drain use and type of drain

From the total number of 1008 patients who required no drains, there were 973 patients (96.5%) without postoperative complications. Minor local wound complications were detected in 16 patients (1.6%). Major postoperative complications were detected in 12 patients (1.2%). General complications such as respiratory and urinary complications were detected in 4 patients (0.4%). There were 3 patients (0.3%) with other gastrointestinal postoperative complications, like gastro enteritis or gastritis [Table 20].

Out of 342 patients with drains, there were 298 (87.1%) without postoperative complications. Eight patients (2.3%) had minor complications, 25 patients (7.3%) had major postoperative complications, 5 patients (1.4%) had general postoperative complications, and in 6 patients (1.7%) other gastrointestinal complications were recorded, like gastroenteritis and gastritis. Patients with drains had a statistically significant higher rate of major postoperative complications compared to patients without drains ($P<0.0001$).

In 292 patients a Robinson drain was used, 258 patients of whom (88.4%) had no postoperative complications, 19 patients (6.5%) had major postoperative complications and 7 patients (2.4%) had local wound complications. Four patients (1.4%) had general postoperative complications and 4 patients had other gastrointestinal complications.

Out of 49 patients who had Easy-Flow drains, 39 patients (79.6%) had no postoperative complications, 6 patients (12.2%) had major postoperative complications, and two patients (4.1%) had gastroenteritis postoperatively. One patient (2%) had a local wound infection and one patient (2%) had general postoperative complications. The patient with a latex drain had no postoperative complications recorded. There were no statistically significant differences between the two types of drains regarding the number of patients with postoperative complications (P=0.142), and regarding the major postoperative complications (P=0.131).

4.1.3.5 Postoperative hospital stay in relation to drains

Our studies and comparisons of the postoperative hospital stays for 1008 patients without a drain showed that the minimum postoperative hospital stay was 1 day, the maximum stay was 20 days and the mean was 3 days with a standard deviation 1.8 days. In 342 patients with drains, the minimum stay was one day, the maximum stay was 23 days, and the mean was 5.4 days with a standard deviation of 3.3 days. Patients with drains had statistically significant longer post operative hospital stays than patients without drain (P<0.001).

Robinson drain was used in 292 patients. Minimum postoperative hospital stay was one day, the maximum stay was 23 days, and the mean was 5.1 days with a standard deviation of 3.2 days. An Easy-Flow drain was used in 49 patients. Minimum postoperative hospital stay was one day, the maximum stay was 20 days, and the mean postoperative stay was 6.6 days with a standard deviation of 3.3 days. Patients with an Easy-Flow drain had statistically significant longer postoperative hospital stays than patients with a Robinson drain (P<0.001).

4.1.3.6 Reoperation in relation to drains

Reviewing the data of patients who required reintervention, the following results were noted [Table 21]. Out of 1008 patients without a drain, 990 patients (98.2%) required no reintervention. Nine patients (0.9%) had relaparoscopy. Laparotomy was required in 3 patients (0.3%). Five patients (0.5%) had local wound management. One patient required tracheotomy for post operative severe pulmonary infection.

Out of 342 Patients with drains, 311 patients (91%) required no reintervention and 19 patients (5.5%) had relaparoscopy. Laparotomy was required in 5 patients (1.4%) and another 5 patients (1.4%) had local wound management. Patients with drains had statistically significant higher rates of reintervention compared to patients without drains (P<0.001).

In 292 patients with Robinson drains, 267 patients (91.4%) required no reintervention. 14 patients (4.8%) underwent relaparoscopy. A laparotomy was required for 5 patients (1.7%), and another 5 patients (1.7%) required local wound management. Adenocarcinoma of the appendix was found in one patient, who consequently underwent a right hemicolectomy. Easy-Flow drains were used in 49 patients, 43 (87.8%) of them required no reintervention. In 5 patients (10.2%) relaparoscopy was required. One patient (2%) underwent laparoscopic cholecystectomy during the postoperative stay.

No statistically significant differences were noted when comparing the numbers of reoperation required for patients with Easy-Flow drain and patients with Robinson drain (P=0.249).

Drain type			Reoperation					Total
			No reoperation	Local wound management	Relaparo-scopy	Laparotomy	Others	
	No drain	Count	990	5	9	3	1	1008
		% within drain type	98.2%	0.5%	0.9%	0.3%	0.1%	100%
	Easy-Flow	Count	43		5		1	49
		% within drain type	87.8%		10.2%		2%	100%
	Robinson	Count	267	5	14	5	1	292
		% within drain type	91.4%	1.7%	4.8%	1.7%	0.3%	100%
	Latex	Count	1					1
		% within drain type	100%					100%
Total		Count	1301	10	28	8	3	1350
			96.4%	0.7%	2.1%	0.6%	0.2%	100%

Table 21: Patients with reoperation in relation to drain use and type of drain

4.1.4 Conversion to conventional appendectomy patients

4.1.4.1 Patients' numbers, gender and age

The surgical procedure was started laparoscopically in 1397 patients. 47 patients (3.4%) out of this number had conversion to conventional procedure and 1350 patients (96.6%) were completed as laparoscopic procedure [Figure 11].

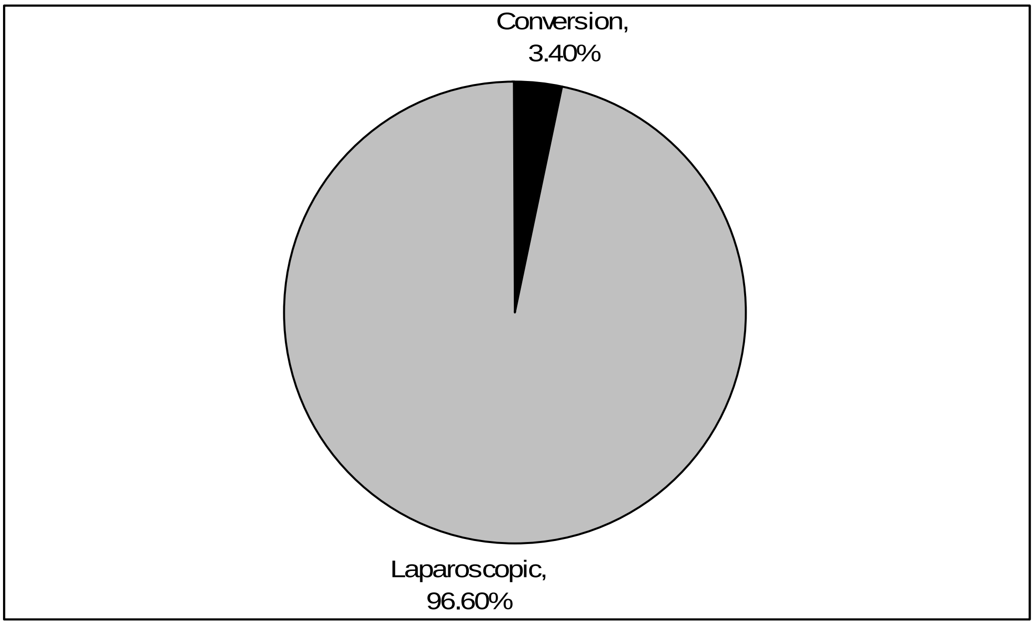

Figure 11: Number of conversion cases and completed laparoscopic cases

Of the 47 patients who underwent conversion, 27 patients were male (57.4%) and 20 patients were female (42.6%). There was a statistically significant higher number of male patients compared to female patients with conversion (P=0.030).

An analysis of the ages of patients with conversion at the time of the operation showed that the number of conversion cases was higher in the older age group. There were 8 patients in the age group 50-60 years and in the age group 60-70 years. There were 7 patients with conversion in the age group 70-80 years and in the age group 30-40 years. In the age group above 80 years there were two patients. There were two patients in the children's group under 10 years. In the age group 10-20 years there were 5 patients with conversion.

4.1.4.2 Reasons for conversion

Studying the reasons for conversion to conventional appendectomy in the 47 patients with conversion [Table 22], we found that in more than half of the patients with conversion (26 patients, 55.3%) the reason for conversion to a conventional appendectomy was perforation of the appendix and severe peritonitis. In 10 patients (21.3%) the reason for conversion was the anatomical position of the appendix in the retrocecal position with difficulty localizing the base of the appendix. Severe intraabdominal adhesions were the reason for conversion in 7 patients (14.9%).

Two patients (4.3%) had an iatrogenic perforation of the bowel and were converted to conventional procedure. One patient had injury to the ascending colon and the other patient had injury to the small intestine.

One patient was converted to the conventional procedure because of severe ileus and dilated loops of the small intestine. Another patient had omental necrosis and was converted to a conventional procedure

Reasons for conversion	Number of patients
Perforation of the appendix and sever peritonitis	26
Retrocecal position of the appendix and difficult to identify the base	10
Severe adhesions	7
Iatrogenic injury to the bowel	2
Other causes	2 (one case due to severe ileus and distended small bowel loops and the other case due to greater omentum necrosis)
Total number	47

Table 22: Reasons for conversion

4.1.4.3 Years of operation

From 97 patients in the year 1999, there were 3 patients with conversion. The conversion rate was 3.1%. In 2000, there were 7 patients out of 84 who underwent conversion (8.3%). The following year, 2001, the conversion rate was 4.8 % (8 patients out of 164 attempted laparoscopic appendectomy patients). In the year 2002, there were 10 conversion patients (4.4%) out of 226. The year 2003 had a conversion rate 3.4%, with 8 conversion patients out of 238. The following year, 2004, had 7 conversion patients (3.2%) out of 218. In the year 2005, there were 3 conversion patients (1.2%) out of 258. In the last year of the study, 2006, there were 112 patients in which only 1 of them (0.9%) converted to conventional appendectomy [Table 23]. There was a significant difference in conversion rate, the conversion rate in the last years of the study being lower when compared to the first years (P=0.003) [Figure 12].

Year	Laparoscopic patients	Conversion patients	Total number of patients	Rate of conversion
1999	94	3	97	3.1%
2000	77	7	84	8.3%
2001	156	8	164	4.8%
2002	216	10	226	4.4%
2003	230	8	238	3.4%
2004	211	7	218	3.2%
2005	255	3	258	1.2%
2006	111	1	112	0.9%
Total	1350	47	1397	

Table 23: The conversion rate and the number of conversion patients over the period of the study

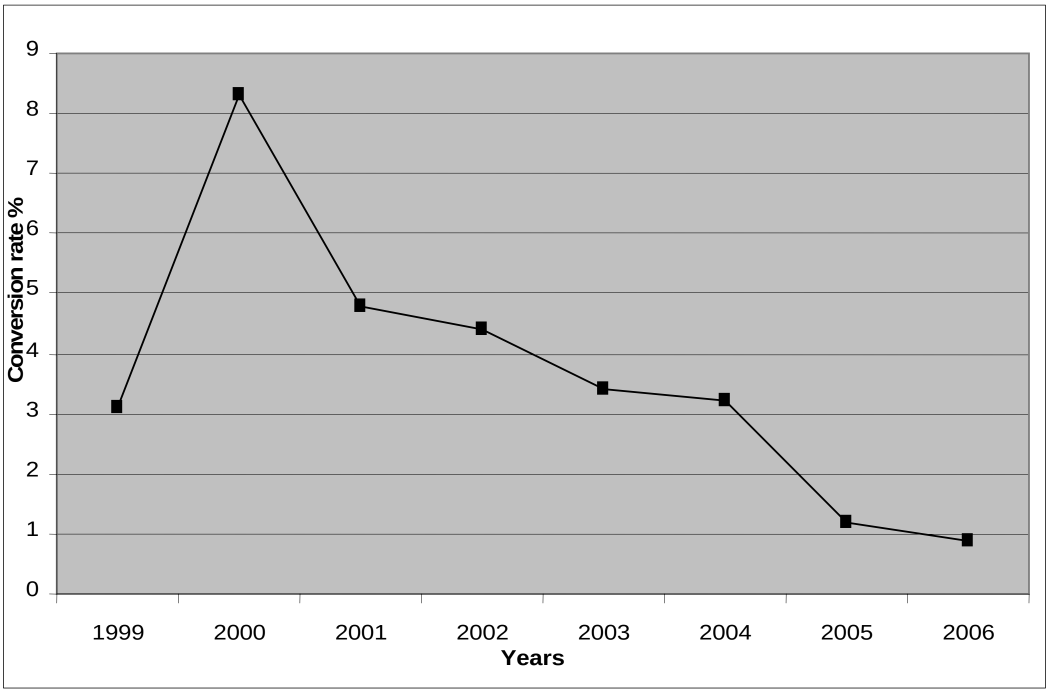

Figure 12: The conversion rate percentage over the period of the study

4.1.4.4 Previous abdominal operations

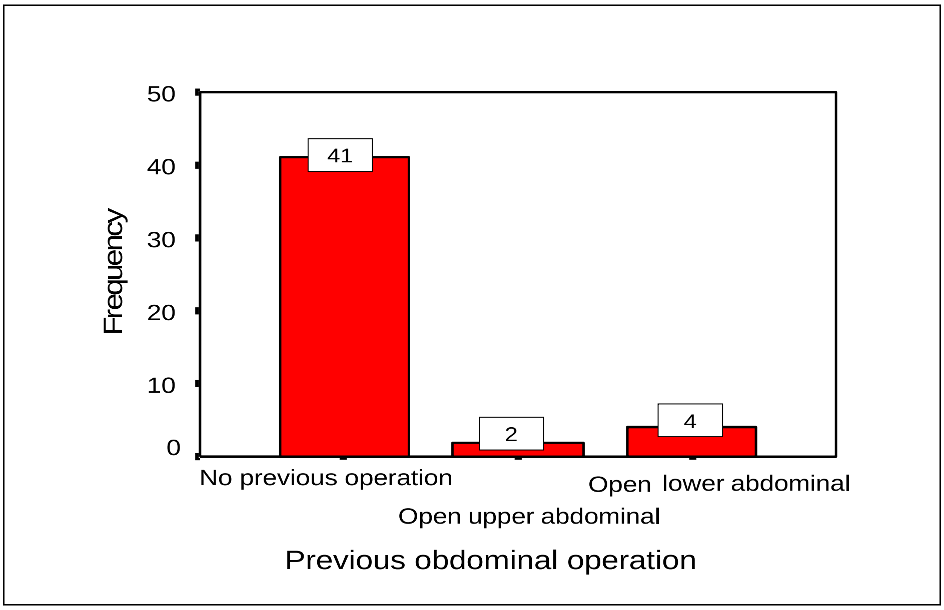

Figure 13: Pre abdominal operation in relation to patients of conversion

In analysing the data for patients with conversion to determine if the patients had previous abdominal operations, we obtained the following results. 41 patients (87.2%) out of the 47 patients with conversion had no previous abdominal operations [Figure 13].

Two patients (4.3%) had a previous upper abdominal operation with conventional incision. One patient had conventional cholecystectomy and the other one had a traumatic splenectomy. Four patients (8.5%) had lower conventional abdominal operations. Two of them had a lower median laparotomy, one of them had prostatectomy and the other one had a hysterectomy with bilateral ovariectomy. One patient had an inguinal hernia, and another had a caesarean incision. No significant differences in conversion rates were detected between patients with and without previous abdominal operations (P=0.392). Also, there were no significant differences in conversion rates between patients with and those without previous conventional lower abdominal operation (P=0.199).

4.1.4.5 Histopathology of conversion patients

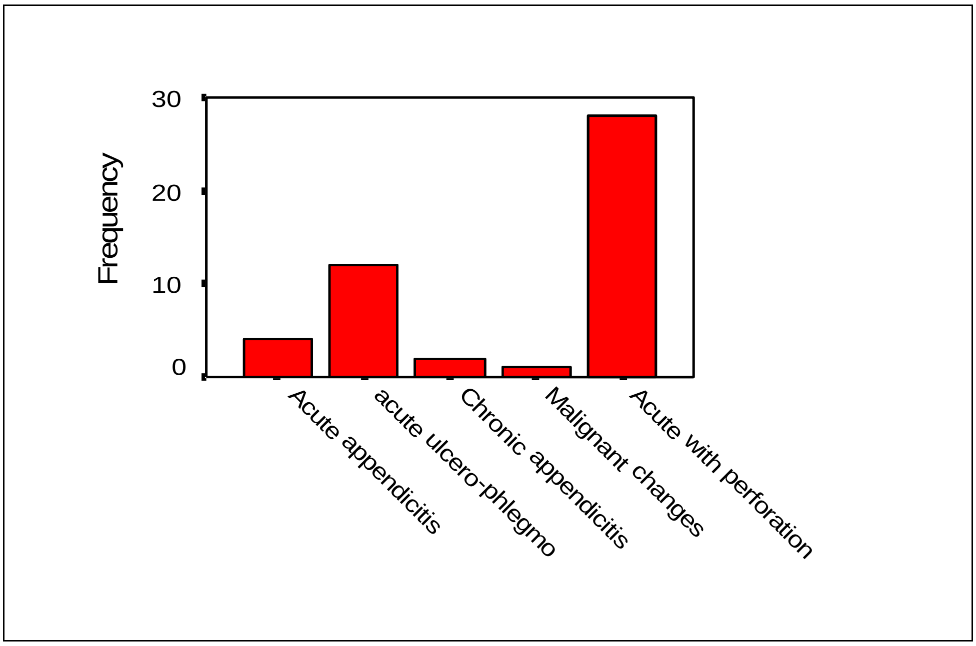

Figure 14: Histopathology of conversion patients

By studying the histopathological reports of the 47 patients with conversion the following was noticed [Figure 14]. 28 patients (59.6%) had acute perforated appendicitis.12 patients (25.5%) had ulcerative necrotic appendicitis. There were 4 patients (8.5%) with acute catarrhal appendicitis. Two patients (4.3%) had chronic appendicitis. One patient (2.1%) had a carcinoid tumour of the appendix. Among the patients with acute appendicitis, patients with perforation showed a significant higher rate of conversion than patients without perforation (P<0.0001), and also a higher rate than patients with chronic appendicitis (P<0.0001). There was no statistically significant difference between rates of conversion in patients with chronic appendicitis and patients with acute nonperforated appendicitis (P=0.339).

Analyzing the histopathological findings for patients with and without conversion, the following observations were noticed [Table 24]. The highest rate of conversion was among the patients with acute perforated appendicitis. 28 patients (19.6%) had conversion out of 143 patients with acute perforated appendicitis. In acute appendicitis without perforation, 4 patients had conversion (1.1%) out of 361 patients. The patients with perforation had statistically significant increased conversion rate compared to patients without conversion (P<0.0001).

Histopathological finding	Laparoscopic	Conversion	Total	Conversion rate %
Acute catarrhal appendicitis	357	4	361	1.1%
Acute ulcerative appendicitis	617	12	629	1.9%
Chronic appendicitis	254	2	256	0.8%
Malignant changes	7	1	8	12.5%
Acute perforated appendicitis	115	28	143	19.6%
Total	1350	47	1397	

Table 24: Histopathological findings of patients with conversion in comparison to patients without conversion

4.1.4.6 Operating time for patients with conversion

In patients with conversion, the minimum operating time was 35 minutes. The maximum operating time was 165 minutes. The median was 87minutes and the standard deviation was 31. Out of 47 patients with conversion, 28 patients (59.6%) had operating times between 60 and 120 minutes. 11 patients (23.4%) had operating times of less than 60 minutes, and 8 patients (17%) had operating times of more than 120 minutes. The operating times for patients with conversion are statistically significant longer compared to operating times for patients without conversion ($P<0.0001$).

4.1.4.7 Operative complication in patients with conversion

There were 40 patients (85.1%) out of the 47 patients with conversion who had no postoperative complications [Figure 15]. Four patients (8.5%) had general complications. Two patients had pulmonary infections and the other two had urinary infections.

Two patients (4.3%) had minor postoperative complications. One patient had a wound infection and was treated by local measures. The other patient had a minor intraabdominal collection, which was resolved conservatively. There was one patient (2.1%) with major postoperative complication in the form of an abdominal wound dehiscence of median laparotomy incision, which was treated by reoperation and lavage. The patients with conversion were associated with a statistically significant higher number of postoperative complications than patients without conversion

(P=0.022). There was no statistically significant difference regarding the number of major postoperative complications in the two groups (P=0.632).

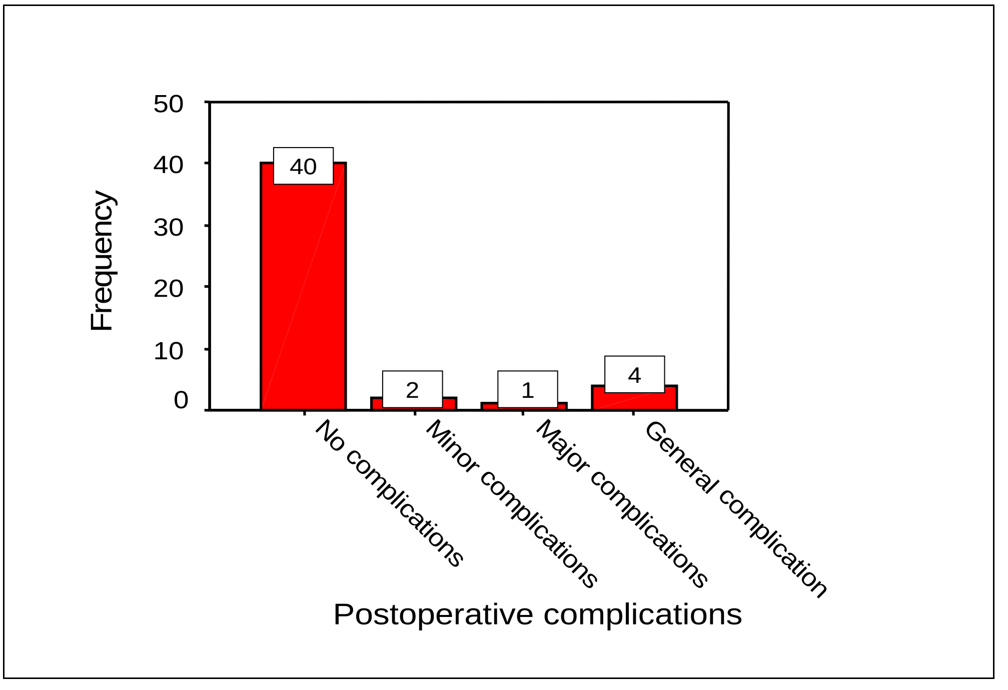

Figure 15: Postoperative complications in patients with conversion

4.1.4.8 Postoperative hospital stay for patients with conversion

The minimum postoperative hospital stay for the patients with conversion was 4 days and the maximum stay was 24 days. The mean postoperative hospital stay was 9.9 days, and the standard deviation was 4.2. The minimum postoperative hospital stay for patients without conversion was one day and the maximum stay was 23 days. The mean postoperative hospital stay was 3.6 days and the standard deviation was 2.5 [Table 25].

The postoperative hospital stay was statistically significant longer for patients with conversion compared to patients without conversion (P<0.001).

Technique	Minimum (days)	Maximum (days)	Mean (days)	Standard Deviation
Laparoscopic (1350 patients)	1	23	3.6	2.5
Conversion (47 patients)	4	24	9.9	4.2

Table 25: Postoperative hospital stay for patients with and without conversion in days

4.1.4.9 Reoperation in patients with conversion

There were 45 patients (95.7%) without postoperative reintervention after the primary operation [Figure 16]. Two patients (4.3%) from a total of 47 patients with conversion underwent reoperation. One patient, who had a perforated appendicitis and generalised peritonitis, was reoperated on one week after the appendectomy operation. This patient had a dehiscence in a median abdominal laparotomy incision. A histopathological examination revealed that the other patient had an adenocarcinoid of the appendix. He underwent a right hemicolectomy one week later.

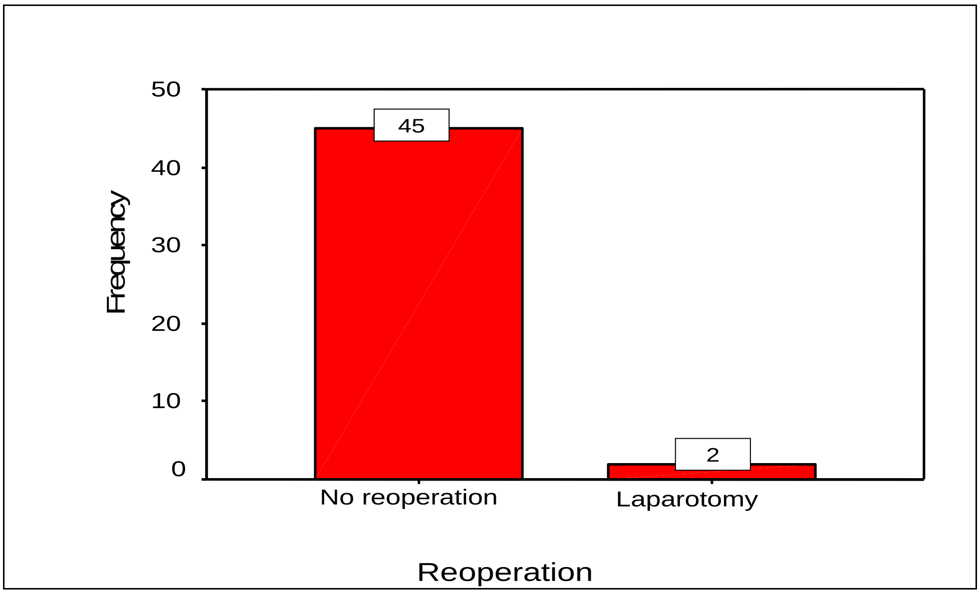

Figure 16: Patients with and without reoperation among the patients with conversion

4.2 Results of laparoscopic appendectomy as training operation

4.2.1 Patients' number, gender, and age

During the study period from first of January 1999 till end of June 2006 there were 1350 completed laparoscopic appendectomy operations. From this number, 697 were performed by consultant surgeons (51.6%) and 653 performed by resident surgeons (48.4%).

Surgeons	Patients		
	Female	Male	Total
Consultants	393	304	697
Residents	383	270	653
Total	776	574	1350

Table 26: Numbers of patients for both groups of surgeons

The consultant surgeons operated on 393 females (56.4%) and 304 males (43.6%). The resident surgeons operated on 383 females (58.6%) and 270 males (41.4%) [Table 26]. Regarding the age of patients for the two groups of surgeons, for the consultant surgeons the youngest patient was 5 years old and the eldest patient was 90 years. The mean age was 31 years and the standard deviation was 18. Of the patients operated on by resident surgeons, the youngest patient was 7 years old and the eldest patient was 88 years with a mean age of 29 years and a standard deviation of 15. The consultant surgeons operated on a significantly greater number of older patients compared with resident surgeons ($P<0.001$).

Considering the ages of patients at the time of operation [Figure 17], the consultant surgeons operated on more patients in all patient age groups except in the age group 20-30 years. In these young patients the resident surgeons operated on more patients (212 patients for residents and 133 for consultants). In the children's group (patients less than 10 years old) the consultant surgeons operated on a larger number of patients compared to resident surgeons (42 for consultant surgeons and 14 for resident surgeons), as well as in patients above 60 years old (72 for consultant surgeons and 40 for resident surgeons).

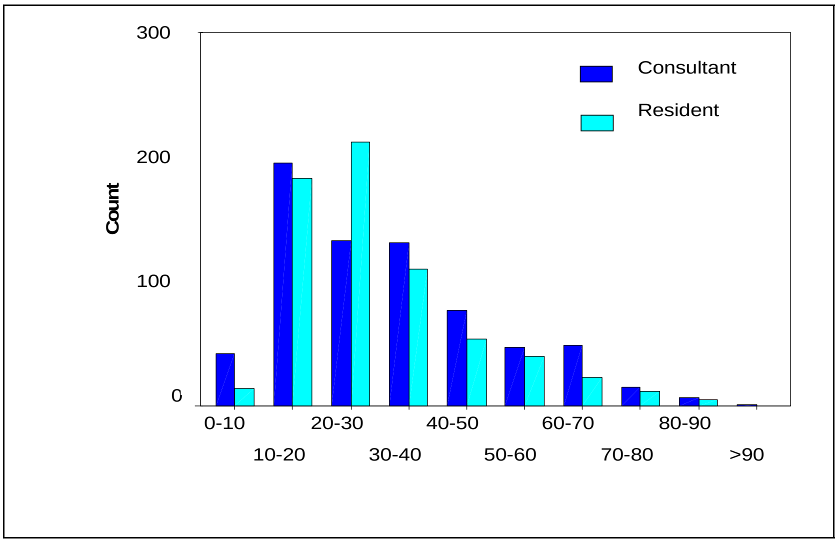

Figure 17: Ages of patients at operation time for both groups of surgeons

4.2.2 Day of operation

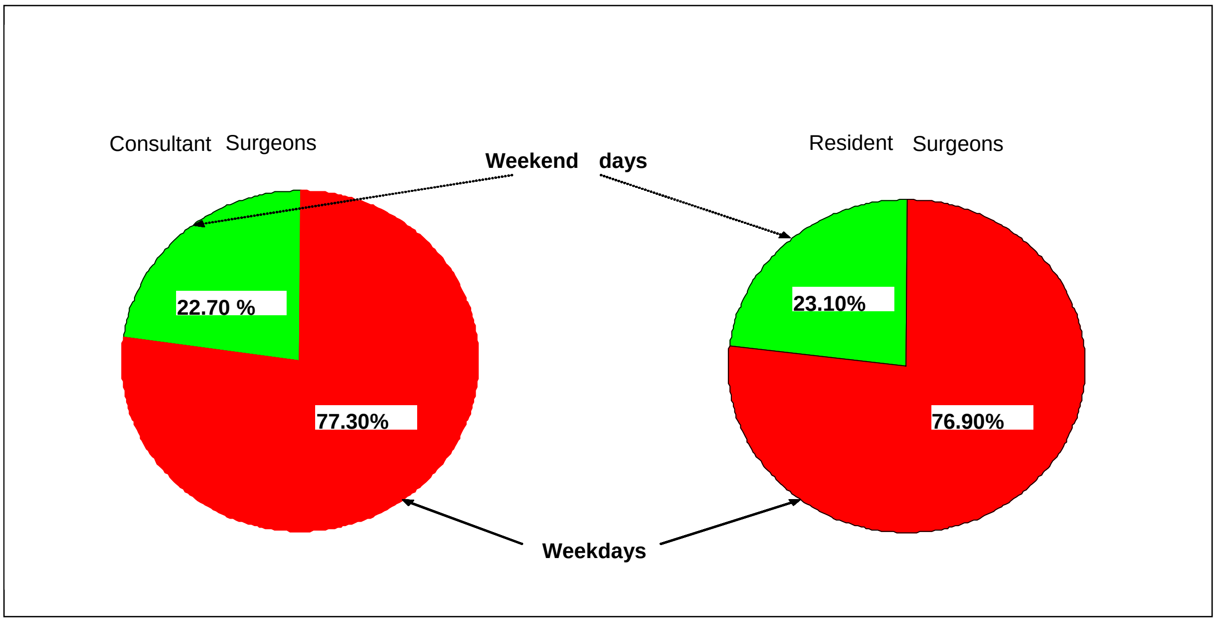

Figure 18: Day of operation

The consultant surgeons operated on 539 patients (77.3%) on weekdays and 158 patients (22.7%) on weekends. Surgical residents operated 502 patients (76.9%) on weekdays and 151 patients (23.1%) on weekends [Figure 18].

Comparing the number of patients operated upon on weekdays between the two groups, there was no statistically significant difference between the consultant surgeons and surgical residents (P=0.25). Also on weekends, there was no significant difference between the two groups of surgeons (P=0.69).

4.2.3 Time of operation

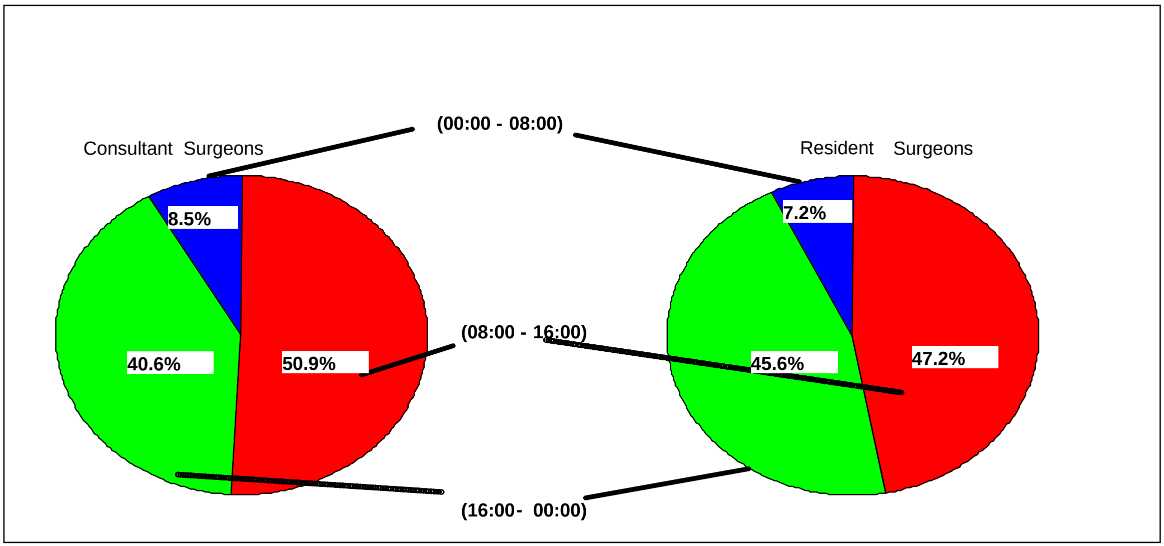

Figure 19: Time of operation

For studying the time of day of the operation, the 24 hours of the day can be divided into three divisions: from 08:00 to 16:00, from 16:00 to midnight and from midnight till next morning 8:00 o'clock [Figure 19]. For the consultant surgeons group, 355 (50.9%) patients were operated upon between 08:00 and 16:00, 283 (40.6%) patients between 16:00 and 00:00, and in the night between 00:00 and 08:00 of the next morning, there were 59 patients (8.5%).

Concerning the resident surgeons, 308 (47.2%) patients were operated on between 08:00 and 16:00, 298 patients (45.6) between 16:00 and 00:00, and 47 patients were operated on (7.2%) between 00:00 and 08:00 of the next morning. These results show that most appendectomy patients were operated on between 08:00 and 16:00, which are the ordinary working hours of the day. They also show that between 08:00-16:00, the consultant surgeons operated on a higher number of patients than resident surgeons, with no statistically significant differences (P=0.092). In the time period between 16:00-00:00 the resident surgeons operated on a significantly higher number of cases than consultant surgeons (P=0.035). During the time between 00:00-08:00, the consultant surgeons operated on larger number of cases, but with no statistically significant differences (P=0.223).

4.2.4 Operating Time

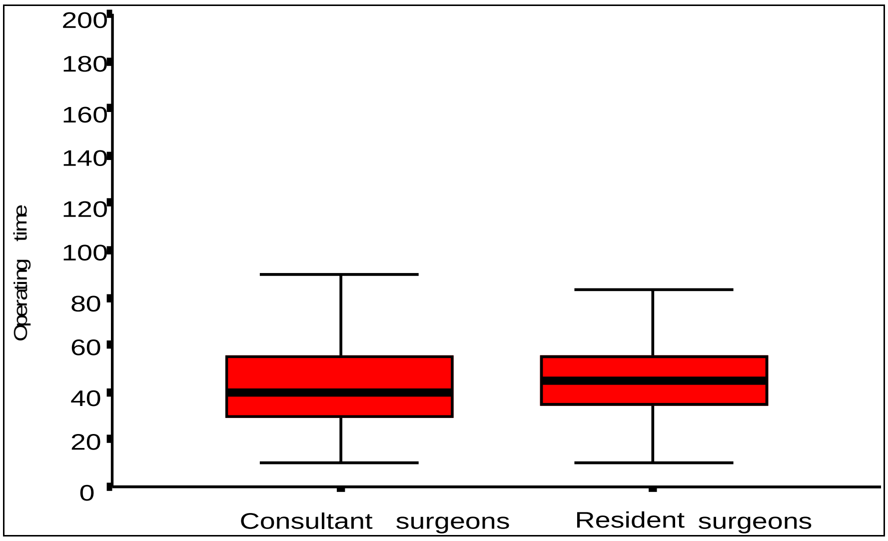

Figure 20: Operating time for both groups of surgeons

Regarding the duration of the operation for the two groups of surgeons, for the consultant surgeons the minimum operating time was 15 minutes and the maximum was 180 minutes. The mean was 46 minutes, and the standard deviation was 20.5 minutes. Regarding the group of resident surgeons, the minimum operating time was 20 minutes and the maximum was 155 minutes. The mean operating time of this group was 47.9 minutes, and the standard deviation was 17.8 minutes. The operating time for the consultant surgeons was significantly shorter than that for the resident surgeons (P<0.001) [Figure 20].

4.2.5 Previous abdominal operations

To show if patients with previous abdominal operations can be suitable to be operated upon by surgical residents, a review of patients with and without previous abdominal operation was done [Table 27]. In patients without previous abdominal operations, the consultant surgeons operated on a larger number (630 patients) than resident surgeons (576 patients). It was observed that resident surgeons also operated on almost the same number (33 patients) as consultant surgeons (32 patients) in the group of patients with previous lower abdominal operation. In patients with previous conventional abdominal procedures, 42 patients were operated by consultant surgeons, and 41 patients were operated by resident surgeons. For patients who had previous laparoscopic operations, 25 patients were operated by consultant surgeons and 35 patients were operated by resident surgeons.

There were no statistically significant differences between the two groups of surgeons concerning the number of patients with previous abdominal surgery operated by each group (P=0.114). Also there were no statistically significant differences for patients with previous open abdominal operations (P=0.468), and also for patients with previous laparoscopic procedures (P=0.074).

Previous abdominal operation		Surgeons		Total
		Consultants	Residents	
No previous operation	Count	630	576	1206
	% within pre-abdominal operation	52.2%	47.8%	100%
	% within surgeon	90.4%	88.2%	89.3%
	% of total	46.7%	42.7%	89.3%
Open upper abdominal	Count	10	8	18
	% within pre-abdominal operation	55.6%	44.4%	100%
	% within surgeon	1.4%	1.2%	1.3%
	% of total	0.7%	0.6%	1.3%
open lower abdominal	Count	32	33	65
	% within pre-abdominal operation	49.2%	50.8%	100%
	% within surgeon	4.6%	5.1%	4.8%
	% of total	2.4%	2.4%	4.8%
Lap. upper abdominal	Count	6	7	13
	% within pre-abdominal operation	46.2%	53.8%	100%
	% within surgeon	0.9%	1.1%	1%
	% of total	0.4%	0.5%	1%
Lap.lower abdominal	Count	19	27	46
	% within pre-abdominal operation	41.3%	58.7%	100%
	% within surgeon	2.7%	4.1%	3.4%
	% of total	1.4%	2%	3.4%
Diagnostic lap.	Count		1	1
	% within pre-abdominal operation		100%	100%
	% within surgeon		0.2%	0.1%
	% of total		0.1%	0.1%
More than one OP	Count		1	1
	% within pre-abdominal operation		100%	100%
	% within surgeon		0.2%	0.1%
	% of total		0.1%	0.1%
Total	Count	697	653	1350
		51.6%	48.4%	100%

Table 27: Distribution of patients with previous abdominal operations among the two groups of surgeons

4.2.6 Conversion rate

From the total number of 1397 patients with attempted laparoscopic appendectomies, 1350 patients (96.6%) were completed as laparoscopic procedures and 47 patients (3.4%) were converted to conventional appendectomies. For the consultant surgeons group, there were 29 patients from 726 attempted laparoscopic appendectomies (conversion rate 3.9%).The causes of conversion in these patients were the following: 15 patients (51.7%) due to macroscopic appendix perforation with massive peritonitis, 6 patients (21%) due to severe intraperitoneal adhesions in the lower right abdomen. The retrocecal position of the appendix and difficulty localizing the base was responsible for conversion in 5 patients (17.3%).There were two patients (7%) with iatrogenic injuries to the bowels: one patient had an injury to the small bowel and the other patient had an injury to the ascending colon. There was one patient (3.5%) with ileus and distended small bowels. No significant differences were noted between the conversion rates for the two groups of surgeons (P=0.113). In the resident surgeons group, there were 18 patients of conversion from a total number of 671 patients of attempted laparoscopic appendectomies (conversion rate 2.7%). The most common cause of conversion was the same as in the consultant group. There were 11 conversions (61%) due to macroscopic perforation of the appendix with severe peritonitis. The second most common cause of conversion was retrocecal position of the appendix with difficulty in localising the base of the appendix. This was the cause in 5 patients (27.7%). In one patient (5.6%) the conversion was due to severe intraperitoneal adhesions. There was one patient (5.6%) with greater omental necrosis of unknown cause [Table 28].

Causes of conversion	Consultant surgeons	Resident surgeons
Perforation of the appendix and severe peritonitis	15	11
Retrocecal position of the appendix and difficult to identify the base	5	5
Severe adhesions	6	1
Iatrogenic injury to the bowel	2	
Other causes	1(severe ileus of small bowel)	1(greater omentum necrosis)
Total number	29 (out of 726)	18 (out of 671)

Table 28: The causes of conversion in the two groups of surgeons

The mean operating time for conversion cases operated by consultant surgeons was 90 minutes (minimum 35 minutes, maximum 165 minutes with a standard deviation of 31 minutes).

For the surgical residents, the mean operating time was 82 minutes (minimum 40 minutes and maximum 165 minutes with a standard deviation of 32 minutes).

From the 29 patients of conversion in the group of consultant surgeons, 15 patients had perforated appendicitis and 9 patients had acute ulcerative necrotic appendicitis. The remaining 5 patients had 3 catarrhal inflammations, one patient had a chronic inflammation and one patient had carcinoid. Regarding resident surgeons, from the total number of 18 patients with conversion, 13 patients had perforated appendicitis and 3 patients had acute ulcerative necrotic appendicitis. Of the remaining two patients, one of them had catarrhal inflammation and the other one had chronic appendicitis.

4.2.7 Histopathology

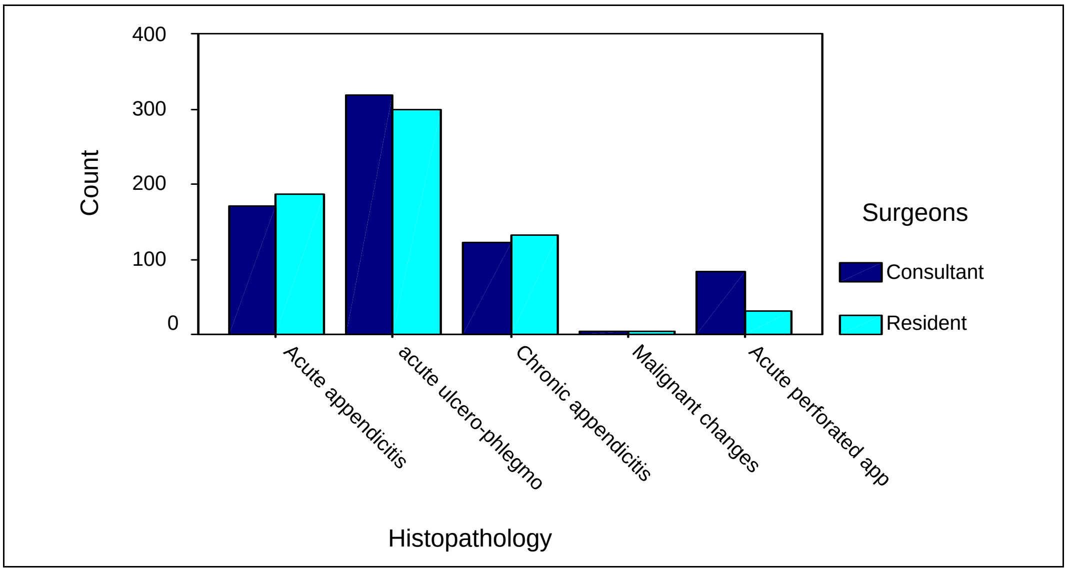

Figure 21: The histopathological results for completed laparoscopic patients for the two groups of surgeons

The histopathological findings for the patients with completed laparoscopic appendectomy for the two groups of surgeons were analysed [Figure 21]. For the consultant surgeons group, 401 patients (57.5%) out of 697 patients had appendicitis with complicated findings. 318 patients (45.6%) had acute ulcerative necrotic appendicitis and 83 patients (11.9%) had a perforated appendix. 170 patients (24.4%) had acute catarrhal appendicitis, 122 patients (17.5%) had chronic inflammation and 4 patients (0.5%) had neoplastic changes. Regarding the patients operated upon by the

resident surgeons, 331 patients (50.7%) out of a total number of 653 patients had appendicitis with complicated findings. 299 patients (45.8%) had acute ulcerative necrotic appendicitis and 32 patients (4.9%) had perforated appendix. 187 patients (28.6%) had acute catarrhal appendicitis, 132 patients (20.2%) had chronic inflammation, and 3 patients had neoplastic changes (0.4%).
There was no statistically significant difference between the two groups of surgeons regarding patients with chronic appendicitis (P=0.323). Consultant surgeons operated on a statistically significant higher number of patients with acute appendicitis without perforation than resident surgeons (P=0.039). Also, consultant surgeons operated on a statistically significant higher number of patients with perforated appendicitis than resident surgeons (P<0.001).

4.2.8 Operative Complications

Number of the case	Gender	Age of the patients	Year of operation	Operator	Complication	Procedure followed
Case 1	Male	20 Years	1999	Consultant surgeon	Iatrogenic injury to the small intestine	Laparotomy
Case 2	Male	10 Years	2000	Consultant surgeon	Iatrogenic injury to the small intestine	Conversion to conventional appendectomy
Case 3	Male	17 Years	2003	Resident surgeon	Iatrogenic injury to the ascending colon	Laparotomy
Case 4	Male	32 Years	2004	Consultant surgeon	Iatrogenic injury to the ascending colon	Conversion to conventional appendectomy

Table 29: Intraoperative complications for the two groups of surgeons

Regarding the operative complications, there were 4 patients with intraoperative complications from the total number of 1397 patients of attempted laparoscopic surgery (0.28%). All 4 patients were males. Three patients were operated upon by consultant surgeons and one patient by a resident surgeon. Two patients were converted to conventional appendectomy in the same session and two patients required explorative laparotomy later during the postoperative period. Two patients had small intestinal injury and the other two patients had ascending colon injury [Table 29].

A review of the results of both groups of surgeons in relation to postoperative complications shows that there were 646 patients (92.7%) without postoperative complications and 51 patients (7.3%) with postoperative complications in the consultant surgeons group. Regarding the resident surgeons group, there were 625 patients (95.7%) without postoperative complications and 28 patients (4.3%) with postoperative complications.

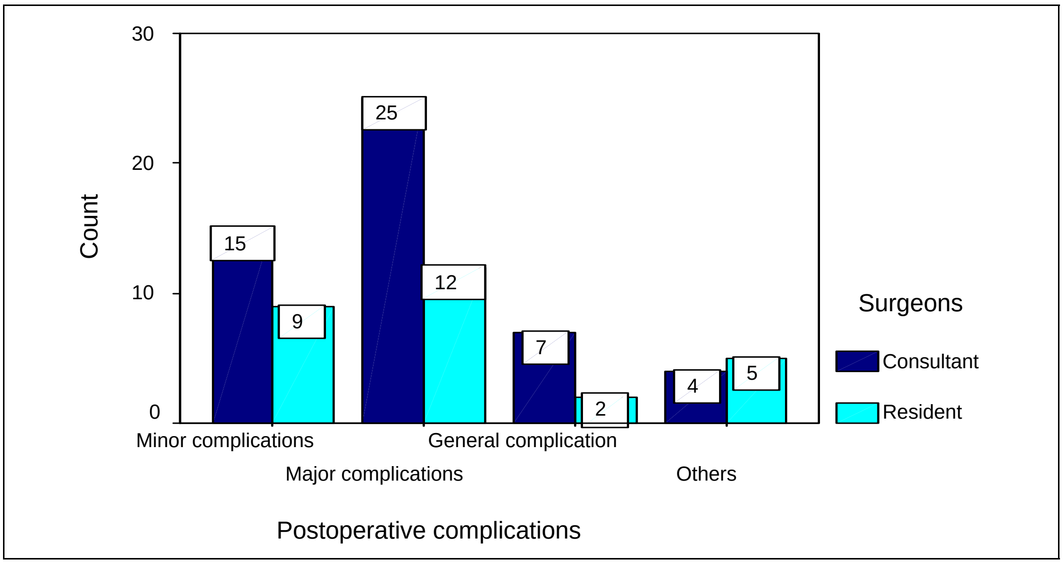

Figure 22: Postoperative complications for the two groups of surgeons

For the consultant surgeons [Figure 22], 15 patients (2.2%) had minor postoperative complications: 8 patients had local wound complications, 5 patients had intraabdominal seroma which required only conservative management and two patients had trocar site hernia. In these two patients a 13 mm trocar size were used in the left lower abdomen. 25 patients (3.6%) had major postoperative complications: 15 patients had intraabdominal abscess, 10 patients were treated by relaparoscopy and lavage, and the other 5 patients were treated with a laparotomy. The complication in one of these 5 patients was due to iatrogenic injury to the bowel during the laparoscopic procedure. Five patients had intraabdominal bleeding treated with relaparoscopy and lavage. Three patients had a paralytic ileus, two of whom needed relaparoscopy and adhesiolysis while the other one could be treated by conservative measures.

Two patients with stump abscess were reported, one of whom was treated with relaparoscopy and the other with explorative laparotomy. Seven patients (1%) were reported with postoperative general complications. Five patients had pulmonary complications and two patients had cardiac complications. All these patients were managed conservatively. Four patients (0.6%) were reported with other postoperative complications, two patients with gastroenteritis and one patient with peptic ulcer. The three latter patients were managed by conservative measures. One patient had difficult drain withdrawal. In this patient, relaparoscopy was done to enable the drain removal. This drain was an Easy-Flow drain [Table 30].

	Total number of patients	Management		
		Conservative	Operative	Relaparoscopy
Minor complications	15	8	7	
Wound infection	8	3	5	
Hernia in the trocar incision	2		2	
Intra-abdominal seroma	5	5		
Major complications	25	1	6	18
Intra-abdominal abscess	15		5	10
Intra-abdominal bleeding	5			5
Stump abscess	2		1	1
Paralytic ileus	3	1		2
General complications	7	7		
Cardiac complications	2	2		
Pulmonary complications	5	5		
Others	4	3		1
Gastroenteritis	2	2		
Peptic ulcer	1	1		
Difficult drain extraction	1			1
Total numbers	51	19	13	19

Table 30: Postoperative complications for patients operated by consultant surgeons

Of the 28 patients with postoperative complications in the resident surgeons group, there were 9 patients (1.4%) with minor complications. Six patients with wound infection of whom 5 were treated by operative management and one patient was treated conservatively.

Two patients were reported with intraabdominal seroma and were managed with conservative measures. One patient had a trocar site hernia and required operation later in the post operative period. 12 patients (1.8%) with major postoperative complications were reported in this group of surgeons. Eight patients had an intraabdominal abscess of whom 5 were managed by conservative measures and 2 required a relaparoscopy and lavage. One patient had an iatrogenic injury to the ascending colon and required a laparotomy. Two patients had intraabdominal bleeding, one of whom was managed by relaparoscopy and the other with a laparotomy. Two patients with paralytic ileus were managed conservatively.

Two patients (0.3%) had general postoperative complications, one of whom had a pulmonary infection and the other a urinary tract infection. Both patients were managed through conservative measures. There were 5 patients (0.8%) with other postoperative complications, 4 with gastroenteritis and one with duodenal ulcer postoperatively. All 5 patients were managed conservatively [Table 31].

	Total number of patients	Management		
		Conservative	Operative	Relaparoscopy
Minor complications	**9**	**3**	**6**	
Wound infection	**6**	**1**	**5**	
Hernia in the trocar incision	**1**		**1**	
Intra-abdominal seroma	**2**	**2**		
Major complications	**12**	**7**	**2**	**3**
Intra-abdominal abscess	**8**	**5**	**1**	**2**
Intra-abdominal bleeding	**2**		**1**	**1**
Paralytic ileus	**2**	**2**		
General complications	**2**	**2**		
Pulmonary complications	**1**	**1**		
Urinary tract complications	**1**	**1**		
Others	**5**	**5**		
Gastroenteritis	**4**	**4**		
Peptic ulcer	**1**	**1**		
Total numbers	**28**	**17**	**8**	**3**

Table 31: Postoperative complications for patients operated by resident surgeons

The consultant surgeons group had a statistically significant higher number of patients with postoperative complications compared to the resident surgeons group (P=0.012).

Especially the number of patients with major postoperative complications was statistically significant higher in consultant surgeons group compared to resident surgeons group (P=0.035).

4.2.9 Postoperative hospital stay

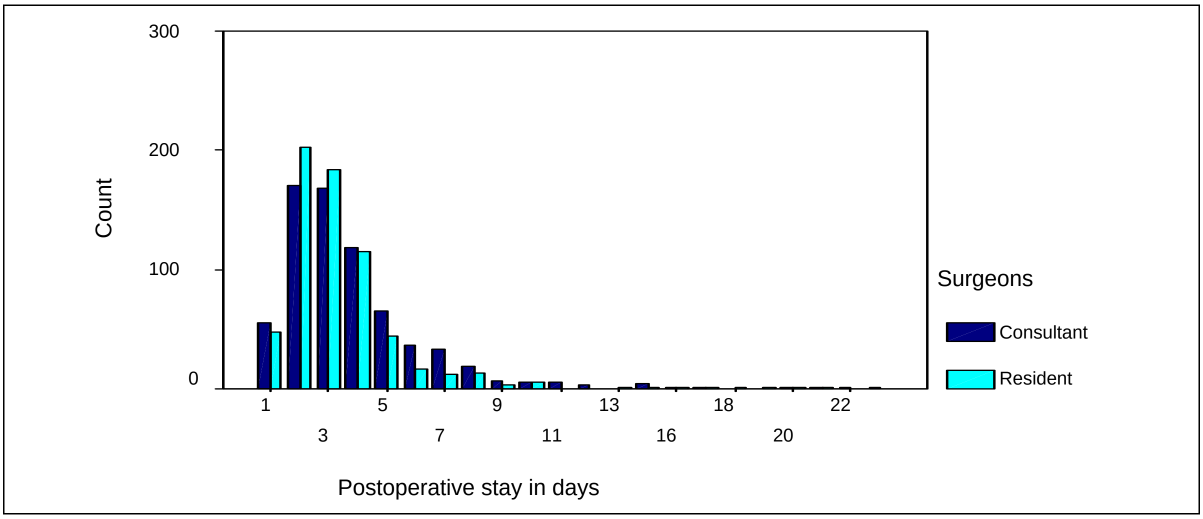

Figure 23: Postoperative hospital stay for both groups of surgeons

The postoperative stay for the patients from both groups of surgeons was also compared. For the consultant surgeons group, the minimum was 1 day and the maximum 23 days. The mean postoperative stay was 3.8 days. About 35% of the patients have postoperative stays of 2 days, and 90% of the patients were in the hospital for less than a week postoperatively [Figure 23].

Concerning the patients operated by the resident surgeons, the minimum was one day and the maximum 21 days. The mean postoperative stay was 3.4 days. About 38% of the patients have postoperative stays of 2 days, and 94% of the patients were in the hospital for less than a week postoperatively. Patients operated by resident surgeons had a statistically significant lower postoperative hospital stay than patients operated by consultant surgeons (P<0.001) [Table 32].

Surgeon group	Number of cases	Minimum (days)	Maximum (days)	Mean (days)	Standard Deviation
Consultants	697	1	23	3.8	2.65
Residents	653	1	21	3.4	2.27

Table 32: Postoperative stay for both groups of surgeons' patients

4.2.10 Reoperation

Of the total number of 1350 patients with completed laparoscopically, 49 patients (3.6%) required reoperation during the postoperative period.

For the consultant surgeons, from a total number of 697 patients, there were 33 patients (4.7%) who required reoperation. Five patients needed local wound management for a wound infection. 20 patients required relaparoscopy, 10 for intraabdominal abscess, 5 for intraabdominal bleeding and 2 for adhesiolysis of intraabdominal adhesions causing ileus postoperatively. One patient had a difficult Easy-Flow drain withdrawal and needed relaparoscopy and another one had stump abscess and also needed relaparoscopy. One patient had severe lower abdominal pain and required relaparoscopy for diagnosis of the cause of that pain. No pathological finding was discovered in that patient.

Six patients required explorative laparotomy, of whom 5 patients had intraabdominal abscess and one had stump abscess. Two other patients were reported with trocar site incisional hernia needing operative intervention to treat the hernia.

Of the total number of 653 patients operated by the resident surgeons, 16 patients (2.4%) required reoperation during the post operative period.

Five patients needed local wound management for wound infection. Eight patients required relaparoscopy: 4 patients with intraabdominal abscess, one patient with intraabdominal bleeding, and 3 patients had relaparoscopy for severe lower abdominal pain after the operation and in these 3 patients no pathological findings were discovered. Two patients underwent explorative laparotomy, one of whom had intraabdominal abscess and the other one had intraabdominal bleeding and subhepatic haematoma. One patient had a trocar site hernia postoperatively needing operative management for the hernia [Table 33].

Reoperation			Surgeons		Total
			Consultant	Resident	
	Local wound management	Count	5	5	10
		% within reoperation	50%	50%	100%
		% within surgeon	15.2%	31.3%	20.4%
		% of total	10.2%	10.2%	20.4%
	Relaparoscopy	Count	20	8	28
		% within reoperation	71.4%	28.6%	100%
		% within surgeon	60.6%	50%	57.1%
		% of total	40.8%	16.3%	57.1%
	Laparotomy	Count	6	2	8
		% within reoperation	75%	25%	100%
		% within surgeon	18.2%	12.5%	16.3%
		% of total	12.2%	4.1%	16.3%
	Others	Count	2	1	3
		% within reoperation	66.7%	33.3%	100%
		% within surgeon	6.1%	6.3%	6.1%
		% of total	4.1%	2%	6.1%
Total		Count	33	16	49
		% within reoperation	67.3%	32.7%	100%

Table 33: Patients with reoperation for the two groups of surgeons

There was a statistically significant lower number of patients who needed reoperation in the group of patients operated by resident surgeons compared to the group of patients operated by consultant surgeons (P=0.017). The number of patients who needed relaparoscopy was significantly lower in the resident surgeons group (P=0.026). There was no statistically significant difference between the two groups of surgeons with regard to the number of patients who needed relaparotomy (P=0.166).

5. Discussion

During the time period between the first of January 1999 and the end of June 2006, 1473 patients underwent an appendectomy operation for suspected appendicitis. The laparoscopic technique is the routine technique to treat patients with suspected appendicitis in DRK-Kliniken-Westend in Berlin, where this retrospective study was carried out. Of these 1473 appendectomy procedures, 1397 (94.85%) were started as laparoscopic procedures. The procedure was completed laparoscopically in 1350 patients (96.6%) and in 47 patients (3.4%) the procedure was converted to conventional appendectomy.

An analysis of the number of patients with conventional procedure and of those with laparoscopic procedure from 1999 till the end of the study in 2006 revealed that there was a decrease in the number of the conventional cases over the years. Laparoscopic appendectomy increasingly became the standard procedure for managing patients with suspected appendicitis. With growing experience in the field of laparoscopic surgery, an increasing proportion of patients with suspected appendicitis can be treated with the laparoscopic procedure.

5.1 Patients

The incidence of appendicitis is higher in males than females as stated in the literature.[10,35-37] From these data, we expect that the number of appendectomy procedures in male patients would be higher than the number in female patients. In this work, the number of female patients who underwent appendectomy is larger than that of male patients. There were 640 male patients (43.3%) and 833 female patients (56.6%). 776 (57.5%) female patients underwent laparoscopically completed operations compared to 574 (42.5%) male patients. After comparing the pathological results of the male and female patients we noticed that there were 350 males and 311 females with acute gangrenous appendicitis without perforation and 93 males and 81 females with perforated appendicitis. The number of female patients with catarrhal inflammation or chronic inflammation was higher than male patients. There were 252 females and 119 males with catarrhal inflammation and 183 females and 75 males with chronic appendicitis. The number of appendectomy procedures in females was higher than that in males, however the severity of appendicial inflammation in male patients was greater than in females.[37, 38] This difference is attributed by the fact that in females with unclear lower abdominal pain a diagnostic laparoscopy is often performed together with the removal of the appendix at the end of the procedure.

The appendectomy operation was most commonly performed in the age group 10-20 years. In this age group the incidence of appendicitis was the highest compared to the other age groups. The youngest patient in this study was 5 years old and the eldest was 90 years old. This finding was the same as reported by Addiss et al.,[10] who analyzed National Hospital Discharge Survey data in USA from the year 1979 to the year 1984, and as mentioned in a Canadian study which has been presented by Al-Omran et al.[20]

Previous abdominal surgery has been reported as a relative contraindication to laparoscopic procedures. Since laparoscopic cholecystectomy was widely accepted and since it increasingly replaced the conventional cholecystectomy, some authors discussed the impact of previous abdominal operations on laparoscopic cholecystectomy procedure. Yu SC et al.[39] found that laparoscopic cholecystectomy can be performed safely in patients with previous abdominal surgery. Another study[40] stated that previous abdominal operations, even in the upper abdomen, are not a contraindication to a safe laparoscopic cholecystectomy. However, previous upper abdominal surgery is associated with an increased need for adhesiolysis, a higher conversion rate, a prolonged operating time, an increased incidence of postoperative wound infection, and a longer postoperative stay.

As regards the impact of previous abdominal operation on the laparoscopic appendectomy, one study of this question was carried out by Wu JM et al.[41] In this study the patients were divided into three groups: patients with no previous abdominal operations, patients with upper abdominal operations and the third group with lower abdominal operations. There were no significant differences between the three groups regarding the conversion rate, operative time, postoperative complication rates, and hospital stay. In our study the patients were divided into many groups depending upon whether they had previous laparoscopic or conventional procedures, and each group was divided into upper or lower abdominal procedures. Conversion in patients with no previous operations was 41 out of 1247 patients (3.4%). In 69 patients who have had conventional lower abdominal operations 4 patients (5.7%) had conversions, and there were 2 patients with conversion out of 20 (10%) who had undergone previous upper conventional operations. There was no conversion case noted in the patients who had undergone previous laparoscopic procedures.

5.2 Laparoscopic appendectomy also for patients with complicated appendicitis

Laparoscopic appendectomy has been widely practiced for uncomplicated appendicitis. Various reports demonstrated its merits in assisting diagnosis, reducing postoperative pain, analgesic requirement, and incidence of wound infection.

Complicated appendicitis is defined as an acute appendicitis in which perforation or an intraabdominal abscess is present. The role of laparoscopy in the management of complicated appendicitis remains undefined.

Insufflation of CO_2 in the peritoneal cavity has been theorized to spread pus intraabdominally when a purulent intraabdominal infection is present. Therefore, laparoscopic appendectomy would be expected to result in a higher rate of postoperative intraabdominal abscesses, and conversion to conventional operation was advocated by many studies if there is evidence of complicated appendicitis.[42] Controversy exists regarding the effect of pneumoperitoneum on animal models of peritonitis.[42] Yau KK et al.[43] have studied and compared the results of laparoscopic and conventional appendectomy for complicated appendicitis. The laparoscopic appendectomy in that study was feasible, safe and was associated with a significantly shorter operative time, lower incidence of wound infection, and reduced length of hospital stay. In another study by So, J. B. et al.[44] it was demonstrated that the laparoscopic appendectomy is a safe approach for perforated appendicitis and that it reduces the risk of postoperative infections. The rate of conversion was high (47%), but it may be improved with the surgeon's experience.

In the present study, laparoscopic appendectomies for complicated appendicitis were successfully accomplished in 617 patients (45.7%) with acute gangrenous appendicitis and in 115 patients (8.5%) with perforated appendicitis. The conversion rate in patients with perforated appendicitis was higher than those without perforation. The conversion rate for patients with perforation in this study was 19.5 % (28 patients out of 143 patients). Fukami et al.[45] have demonstrated that laparoscopic appendectomy for perforated appendicitis can be performed safely with a low incidence of infectious complications and a short hospital stay. In that study there was no case of conversion to conventional appendectomy. Although the laparoscopic procedure is feasible for complicated appendicitis, our study has shown that there was a significant increase in the number of postoperative complications in patients with perforated appendicitis compared to those without perforation. A study done by Ball et al.[46] demonstrated no difference in analgesia requirement, recovery, or complications between laparoscopic appendectomies for complicated or uncomplicated patients of appendicitis. In that study the comparison in postoperative complication was regarded to overall complication rates. Postoperative complications in our study were divided into general, major and minor complications. From a total 24 patients with wound complications, 6 patients had perforated appendicitis (25%). Regarding major intraabdominal postoperative complications, such as peritonitis or intraperitoneal abscess, there were a total number of 37 patients, and from this number 13 patients (35%) had perforated appendicitis.

5.3 Operating time

One of the reasons for the non acceptance of the laparoscopic appendectomy as the gold standard technique for managing all patients with acute appendicitis is the longer operating time for laparoscopic procedure in relation to the open conventional method. Many studies have shown that the operating time is significantly longer for laparoscopic appendectomy compared to conventional appendectomy. Katkhouda, et al.[47] have reported that the mean operating time was 80 minutes for laparoscopic versus 60 minutes for conventional cases. In the study by Minne et al.[48] 81.7 versus 66.8 minutes. This may be due to the inclusion of additional steps for setup, insufflation, trocar entry under direct vision, and diagnostic laparoscopy. There was no study demonstrating a shorter time for laparoscopic appendectomy, despite the subjective perception that it can be an easier operation. In our study, the operating time for laparoscopic appendectomy is longer than conventional appendectomy, i.e. 47 minutes for laparoscopic versus 44 minutes for conventional appendectomy. Bennett et al.[49] have carried out a systematic review and meta-analysis of all randomized controlled trials between 1995 and 2006 concerning appendectomy. The Studies were analyzed overall and in 2 subgroups (pre-2000 and post-2000) to examine for changes in outcomes. The operating time was longer for the laparoscopy group and hospital stay was shorter. The operating time dropped markedly for laparoscopy on subgroup analysis. On this basis the shorter operating time for laparoscopic procedures in our present study can be explained on the basis of increasing experience with laparoscopic procedures with the time.

Comparing the mean operating time in the first year of the study (47.8 minutes in 1999) with the last year of the study (46.2 minutes in 2006), there was no statistically significant difference. We can claim that as surgeons gained more experience with laparoscopic procedures, more patients with perforated appendicitis and peritonitis were operated laparoscopically. The ratio of patients with perforated appendicitis operated by laparoscopic technique to the total number of laparoscopic patients in 1999 was 7.4% and in 2006 10.8%. Also our explanation for the fact that the mean operating time of laparoscopic procedures did not decrease over the years of this study is that there was an increase in the number of laparoscopic procedures operated by resident surgeons in comparison with consultant surgeons over the years of the study. In 1999, 50% of laparoscopic appendectomies were done by resident surgeons and in 2006, 57% of total laparoscopic appendectomies were done by resident surgeons.

5.4 Intraoperative complications

Intraoperative bleeding, perforation of the appendix and iatrogenic injury to adjacent organs are probably the most common intraoperative complications, in addition to the complications related to laparoscopic access, instrumentation and pneumoperitoneum[5].
In audit of laparoscopic appendectomies carried by Agresta et al.,[50] the incidence of intraoperative complication in cases with laparoscopic appendectomy was (0.32%). In our present study there were 4 patients (0.28%) from 1397 attempted laparoscopic procedures with intraoperative complications. All patients were males and had an iatrogenic injury to the bowel (2 patients with injury to the small intestine and 2 patients with injury to the ascending colon). The injury in two patients was discovered during the laparoscopic procedure at which point the procedure was converted to conventional appendectomy. In the other two patients the injury was discovered during the early post operative period and required laparotomy. None of these 4 patients had either previous abdominal operations or perforated appendicitis. With advanced laparoscopic

experience iatrogenic injury to near by organs can be managed laparoscopically if detected during the initial procedure. In a study by Kazemier et al.[51] one out of 97 patients with laparoscopic appendectomy had ileal perforation caused by electrocautery. The injury was overswen laparoscopically during the initial operation.

5.5 Postoperative complications

One of the drawbacks attributed to laparoscopic appendectomy in relation to conventional appendectomy was the higher rate of intraabdominal abscess formation after laparoscopic procedure. There was a Cochrane review,[52] which reported a prevalence of intraabdominal abscess of 2.7% in conventional appendectomies as compared to 4.7% in laparoscopic appendectomies. Other studies reported a lower rate of intraabdominal abscess in laparoscopic appendectomies compared to the conventional procedure.[53, 54] In our study the incidence of intraabdominal abscess was 1.7 %, in 23 patients out of 1350 patients completed as laparoscopic appendectomy. This figure was lower than the rate of intraabdominal abscess detected postoperatively in many studies comparing laparoscopic and conventional appendectomy. Kouwenhoven et al.[55] have reported that the rate of intraabdominal abscess was 3.5 % for conventional appendectomy and 3.6 % for laparoscopic appendectomy. Our results might be biased because of the hospital where the present study was carried out and the operating surgeons who had expertise and interest in laparoscopic surgery. In our study, the rate of major postoperative complications decreased in the first 3 years, and then increased followed by a further decrease in the number of patients with major postoperative complications. This can also be explained, as stated before, in the operating times over the years of the study. It may reflect an increase of the laparoscopic experience which led to managing many patients with complicated and perforated appendicitis laparoscopically. In our study there was a significant increase in the rate of major postoperative complications and intraabdominal abscesses in the patients with perforated appendicitis in comparison to the patients with non-perforated appendicitis. This has also been stated in numerous other studies.[56, 57]

In our study there were 2 patients (0.14%) reported with stump abscess. One patient was managed successfully with laparoscopic procedure and the other patient had an explorative laparotomy. A review of 70 laparoscopic appendectomies by Panton et al.[58] reported one patient with an appendicial stump abscess, managed with intravenous antibiotics. In another study a late discovery of appendicial stump abscess was diagnosed 2 years after laparoscopic appendectomy.[59] In our own study, the two patients with stump abscesses were detected and operated on in the early postoperative period during the same hospital admission.

Wound infections may not be a serious complication per se but represent a major inconvenience to the patient, impacting his convalescence time and the quality of life. In our study, there were 14 patients with wound infection (1%). In all patients the site of wound infection was the site of appendectomy specimen extraction. A study by Khan et al.[60] showed that the wound infection rate in conventional appendectomies was 9 % and 1.25 % in laparoscopic appendectomies. In that study, the site of wound infection was the port of specimen extraction in the laparoscopic group and an extraction bag was not used. Wound infection delayed the hospital discharge by an average of 2 days. An extraction bag was used in 83 % of laparoscopic appendectomies of that study. In our study the extraction bag was used in 54 % patients. Since 2006 we routinely use extraction bags.

Trocar sites with fascial defects of 10 mm or larger should be closed, including the peritoneum. Opinion varied if a 5-mm trocar site defect should be closed.[61] Coda et al.[62] stated that the incidence of trocar site hernia was 1%. Risk factors, such as chronic bronchitis or weight increase, which give rise to high intraabdominal pressure, were present in some patients. Malnutrition may have a major role in many patients. In our study 3 patients (0.2%) had a trocar site hernia. In all three patients the hernia developed in the 13 mm trocar site in the left lower abdomen. This trocar site was used for Endo-GIA and for appendix extraction. In all 3 patients the fascial defect was closed. Care should be taken in fascial closure in all ports more than 10 mm. In a case report presented by Nakajima et al.,[63] there was an infant who had a 5 mm incarcerated port site hernia. Intraoperative dislodgment and reinsertion of the working trocar may create fascial defects larger than the actual size of the trocar. Other literature has focused on the site of the trocar in relation to the midline and the peritoneum closure. It was stated that the peritoneum may also require closure at 12 mm trocar sites, if the trocar is placed through, rather than laterally to the rectus sheath.[64]

5.6 Hospital stay

The development of laparoscopic surgery has decreased the length of hospital stay and its related costs. Several randomized studies showed shorter hospital stays for laparoscopic appendectomy compared to conventional appendectomy patients.[65, 66]

In our presented study we have noticed a short postoperative hospital stay for our patients with laparoscopic appendectomy comparable with the results from other studies. Also it was noted that the postoperative hospital stay in our study decreased significantly over the years of the study. This decrease can be related to some extent to the more competence in laparoscopic procedure. The postoperative hospital stay in this study was also significantly related to the state of appendix inflammation. It was longer in patients with perforated appendicitis and gangrenous appendicitis compared to patients with catarrhal or chronic appendicitis. This finding was also concordant with the results stated by Amaral et al.[67] In that study, in addition to the state of appendix inflammation and its appearance, preoperative fever and the anatomical position of the appendix were also factors related to a prolonged hospital stay.

5.7 Reoperation

In the field of visceral surgery, complications requiring reintervention following laparoscopy are currently most likely to be approached with conventional laparotomy.

However, relaparoscopy has the theoretical advantage of maintaining the reduced morbidity allowed by the first laparoscopic procedure. Essential to the success of relaparoscopy is a clear understanding of the various specific complications following laparoscopic appendectomy. Relaparoscopy has the theoretical advantage of allowing recognition and treatment of the postoperative complications.[68] In our presented study, reoperative intervention was needed in 49 patients (3.6 %), 28 of them had relaparoscopy. A laparotomy was required in 8 cases. Deredzhian et al.[69] had a study covering 2555 appendectomy patients and discussed the incidence and causes of relaparotomy in them. The rate of laparotomy in that study was 1 % and the most frequent cause of relaparotomy was gangrenous and perforated appendicitis with generalized peritonitis. The rate of relaparotomy in our study was 0.57 %. It also showed that high rates of reoperation occurred in patients with perforated or gangrenous appendicitis.

In our present study the number of reoperative intervention decreased over the years of the study. This can be explained by the surgeons' gaining more laparoscopic experience and laparoscopic surgical skills.

5.8 Different techniques for closing the appendiceal stump

The decision as to which technique to use for securing the appendiceal stump in the laparoscopic appendectomy is currently based on the surgeon's personal preference rather than on knowledge of patients' outcome or comparative costs. In this study there was an evaluation of the data from the three different methods of securing the appendicial stump used in our hospital as a trial to determine which method was more effective based on patient outcomes. The three methods were Endo-GIA staplers, Endo-Loop, and clips.

When performing a laparoscopic appendectomy, the appendiceal stump should be as short as possible, and the ligation of the root of the appendix should be only moderately tight, so as not to cause ischemic change of the stump, indicated by discoloration or edema. Ischemia caused by tight ligation of the root of the appendix may lead to gangrenous change in the appendicial stump and later on may develop into a stump abscess and intraabdominal abscess.[70] Kellnar et al.[71] used Endo-GIA for laparoscopic appendectomies in 41 patients without any postoperative intraabdominal infectious complications after their experience of 2 patients with postoperative abscess formation in 87 cases of laparoscopic appendectomies. In those two patients two cat-gut loops for ligation of the stump were applied. In another study comparing Endo-GIA and Endo-Loop results for securing appendiceal stump it was reported that the clinical evidence on stump closure methods in laparoscopic appendectomy favors the routine use of endoscopic staplers.[72]

Use of clips or Endo-Loop to secure the appendicial stump requires more skill and experience for careful dissection of mesoappendix during laparoscopic appendectomy. In the single Endo-GIA stapler technique, both mesoappendix and the base of the appendix may be divided in one step with the application of a single Endo-GIA stapler. In a study by Olguner et al.[73] this technique was shown to be a quick, easy, and versatile method for laparoscopic appendectomy in children that obviates dissection of mesoappendix and related problems. Thus, it enables laparoscopic appendectomy to be performed by surgeons with little experience in laparoscopic surgery. This method can also be used for appendix with thin lumen and with suitable size mesoappendix.

The Endo-GIA was the most common method used for ligation of appendicial stump in our study. It was used in 60 % of 1350 patients with laparoscopic appendectomy. In the first two years of the study, Endo-GIA was the only method used for the stump ligation. From 2001 clips and Endo-loop were also introduced. By the last year of the study (2006), it was noticed that both Endo-GIA and clips were used nearly equally in patients with laparoscopic appendectomy (around the figure of 45 % for each). The Endo-Loop method was used in about 10 % of patients.

Regarding the operating time for patients from the three different groups of appendicial stump ligation, the Endo-Loop method had significant longer operative time in comparison to the other two methods.

The Endo-GIA was used more frequently than the other two methods in patients with perforated appendicitis or gangrenous appendicitis. This reflects the trust of operating surgeons in this method to secure the appendicial stump in cases of highly inflamed appendix as noted before in the literature presented by Kellnar et al.[71] In our study, when the postoperative complication rates for the patients of the three different groups were compared statistically, there was no significant difference between the three groups. Klima and Schyra[74] stated in their study that Endo-GIA is a safe technique with the best results. In that study the stapler technique was compared with the Endo-Loop. Another study by Hanssen et al.[75] comparing the Endo-GIA method with polymeric clips for securing the appendicial stump in laparoscopic appendicitis concluded that the use of polymeric clips is feasible, safe, and an economical alternative for ligation of the appendicial stump during laparoscopic appendectomies.

In our study there was no significant difference regarding the number of patients requiring reoperation in the same hospital admission for patients from the three different groups. Also, we have noticed that over the years of the study the number of patients where the Endo-GIA had been used was decreasing and the number of patients where the clips had been used was increasing. In the mean time there was no increase in the number of patients with postoperative major complications. Actually there was a decrease in the rate of these complications over the years of the study.

Comparing patients' postoperative hospital stay after undergoing one of the three different methods, patients in whom clips were used had a significantly shorter hospital stay compared to patients with Endo-Loop and Endo-GIA.

As regards the cost of the three methods, in light of the pressures for cost containment, the Endo-GIA is the most expensive tool (Endo-GIA 35mm = €230 and Endo-GIA 45 mm = €260), followed by clips (a 5 PDS clip-packet costs approximately €55 and for Lapro clips, a 2 clip-packet costs €25 and a 6 clip-packet costs €61), then the Endo-Loop (a Roder loop costs around €11 for each loop). A study by Lukish et al.[76] on a group of children that had undergone laparoscopic appendectomy showed that even if there was no significant difference between the Endo-GIA staplers and Endo-Loop regarding the outcome and the postoperative complication rates, the Endo-Loop method is more expensive than the Endo-GIA method. This was because of the additional operating room and anesthesia costs had to be taken into account in addition to the cost of disposable materials. In that study the operating time with Endo-Loop was significantly longer than in patients with Endo-GIA staplers. Another study done also on a group of children who underwent laparoscopic appendectomy for acute appendicitis showed the reverse, namely that Endo-GIA method was more expensive, involved longer total operating times and there was no change in readmission or postoperative complication rates between the two methods.[77]

Arcovedo et al.[78] conducted a study which presented an economical and safe method for securing the appendiceal stump. They used an extracorporeal sliding Prolene knot to secure the stump. In that study they stated that this method was as safe as the stapler for closure of the stump.

5.9 Drainage and drains in laparoscopic appendectomy

The value of drains in surgical practice is hotly debated. Proponents claim that they remove harmful fluids, monitor operative complications, and do little harm. Opponents claim that they cause irritation to the tissues, perpetuate discharge and offer an inward track for contamination. They may also provoke fistula formation. Sims[79] was the first surgeon who used prophylactic drains after gynecologic operations in the last quarter of the 19th century. Since that time, surgeons have routinely used prophylactic drainage of the peritoneal cavity after abdominal surgery. Despite evidence-based data questioning prophylactic drainage in many instances, most surgeons around the world continued to use them on a routine basis. Appendectomy is the most common gastrointestinal operation, usually performed for acute appendicitis. The stage of appendicitis can range from a simple acute type to a severe gangrenous or perforated form. Two randomized control studies investigated the value of prophylactic drainage after open appendectomy for acute or simple appendicitis. One study reported a significantly higher wound infection rate in drained patients with acute or simple appendicitis.[80] Whereas the other study found similar wound and intra-abdominal infection rates in patients with and without drains.[81]

The value of prophylactic drainage after appendectomy might be different in the gangrenous and perforated form. Three randomized control studies were reviewed discussing the role of prophylactic drain in patients with gangrenous and perforated appendicitis. The results showed higher wound infection rates in drained patients (43 - 85 %) than in non-drained patients (29-54%). The pattern of intra-abdominal infections was not uniform among the studies. One study reported slightly higher intra-abdominal infection rates in non-drained patients.[82] Another study showed a higher rate in drained patients[81] and still another study a similar rate in both groups.[83] Interestingly, the development of fecal fistulas was only observed in drained patients with a rate ranging from 4.2 to 7.5%. Another pediatric study discussing patients in the age group (1-15 years) recommended that peritoneal drainage should not be used in childhood appendicitis. It showed that wound infection rate and intraabdominal abscess formation were higher in the patients with intraperitoneal drain compared to patients without drains.[84] All these studies were done on cases with conventional appendectomy procedure. There is still a paucity of studies discussing the role of drains in laparoscopic surgery and laparoscopic appendectomy procedures.

The role of drains and their use in laparoscopic appendectomy were studied in one section of this work. Nearly a quarter of the patients who had laparoscopic appendectomies (342 patients) had a drain and 75 % (1008 patients) had no drain. Patients with drains had significant longer operative stay, higher rate of intraabdominal postoperative complications and reoperation compared with patients without drains. This may be due to the use of the drains and their effects, or it may reflect the inflammatory stage of the appendix and the pathological process. The drains used in our study were used in a significantly higher number of patients with perforated and gangrenous appendicitis rather than in patients with chronic or catarrhal appendicitis.

The types of drains used were Robinson suction drains and Easy-Flow non-suction drains. Both types are closed system drains designed to guard against contamination and conducting organisms to the intraabdominal cavity. The Robinson drain was used more frequently, in about 85 % of the total number of patients with drain. The Easy-Flow was used less commonly (15 %). The drains were mostly used in patients with gangrenous or perforated appendicitis. The Robinson drain was used in 79 % of the patients with perforated appendicitis, the Easy-Flow drain was used in 15 % and in the remaining 6% of the patients no drain was used.

There was no significant difference between the two types of drains regarding the rates of postoperative complications. Also there was no significant difference regarding the rate of reoperation for the patients with the two types of drains. However, there was a significant difference in the number of patients needing reoperation between the drained and non-drained patients. The patients with drain had a higher number of reoperation compared to patients without drains. This can be explained on the basis that most of the patients with drains had gangrenous and perforated appendicitis.

Comparing the postoperative hospital stay of the two types of drains, there was a statistically significant difference between drained and non-drained patients. Patients with drain had a longer postoperative hospital stay compared to patients without drain.

Patients with an Easy-Flow drain had statistically longer postoperative hospital stays than patients with Robinson drain.

5.10 Conversion to conventional appendectomy

During the laparoscopic procedure, complications may arise or the extent of the disease process may make safe resection of the appendix impossible, which may endanger the patient's life and the outcome of the procedure, and these situations result in the conversion to conventional appendectomy. The conversion to conventional appendectomy leads to increases in operating time and higher hospital costs compared to the operating time and costs associated with performing conventional appendectomy in the first place. Also conversion to conventional procedure forgoes the benefits of the laparoscopic approach to the patient, such as less postoperative pain, shortened hospital stay, faster recovery, better and lower wound infection rates in addition to the cosmetic benefit, with decreased scarring.[85] But all this must not pressure the surgeon performing laparoscopic appendectomy in making the decision for conversion to conventional appendectomy. The decision to convert the procedure from laparoscopic to conventional one is neither a complication nor a failure of the surgeon. It is in fact a wise decision taken by the surgeon who performs the laparoscopic procedure in favor of patient safety and outcome after surgery.

The rates of conversion reported in the literature vary. In four studies (each covering more than 1000 patients) the conversion rate was ranged between 1.6 %-6.4 %.[86-89] The conversion rate in our study was 3.4 % (47 out of 1397 patients).

Conversion to conventional appendectomy can be attributed to several factors related to the patient, the surgeon, and technical factors. Regarding the patient, conversion was more common in male patients than in females, in the older age group of patients and in patients with perforated or gangrenous appendicitis.[90] In our study there was a significantly a high number of conversions among male patients and in patients above 60 years old. Perforated and gangrenous appendicitis were the causes of conversion in 55 % of the patients with conversion.

Regarding the technical factors which include: (a) the inability to identify the appendix laparoscopically due to an unusual position of the appendix, for example a retrocecal appendix or a malrotation of the small bowel; (b) the inability to remove the appendix in its entirety laparoscopically; (c) uncontrollable hemorrhage or injury to the small bowel; (d) the inability to maintain adequate pneumoperitoneum; and (e) hypotension due to the Trendelenburg position. Technical factors were the cause of conversion in 21% of the conversion patients due to the difficulty to localize the appendicial base and retrocecal position of the appendix. Among the other causes of conversion in this study were severe intraabdominal adhesions in 15 % of the patients.

The role of the surgeon as a factor for conversion of the laparoscopic appendectomy into a conventional appendectomy can be attributed to the experience in laparoscopic procedures. It is possible that increasing experience with laparoscopic appendectomies will lead to lower conversion rates. This was noticed in our study from the decreasing of the conversion rates along the different years of the study. There was an unexpected rise in the rate in the second year of the study (year 2000) compared to the first year (1999). Other than this rise, the rates of conversion progressively decreased throughout the period of the study from 1999 to 2006. In a trial to explain this observation and to understand the causes behind the conversion of the laparoscopic appendectomy to conventional appendectomy a revision of the data and results regarding the surgeons operating on the patients (consultant or resident surgeon, and the number of patients for each group of surgeons each year) was carried out. Also the histopathological results from the patients operated upon each year were studied. Resident surgeons in 2000 operated upon fewer patients compared with consultant surgeons. In that year there were 4 consultants and 5 residents operating on patients with appendectomy. The year 1999 had nearly the same number and in 2001, seven consultants and eight residents operated. These numbers tend to be close to the numbers of surgeons from each group until the last year of the study. Throughout the course of the study the numbers of patients operated upon by resident surgeons increased while the conversion rates decreased. From the histopathological viewpoint the year 2000 was characterized by a higher number of perforated appendicitis cases compared to the other years of the study (12% of the total attempted laparoscopic patients in that year compared to less than 10 % in other years). This alone, however, cannot explain this observation. In the last two years of the study the number of patients with perforated appendicitis was higher (13.9 % in 2005 and 11 % in 2006). From this data and results we can probably conclude that the high rate in that year was multifactorial. Many factors may play and react together to increase or decrease the conversion rate.

With advances in laparoscopic skills and instruments, previous abdominal surgery has become a relative, but not absolute, contraindication to laparoscopic surgery.[41] Laparoscopic cholecystectomy and laparoscopic appendectomy are commonly performed laparoscopic procedures. Both procedures are safe and effective in most conditions. Several studies reporting patients undergoing laparoscopic cholecystectomy after previous abdominal surgery have demonstrated that this procedure is feasible without an increased risk of conversion.[91] However, in other studies previous abdominal surgery, especially upper abdominal surgery, has been associated with increased conversion to conventional surgery.[92] There is little information regarding the impact of previous abdominal surgery on laparoscopic appendectomy for acute appendicitis and the effect of previous abdominal surgery on the conversion rate in laparoscopic appendectomy. A study by Liu et al.[90] revealed that previous abdominal surgery had no significant influence on the conversion rate of laparoscopic appendectomies. Another study stated that previous abdominal surgery, whether upper or lower, has no significant impact on laparoscopic appendectomy for acute appendicitis with respect to the rates of conversion or on intraoperative or postoperative complications.[41] The results from this present study are comparable with the results from previous two studies. In our study there were 41 patients out of 47 (87 %) with conversion to conventional appendectomy who had no previous abdominal surgery and the remaining 6 patients (13%) had previous abdominal surgery. There was no statistically significant difference between the patients with and patients without previous abdominal surgery regarding the conversion rate in both groups. In the previous two studies the patients with previous abdominal surgery were divided into patients with conventional upper abdominal surgery, patients with conventional lower abdominal surgery and patients with no previous abdominal surgery. In our present study, in addition to these three groups we had also two groups of patients whom had previous laparoscopic procedure in the upper or lower abdomen. In the 6 patients who had previous abdominal surgery and had conversion; we noticed that they all had previous conventional surgery. Four of these patients had previous conventional lower abdominal surgery and the other two had previous conventional upper abdominal surgery. Patients with previous laparoscopic abdominal procedures had no conversion.

In our results there was in general a significantly higher rate of postoperative complications in the patients with conversion compared to patients without conversion. This can be explained on the basis that patients with conversion faced the surgical hazard and co-morbidity of both laparoscopic and conventional surgical procedures. An analysis of the number of patients and the rate of different types of postoperative complications showed that there was a higher rate of general postoperative complications in patients with conversion (8.5 %) compared to (0.7 %) in laparoscopic patients. Also, there was a higher rate of minor postoperative complications and wound infection in patients with conversion (4.3 %) compared to laparoscopic patients (1.8 %). The increased wound infection rate in patients with conversion was concordant with literatures which showed that conventional appendectomy has a higher rate of wound infection compared to the laparoscopic appendectomy.[93]

One of the advantages of the laparoscopic appendectomy procedure over the conventional appendectomy procedure is the short postoperative hospital stay. This advantage can be taken into consideration when the overall cost effectiveness between the two procedures has been compared.[94] Early publications in the 1990s demonstrated a significantly shorter hospital stay in favor of laparoscopic appendectomy.[95] Lord and Sloane showed that a 48-hour discharge policy for conventional appendectomy could be implemented.[96] In our present study comparing the postoperative hospital stay for patients with and without conversion, there was a significantly longer postoperative hospital stay for patients with conversion. The mean postoperative stay for patients with conversion in our study was 9 days (the minimum was 4 days and the maximum 24 days). This is longer than the 48 hours of postoperative stay and early hospital discharge reported by Lord and Slone for conventional appendectomy.

In light of these results we can conclude that the cost of a case of conversion is much higher than that of laparoscopic appendectomy or conventional appendectomy from the start. When the case is converted to a conventional appendectomy there is an additional cost of longer operating and anesthesia time, disposable instruments, as well as longer and slower postoperative recovery.

5.11 Laparoscopic appendectomy as teaching operation

The approach to teach resident surgeons new surgical techniques remains a matter of continuing debate. Although laparoscopic cholecystectomy is an excellent training operation in the field of laparoscopic surgery for resident surgeons,[97] the study of Scott-Conner et al.[98] was one of the first studies to show that the laparoscopic appendectomy can be also a suitable procedure for resident surgeons. In that study, the need for laboratory courses and animal models before this knowledge is applied to clinical practice was defended. This trend has been supported also by others.[99] Other studies defend training in laparoscopic surgery with clinical practice under the supervision of surgeons with experience.[100] The European Association for Endoscopic Surgery requires, among the prerequisites for laparoscopic practice, an apprenticeship in a surgical training program and monitoring of the first operations by surgeons with experience in this type of surgery.[101]

The evaluation of laparoscopic proficiency achieved by residents is as yet an uncertain issue. The performance of residents can be assessed by using simulators.[102] However; real-life performance in the operating room is the ultimate test for resident skills and proficiency.

Several measurable objective parameters have been used to measure laparoscopic skills: operating time, conversion rate, length of postoperative hospital stay, complications, and reoperation. The current study evaluated the laparoscopic proficiency of resident surgeons in a single, large, laparoscopy-oriented surgical service within DRK Hospital in Berlin. Laparoscopic skills were evaluated in terms of operating time, conversion rate, postoperative hospital stay, complications and reoperation. All these parameters were studied, analyzed and compared between the group of resident surgeons and another group of consultant surgeons. Besides these parameters, this study also discussed some factors in the patients or in the operation circumstances, and the effect of these factors on the number of operations done by resident surgeons.

Regarding the gender and age of patients, both residents and consultants operated on almost the same number of male and female patients. The patients' gender played no significant role in the choice for the operation to be done by a resident or consultant surgeon. This was not the case, however, regarding the age of the patient. The consultant surgeons operated older age patients. This may indicate that consultant surgeons felt more comfortable while performing the operation themselves laparoscopically for older age patients. The histopathological results of all patients in different age groups in this study revealed that patients above 65 years had a higher rate of perforated appendicitis compared to patients younger than 65 years.

Most of the procedures were carried out during normal working hours. Nearly half of the patients were operated between (08:00-16:00). At this time of the day the consultant surgeons operated more patients than resident surgeons. The time pressure from the elective procedures and the normal daily surgical work for the residents may be the explanation behind this observation. This is also supported by the significantly increased number of laparoscopic procedures done by resident surgeons after finishing the normal daily operating schedule (the time between 16:00-00:00). After midnight, patients with appendectomy have been operated upon mostly by consultant surgeons. This may reflect added pressure on the training process by the circumstances of late night work. A study by Sweeney et al.,[103] showed no difference in the ratio of day / evening / night procedures carried out by either group of surgeons.

In our study there was no significant difference in the numbers of appendicitis patients with a history of preabdominal operation operated on successfully by laparoscopic procedure between the two groups of surgeons. Therefore the presence of a preabdominal operation in a case of appendicitis could not be considered a contraindication for the laparoscopic procedure to be done by a resident surgeon.

The mean operating time of the residents was longer than that of the consultants. This is in agreement with a study by Bouillot et al.[104] In their study, the operating time of the resident surgeons (60 min) was longer than that of the consultant surgeons (50 min).

The operating time can be shortened significantly with experience because surgeons need to familiarize themselves with the laparoscopic instruments and laparoscopic technique skills.

Besides the operating time, conversion rate is another objective parameter used to measure laparoscopic proficiency. The overall conversion rate in our study was 3.4 %. For the consultant group it was 3.9 %, and for the resident group it was 2.7 %. Similar results were noted in a comparative study done by Shabtai et al.[105] That study compared the laparoscopic skills between junior and senior residents groups. The division into these two groups was dependent upon the overall surgical experience and skill level. The decision to convert the procedure was usually taken by the consultant surgeons irrespective of whether the procedure was performed by a resident or a consultant surgeon. An analysis of the causes of conversion in both groups of surgeons revealed that the same causes were equally affecting the conversion rates for both groups of surgeons. The most common causes of conversion in both groups of surgeons were appendicitis with perforation and retrocecal appendicitis.

The operative complications and the postoperative stay can reflect the severity of the disease and/or the quality of the surgical procedure. Also we can regard them as objective parameters reflecting the proficiency in laparoscopic procedure. From 4 patients with intraoperative complications in our study, 3 patients were operated on by consultants and one patient by a resident surgeon. Even in the study done by Carrasco-Prats et al.,[106] there was no statistically significant difference in complication rates between the patients operated on by experienced surgeons and those who underwent surgery by inexperienced surgeons. In our present study there was a significantly higher complication rate in the group of patients operated upon by consultant surgeons. Also the postoperative hospital stay was significantly longer for the patients operated upon by consultant surgeons compared with patients operated upon by resident surgeons. There was a significantly lower number of reoperations in the group of laparoscopic appendectomy patients operated upon by the resident surgeons compared to patients operated upon by consultant surgeons. These observations can be explained on the basis that the consultant surgeons operated more patients with perforated and gangrenous appendicitis. Older patients were more often operated upon by consultant surgeons than by resident surgeons.

Two additional points related to laparoscopic procedures and the laparoscopic appendectomy are worth mentioning. The first point related to obese patients and laparoscopic surgery. There was a study showing that obese patients who underwent a laparoscopic appendectomy had less postoperative pain and a faster postoperative recovery than obese patients who had a conventional appendectomy. Laparoscopic appendectomy also avoids some of the negative effects that obesity has on the operating time, length of hospital stay, and the amount of sick leave associated with the conventional technique. However, anesthesia and operating times were significantly longer in laparoscopic appendectomy for both obese patients and those with a normal BMI (body mass index).[107] In a study of laparoscopic cholecystectomy, obesity was reported to be a moderate predictor of conversion to conventional cholecystectomy.[108] In another study on laparoscopic appendectomies, obese patients with a BMI of 30 or higher showed no increased risk of conversion to conventional appendectomy.[90] It is possible that the availability of longer trocars and the increasing practice of open insertion of the umbilical port have overcome the problems caused by obesity.

The second point is related to the long-term effects and benefits of laparoscopic procedures compared to conventional procedures. To determine whether the higher efforts and costs of laparoscopic appendectomy compared with conventional appendectomy are worthwhile, one should take into account not only the direct advantages, such as the use of the laparoscope to increase diagnostic ability, less postoperative pain, and less wound infections. The long-term effects, such as fewer postoperative adhesions following laparoscopic appendectomies should also be considered. De Wilde[109] performed laparoscopies 3 months after conventional appendectomies and laparoscopic appendectomies. Eighty percent of patients who underwent a conventional appendectomy developed adhesions whereas only 10% of the patients who underwent a laparoscopic appendectomy developed adhesions.

6. Summary

Appendectomy is one of the most common surgical procedures in surgical practice with an incidence between 100 and 130 per 100.000 of population each year in the Western world. Over the course of many years, the open appendectomy became established as the gold standard for treatment of patients with acute appendicitis, with few associated risks and complications. Recently, minimally invasive surgery has gained in popularity. Until now, the laparoscopic appendectomy has not been adapted as the standard surgical approach to the same extent as has the laparoscopic cholecystectomy.

This retrospective study included all patients who underwent an appendectomy from January 1999 until the end of June 2006 in DRK Westend Hospital in Berlin. A total of 1473 patients had appendectomy surgery during the period of the study. 1350 patients were completed as laparoscopic procedures, 47 were converted to conventional appendectomies and 76 patients were operated upon with a conventional procedure.

In the course of the study more appendectomies have been performed laparoscopically as a result of the increasing amount of experience gained in laparoscopic surgery.

Laparoscopic appendectomy appears to be safe and feasible and can be safely performed on patients with previous open abdominal operations in the upper and lower abdomen.

Through increasing experience in laparoscopic technique, patients with complicated appendicitis and perforated appendicitis can be managed safely with laparoscopic procedures. Patients with perforated and complicated appendicitis had longer operating times, a higher rate of postoperative complications and longer postoperative stays.

Most of the patients who underwent reoperation had perforated and complicated appendicitis. Laparoscopy was the common form of reintervention for the patients requiring reoperation for diagnostic or therapeutic purposes.

Conversion to conventional appendectomy decreased significantly with increasing in experience in laparoscopic surgery, therefore the conversion rate decreased throughout the years of the study. Most patients who underwent conversion were patients with perforated appendicitis, peritonitis and patients with an appendix in the retrocecal position.

An analysis of the three different methods for appendiceal stump closure (Endo-GIA, Endo-Loop and clips) showed that there is no significant difference between these three methods in regard to postoperative complications and reoperation. The higher cost of laparoscopic appendectomy compared to conventional appendectomy can be reduced if the price of the materials and instruments for each method are taken into consideration.

Surgeons in training can safely and effectively perform laparoscopic appendectomies under close supervision from experienced surgeons. Laparoscopic appendectomy can be used as a training operation for resident surgeons in daily clinical practice, including emergency situations. Together with the already established laparoscopic cholecystectomy, laparoscopic appendectomy can be considered as a teaching procedure in the field of laparoscopic surgery.

7. Zusammenfassung

Die Appendektomie ist seit Ende des 19. Jahrhunderts in der westlichen Welt die häufigste Notfalloperation in der Allgemeinchirurgie (100 – 130 Fälle/Kalenderjahr/ 100,000 Einwohner). Über hundert Jahre lang war die offene Appendektomie das Standardverfahren für die akute Appendizitis: Niedriges Operationsrisiko und geringe postoperative Komplikationsrate.

Erst in den 90-iger Jahren des 20. Jahrhunderts bekam auch die laparoskopische Appendektomie Anhänger, jedoch fand sie nie eine vergleichbar hohe Akzeptanz wie die laparoskopische Cholezystektomie.

Die vorliegende retrospektive Beobachtungsstudie beschreibt alle Patienten mit Appendektomie der DRK Kliniken Berlin I Westend von Januar 1999 bis Juni 2006. Insgesamt waren es 1473 Patienten, wovon 1350 laparoskopisch, 76 primär offen und 47 offen nach laparoskopischem Beginn (Konversion) operiert wurden.

Im untersuchten Patientengut gab es mehr Männer als Frauen, die größte Altersgruppe lag zwischen 10 und 20 Jahren. Während des Untersuchungszeitraums nahm mit Zunahme der laparoskopischen Erfahrung der prozentuale Anteil an laparoskopisch durchgeführten Appendektomien zu. Die Daten der vorliegenden Arbeit zeigen, dass ebenso wie die offene auch die laparoskopische Appendektomie als Standardverfahren in einer Klinik durchgeführt werden kann.

Mit zunehmender Operationserfahrung können auch Patienten mit komplizierter Appendizitis oder Perforation laparoskopisch operiert werden, allerdings ist in diesen Fällen die Operationszeit länger, die Rate von postoperativen Komplikationen höher und der postoperative Krankenhausaufenthalt länger als bei den unkomplizierten Fällen. Auch die meisten Patienten mit Revisionsoperationen hatten schon als Primärdiagnose entweder „komplizierte Appendizitis“ oder „perforierte Appendizitis“. Auch die Revisionsoperation lässt sich in der Regel sowohl zur Diagnostik wie Therapie als Re-Laparoskopie durchführen.

Die Zahl der „Konversionen“, d.h. Operationen, die laparoskopisch begonnen wurden und dann offen weitergeführt werden mussten, hatten mit zunehmender Erfahrung deutlich abgenommen. Konversionsgründe waren zu Anfang der Beobachtungsstudie: perforierte Appendizitis, Peritonitis oder retrocoecal gelegene Appendix.

Die Ergebnisse zeigen keine signifikanten Unterschiede hinsichtlich der Sicherheit der Appendix-Stumpfversorgung (Endo-GIA, ENDO-Loop oder Clip-Verschluss), weder was postoperative Komplikationen noch was Revisionseingriffe betrifft. Die höheren Operationskosten für die laparoskopische Appendektomie ergeben sich aus den Kosten für die verwendeten Instrumente und Materialien.

Die laparoskopische Appendektomie zeigt sich unter Anleitung des Erfahrenen als geeignete Trainingsoperation in der Ausbildung, einschließlich Notfalleingriff. Insofern kann die laparoskopische Appendektomie neben der laparoskopischen Cholezystektomie als weitere Trainingsoperation für die Minimal-Invasive Chirurgie eingestuft werden.

8. References

1. Semm K. Endoscopic appendectomy. Endoscopy 1983; 15:59-64.

2. Majeed AW, Troy G, Nicholl JP, et al. Randomised, prospective, single-blind comparison of laparoscopic versus small-incision cholecystectomy. Lancet 1996; 347:989-994.

3. Imhof M, Zacherl J, Rais A, Lipovac M, Jakesz R, Fuegger R. Teaching laparoscopic cholecystectomy: do beginners adversely affect the outcome of the operation? Eur J Surg 2002; 168:470-4.

4. Duff SE, Dixon AR. Laparoscopic appendicectomy: safe and useful for training. Ann R Coll Surg Engl. 2000; 82:388-91.

5. Kavic MS, Semm K. Laparoscopic Appendectomy. In: Kavic MS, Levinson CJ, eds. Prevention and Management of Laparoendoscopic Surgical Complications. Vol. 6. Miami: Society of Laparoendoscopic Surgeons, 1998.

6. Wolff H. [Medical history aspects of appendicitis treatment]. Zentralbl Chir 1998; 123 Suppl 4:2-5.

7. Reith HB. Appendizitis und Perityphilitis:Historischer Überblick. Chir Gastroenterol 1993; 9:184-196.

8. Boschung U. History of ´Right Iliac Fossa Pain´: From Internal to Surgical Treatment-With Special Reference to the Evolution in Switzerland In: L. Krähenbühl, E. Frei, Ch. Klaiber, M.W. Büchler, eds. Acute Appendicitis:Standard Treatment or Laparoscopic Surgery? Vol. 25. Basel, Switzerland: S. Karger AG, 1998:1-9.

9. Fitz RH. Perforating inflammation of the vermiform appendix, with special reference to its early diagnosis and treatment. Trans. Ass. Amer. Phys. 1886; 1:107–144.

10. Addiss DG, Shaffer N, Fowler BS, Tauxe RV. The epidemiology of appendicitis and appendectomy in the United States. Am J Epidemiol 1990; 132:910-25.

11. Häussler B, Schräder WF, Witt K. [Incidence of appendectomy and length of hospital stay in a region of West Germany]. Soz Praventivmed 1989; 34:131-5.

12. Hardin DM, Jr. Accute appendicitis: review and update. Am Fam Physician 1999; 60:2027-34.

13. Luckmann R, Davis P. The epidemiology of acute appendicitis in California: racial, gender, and seasonal variation. Epidemiology 1991; 2:323-30.

14. Barker DJ, Morris J. Acute appendicitis, bathrooms, and diet in Britain and Ireland. British medical journal 1988; 296:953-5.

15. Arnbjornsson E. Acute appendicitis and dietary fiber. Arch Surg 1983; 118:868-70.

16. Livingston EH, Woodward WA, Sarosi GA, Haley RW. Disconnect between incidence of nonperforated and perforated appendicitis: implications for pathophysiology and management. Ann Surg 2007; 245:886-92.

17. Raguveer-Saran MK, Keddie NC. The falling incidence of appendicitis. Br J Surg 1980; 67:681.

18. Ofili OP. Implications of the rising incidence of appendicitis in Africans. Cent Afr J Med 1987; 33:243-6.

19. Arnbjornsson E, Asp NG, Westin SI. Decreasing incidence of acute appendicitis, with special reference to the consumption of dietary fiber. Acta Chir Scand 1982; 148:461-4.

20. Al-Omran M, Mamdani M, McLeod RS. Epidemiologic features of acute appendicitis in Ontario, Canada. Can J Surg 2003; 46:263-8.

21. Wolkomir A, Kornak P, Elsakr M, McGovern P. Seasonal variation of acute appendicitis: a 56-year study. South Med J 1987; 80:958-60.

22. D`Alia C, Lo Schiavo MG, Tonante A, et al. Amyand`s hernia: case report and review of the literature. Hernia 2003; 7:89-91.

23. Mirilas P, Skandalakis JE. Not just an appendix: Sir Frederick Treves. Arch Dis Child 2003; 88:549-52.

24. Smith DC. Appendicitis, appendectomy, and the surgeon. Bull Hist Med 1996; 70:414-41.

25. McBurney C. IV. The Incision Made in the Abdominal Wall in Cases of Appendicitis, with a Description of a New Method of Operating. Ann Surg 1894; 20:38-43.

26. Gordon RC. John B. Murphy: unique among American surgeons. J Invest Surg 2006; 19:279-81.

27. Spaner SJ, Warnock GL. A brief history of endoscopy, laparoscopy, and laparoscopic surgery. J Laparoendosc Adv Surg Tech A 1997; 7:369-73.

28. Marlovits H, Lange J. Die Geschichte der Laparoskopie. Therapeutische Umschau 1997; 54:489-491.

29. Vecchio R, MacFayden BV, Palazzo F. History of laparoscopic surgery. Panminerva Med 2000; 42:87-90.

30. Davis CJ. A history of endoscopic surgery. Surg Laparosc Endosc 1992; 2:16-23.

31. Litynski GS. Kurt Semm and the fight aganist skepticism: endoscopic hemostasis, laparoscopic appendectomy, and Semm`s impact on the "laparoscopic revolution". Jsls 1998; 2:309-13.

32. Dubois F, Berthelot G, Levard H. Laparoscopic cholecystectomy: historic perspective and personal experience. Surg Laparosc Endosc 1991; 1:52-7.

33. Götz F, Pier A, Bacher C. [Laparoscopic appendectomy. Indications, technique and results in 653 patients]. Chirurg 1991; 62:253-6.

34. Pier A, Götz F, Bacher C, Ibald R. Laparoscopic appendectomy. World J Surg 1993; 17:29-33.

35. Andersson R, Hugander A, Thulin A, Nystrom PO, Olaison G. Indications for operation in suspected appendicitis and incidence of perforation. Bmj 1994; 308:107-10.

36. Agresta F, De Simone P, Michelet I, et al. [The rationale of laparoscopic treatment in acute appendiceal disease]. Chir Ital 2000; 52:171-8.

37. Nana AM, Ouandji CN, Simoens C, Smets D, Mendes da Costa P. Laparoscopic appendectomies: results of a monocentric prospective and non-randomized study. Hepatogastroenterology 2007; 54:1146-52.

38. Tzovaras G, Liakou P, Baloyiannis I, et al. Laparoscopic appendectomy: differences between male and female patients with suspected acute appendicitis. World J Surg 2007; 31:409-13.

39. Yu SC, Chen SC, Wang SM, Wei TC. Is previous abdominal surgery a contraindication to laparoscopic cholecystectomy? J Laparoendosc Surg 1994; 4:31-5.

40. Karayiannakis AJ, Polychronidis A, Perente S, Botaitis S, Simopoulos C. Laparoscopic cholecystectomy in patients with previous upper or lower abdominal surgery. Surg Endosc 2004; 18:97-101.

41. Wu JM, Lin HF, Chen KH, Tseng LM, Tsai MS, Huang SH. Impact of previous abdominal surgery on laparoscopic appendectomy for acute appendicitis. Surg Endosc 2007; 21:570-3.

42. Evasovich MR, Clark TC, Horattas MC, Holda S, Treen L. Does pneumoperitoneum during laparoscopy increase bacterial translocation? Surg Endosc 1996; 10:1176-9.

43. Yau KK, Siu WT, Tang CN, Yang GP, Li MK. Laparoscopic versus open appendectomy for complicated appendicitis. J Am Coll Surg 2007; 205:60-5.

44. So JB, Chiong EC, Chiong E, et al. Laparoscopic appendectomy for perforated appendicitis. World J Surg 2002; 26:1485-8.

45. Fukami Y, Hasegawa H, Sakamoto E, Komatsu S, Hiromatsu T. Value of laparoscopic appendectomy in perforated appendicitis. World J Surg 2007; 31:93-7.

46. Ball CG, Kortbeek JB, Kirkpatrick AW, Mitchell P. Laparoscopic appendectomy for complicated appendicitis: an evaluation of postoperative factors. Surg Endosc 2004; 18:969-73.

47. Katkhouda N, Mason RJ, Towfigh S , Gevorgyan A , Essani R. Laparoscopic Versus Open Appendectomy: A Prospective Randomized Double-Blind Study. Ann Surg. 2005; 242:439-50.

48. Minné L, Varner D, Burnell A, Ratzer E, Clark J, Haun W. Laparoscopic vs open appendectomy. Prospective randomized study of outcomes. Arch Surg. 1997; 132:708-11.

49. Bennett J, Boddy A, Rhodes M. Choice of approach for appendicectomy: a meta-analysis of open versus laparoscopic appendicectomy. Surg Laparosc Endosc Percutan Tech 2007; 17:245-55.

50. Agresta F, De Simone P, Leone L, et al. Laparoscopic appendectomy in Italy: an appraisal of 26,863 cases. J Laparoendosc Adv Surg Tech A 2004; 14:1-8.

51. Kazemier G, de Zeeuw GR, Lange JF, Hop WC, Bonjer HJ. Laparoscopic vs open appendectomy. A randomized clinical trial. Surg Endosc 1997; 11:336-40.

52. Sauerland S, Lefering R, Neugebauer EA. Laparoscopic versus open surgery for suspected appendicitis. Cochrane Database Syst Rev 2002; 18.

53. McCALL JL, Sharples K, Jadallah F. Systematic review of randomized controlled trials comparing laparoscopic with open appendicectomy. British Journal of Surgery 1997; 84:1045-1050.

54. Guller U, Hervey S, Purves H, et al. Laparoscopic Versus Open Appendectomy: Outcomes Comparison Based on a Large Administrative Database. . Annals of Surgery. 2004; 239:43-52.

55. Kouwenhoven EA, Repelaer van Driel OJ, van Erp WF. Fear for the intraabdominal abscess after laparoscopic appendectomy: not realistic. Surg Endosc 2005; 19:923-6.

56. Piskun G, Kozik D, Rajpal S, Shaftan G, Fogler R. Comparison of laparoscopic, open, and converted appendectomy for perforated appendicitis. Surg Endosc 2001; 15:660-2.

57. Cueto J, Allemagne BD, Va´ zquez-Frias JA, et al. Morbidity of laparoscopic surgery for complicated appendicitis: an international study. Surg Endosc 2006; 20:717–720.

58. Panton ON, Samson C, Segal J, Panton R. A four-year experience with laparoscopy in the management of appendicitis. Am J Surg 1996; 171:538-41.

59. Filippi de la Palavesa MM, Vaxmann D, Campos M, Tuchmann C, Guth S, Dietemann JL. Appendiceal stump abscess. Abdom Imaging 1996; 21:65-6.

60. Khan MN, Fayyad T, Cecil TD, Moran BJ. Laparoscopic versus open appendectomy: the risk of postoperative infectious complications. Jsls 2007; 11:363-7.

61. Tonouchi H, Ohmori Y, Kobayashi M, Kusunoki M. Trocar site hernia. Arch Surg 2004; 139:1248-56.

62. Coda A, Bossotti M, Ferri F, et al. Incisional hernia and fascial defect following laparoscopic surgery. Surg Laparosc Endosc Percutan Tech 2000; 10:34-8.

63. Nakajima K, Wasa M, Kawahara H, et al. Revision laparoscopy for incarcerated hernia at a 5-mm trocar site following pediatric laparoscopic surgery. Surg Laparosc Endosc Percutan Tech 1999; 9:294-5.

64. Kadar N, Reich H, Liu CY, Manko GF, Gimpelson R. Incisional hernias after major laparoscopic gynecologic procedures. Am J Obstet Gynecol 1993; 168:1493-5.

65. Slim K, Pezet D, Chipponi J. Laparoscopic or open appendectomy? Critical review of randomized, controlled trials. Dis Colon Rectum 1998; 41:398-403.

66. Azaro EM, Amaral PC, Ettinger JE, et al. Laparoscopic versus open appendicectomy: a comparative study. Jsls 1999; 3:279-83.

67. do Amaral PC, Filho Ede M, Galvao TD, et al. Factors leading to long-term hospitalization after laparoscopic appendectomy. Jsls 2006; 10:355-8.

68. Leister I, Becker H. Relaparoskopie bei laparoskopischen Komplikationen. Chirurg 2006; 77:986–997.

69. Deredzhian Kh, Kolarov E, Giurova Z. [Relaparotomy after an appendectomy]. Khirurgiia (Sofiia). 1998; 51:49-51.

70. Chikamori F, Kuniyoshi N, Shibuya S, Takase Y. Appendiceal stump abscess as an early complication of laparoscopic appendectomy: report of a case. Surg Today 2002; 32:919-21.

71. Kellnar S, Trammer A, Till H, Lochbuhler H. Endoscopic appendectomy in childhood--technical aspects. Eur J Pediatr Surg 1994; 4:341-3.

72. Kazemier G, in't Hof KH, Saad S, Bonjer HJ, Sauerland S. Securing the appendiceal stump in laparoscopic appendectomy: evidence for routine stapling? Surg Endosc 2006; 20:1473-6.

73. Olguner M, Akgur FM, Ucan B, Aktug T. Laparoscopic appendectomy in children performed using single endoscopic GIA stapler for both mesoappendix and base of appendix. J Pediatr Surg 1998; 33:1347-9.

74. Klima S, Schyra B. [Technique and significance of stump management for outcome of laparoscopic appendectomy]. Langenbecks Arch Chir Suppl Kongressbd 1996; 113:556-8.

75. Hanssen A, Plotnikov S, Dubois R. Laparoscopic appendectomy using a polymeric clip to close the appendicular stump. Jsls 2007; 11:59-62.

76. Lukish J, Powell D, Morrow S, Cruess D, Guzzetta P. Laparoscopic appendectomy in children: use of the endoloop vs the endostapler. Arch Surg 2007; 142:58-61; discussion 62.

77. Wehrman WE, Tangren CM, Inge TH. Cost analysis of ligature versus stapling techniques of laparoscopic appendectomy in children. J Laparoendosc Adv Surg Tech A 2007; 17:371-4.

78. Arcovedo R, Barrera H, Reyes HS. Securing the appendiceal stump with the Gea extracorporeal sliding knot during laparoscopic appendectomy is safe and economical. Surg Endosc 2007; 21:1764-7.

79. Robinson JO. Surgical drainage: an historical perspective. Br J Surg 1986; 73:422-6.

80. Magarey CJ, Chant AD, Rickford CR, Margarey JR. Peritoneal drainage and systemic antibiotics after appendicectomy. A prospective trial. Lancet 1971; 2:179-82.

81. Stone HH, Hooper CA, Millikan WJ, Jr. Abdominal drainage following appendectomy and cholecystectomy. Ann Surg 1978; 187:606-12.

82. Greenall MJ, Evans M, Pollock AV. Should you drain a perforated appendix? Br J Surg 1978; 65:880-2.

83. Dandapat MC, Panda C. A perforated appendix: should we drain? J Indian Med Assoc 1992; 90:147-8.

84. Narci A, Karaman I, Karaman A, et al. Is peritoneal drainage necessary in childhood perforated appendicitis?--a comparative study. J Pediatr Surg 2007; 42:1864-8.

85. Hansen JB, Smithers BM, Schache D, Wall DR, Miller BJ, Menzies BL. Laparoscopic versus open appendectomy: prospective randomized trial. World J Surg 1996; 20:17-20; discussion 21.

86. Esposito C, Borzi P, Valla JS, et al. Laparoscopic versus open appendectomy in children: retrospective comparative study of 2,332 cases. World J Surg 2007; 31:750-5.

87. Raguse T, Hufschmidt M. Komplikationen bei der laparoskopischenAppendektomie. Chir Gastroenterol 1993; 9:28–32.

88. Schäfer M, Krähenbühl L, Borer D, Klaiber Ch, Frei E. Aktueller Stellenwert der laparoskopischen Appendektomie in der Schweiz Min Inv Chir 1998; 7:13-16.

89. Schick KS, Hüttl TP, Fertmann JM, Hornung HM, Jauch KW, Hoffmann JN. A Critical Analysis of Laparoscopic Appendectomy: How Experience with 1,400 Appendectomies Allowed Innovative Treatment to Become Standard in a University Hospital. World J Surg. 2008.

90. Liu SI, Siewert B, Raptopoulos V, Hodin RA. Factors associated with conversion to laparotomy in patients undergoing laparoscopic appendectomy. J Am Coll Surg 2002; 194:298-305.

91. Akyurek N, Salman B, Irkorucu O, et al. Laparoscopic Cholecystectomy in Patients With Previous Abdominal Surgery. JSLS 2005; 9:178–183.

92. Simopoulos C, Botaitis S, Karayiannakis AJ, Tripsianis G, Pitiakoudis M, Polychronidis A. The contribution of acute cholecystitis, obesity, and previous abdominal surgery on the outcome of laparoscopic cholecystectomy. Am Surg 2007; 73:371-6.

93. Chung RS, Rowland DY, Li P, Diaz J. A meta-analysis of randomized controlled trials of laparoscopic versus conventional appendectomy. Am J Surg 1999; 177:250-6.

94. Long KH, Bannon MP, Zietlow SP, et al. A prospective randomized comparison of laparoscopic appendectomy with open appendectomy: Clinical and economic analyses. Surgery 2001; 129:390-400.

95. Frazee RC, Roberts JW, Symmonds RE, et al. A prospective randomized trial comparing open versus laparoscopic appendectomy. Ann Surg 1994; 219:725-8; discussion 728-31.

96. Lord RV, Sloan DR. Early Discharge After Open Appendicectomy. Aust. N.Z. J. Surg. 1996; 66:361-365.

97. Atabek U, Spence RK, Pello MJ, Alexander JB, Villanueva D, Camishion RC. Safety of teaching laparoscopic cholecystectomy to surgical residents. J Laparoendosc Surg 1993; 3:23-6.

98. Scott-Conner CE, Hall TJ, Anglin BL, Muakkassa FF. Laparoscopic appendectomy. Initial experience in a teaching program. Ann Surg 1992; 215:660-7; discussion 667-8.

99. Cuschieri A. Reflections on surgical training. Surg Endosc 1993; 7:73-74.

100. Sefr R, Penka I, Olivero R, Jagos F, Munteanu A. The impact of laparoendoscopic surgery on the training of surgical residents. Int Surg 1995; 80:358-60.

101. Neugebauer E, Troidl H, Kum CK, Eypasch E, Miserez M, Paul A. The E.A.E.S. Consensus Development Conferences on laparoscopic cholecystectomy, appendectomy, and hernia repair. Consensus statements--September 1994. The Educational Committee of the European Association for Endoscopic Surgery. Surg Endosc 1995; 9:550-63.

102. Smith CD, Farrell TM, McNatt SS, Metreveli RE. Assessing laparoscopic manipulative skills. Am J Surg 2001; 181:547-50.

103. Sweeney KJ, Dillon M, Johnston SM, Keane FB, Conlon KC. Training in laparoscopic appendectomy. World J Surg 2006; 30:358-63.

104. Bouillot JL, Salah S, Fernandez F, et al. Laparoscopic procedure for suspected appendicitis. A prospective study in 283 consecutive patients. Surg Endosc 1995; 9:957-60.

105. Shabtai M, Rosin D, Zmora O, et al. The impact of a resident's seniority on operative time and length of hospital stay for laparoscopic appendectomy: outcomes used to measure the resident's laparoscopic skills. Surg Endosc 2004; 18:1328-30.

106. Carrasco-Prats M, Soria Aledo V, Lujan-Mompean JA, Rios-Zambudio A, Perez-Flores D, Parrilla-Paricio P. Role of appendectomy in training for laparoscopic surgery. Surg Endosc 2003; 17:111-4.

107. Enochsson L, Hellberg A, Rudberg C, et al. Laparoscopic vs open appendectomy in overweight patients. Surg Endosc 2001; 15:387-92.

108. Fried GM, Barkun JS, Sigman HH, et al. Factors Determining Conversion to Laparotomy in Patients Undergoing Laparoscopic Cholecystectomy. The American Journal of Surgery 1994; 167.

109. de Wilde RL. Goodbye to late bowel obstruction after appendicectomy. Lancet 1991; 338:1012.

9. Eidesstattliche Erklärung

Hiermit erkläre ich, Maged Header, geboren am 13.05.1967 in Kairo (Ägypten), an Eides Statt, daß meine Dissertation mit dem Thema “Experience with laparoscopic appendectomy as routine operation to manage patients with appendicitis: special attention to the role of laparoscopic appendectomy in training for resident surgeons” von mir selbst und ohne Hilfe Dritter verfaßt wurde, auch in Teilen keine Kopie anderer Arbeiten darstellt und die benutzten Hilfsmittel sowie die Literatur vollständig angegeben sind. Ich habe mich anderwärtig nicht um einen Doktorgrad beworben und besitze einen entsprechenden Doktorgrad nicht. Ich erkläre die Kenntnisnahme der dem Verfahren zugrunde liegenden Promotionsordnung der Medizinischen Fakultät Charite` der Humboldt-Universität zu Berlin.

Berlin ,den

10. Acknowledgement

I would like to express my deepest gratitude and sincere appreciation to Prof. Dr. med. Ernst Kraas, Chefarzt of Minimally invasive surgery clinic in DRK, Westend Hospital, Berlin, for suggesting the point, constant and continuous support, valuable foresight, careful guidance and helpful suggestions. It is really a great honour for me to work under his supervision and guidance.

My grateful appreciation directed to Dr. Albert Jägle, Oberarzt in surgery clinic in DRK, Westend Hospital, Berlin. I am deeply indebted to him for the valuable advises beneficial discussions during work and faithful support he offered me.

I wish to express my deep gratitude and respect to Dr. Erik Weise and Dr. Joscha Buckendahl, from the surgical department in DRK, Westend Hospital, Berlin, for their support, assistance and encouragement. My special thanks go to Dr. David Syverson for his help and advice in English language revision.

Certainly, last but not least, my most special thanks go to my parents for their understanding and encouragement during my whole life. Deep special thanks go to my wife Shereen for her patience, unconditional care, so much effort and support during my work in this thesis. I want also to mention and thank my 5-years old son Mohammed for being patient with his father during my time of writing and working in my thesis.

11. Tabellarischer Lebenslauf

Mein Lebenslauf wird aus Datenschutzgründen in der elektronischen Version meiner Arbeit nicht mit veröffentlicht.