DIPLOMARBEIT

Entwicklung der Diagnostik und des Managements der Patienten mit einfacher Appendizitis an der Universitätsklinik für Kinder- und Jugendchirurgie Graz im Zeitraum 1999 - 2008.

eingereicht von

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Graz, am: 11. April 2014 *Qendrim Zahiri & Majlinda Hoxha*

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Zusammenfassung

Einleitung: Die Appendizitis ist die häufigste Ursache des akuten Abdomens im Kindesalter. Eine Appendektomie aufgrund einer Begleitappendizitis oder aufgrund eines nicht entzündeten Appendix wird allgemein als ein Fehleingriff gewertet. Zahlreiche Studien versuchten daher Wege zu finden, um die Anzahl der unnötigen Appendektomien zu reduzieren.

Diese Arbeit untersuchte den Einfluss der Entwicklung der diagnostischen Vorgehensweise der Patienten mit Verdacht auf eine Blinddarmentzündung auf deren Behandlung über einen 10-jährigen Zeitraum.

Material und Methoden: Es wurde eine retrospektive Untersuchung des gesamten Patientinnen- und Patientenkollektivs der Universitätsklinik für Kinder- und Jugendchirurgie Graz aus dem Zeitraum 01.01.1999 - 31.12.2008 durchgeführt. Eingeschlossen wurden alle Patienten die entweder aufgrund einer einfachen Appendizitis operiert, oder aufgrund des Verdachtes auf Appendizitis stationär aufgenommen und ohne Operation wieder nach Hause entlassen wurden. Folgende Parameter wurden erhoben: Geschlecht, Alter, Dauer des stationären Aufenthaltes, Anzahl der aufgrund einer einfachen Appendizitis operierten Patienten auf Basis der Entlassungsdiagnose im Arztbrief (gesamt/pro Jahr), histologische Diagnose der entfernten Appendizes, Anzahl der zur Beobachtung aufgenommenen und ohne Operation wieder entlassenen Patienten (gesamt/pro Jahr), Anzahl der durchgeführten Sonographien des Abdomens mit gezielter Appendix-Suche (pro Jahr), Anzahl der sonographisch dargestellten Appendices (pro Jahr), Größe der Appendix-Durchmesser bei erfolgreicher sonographischer Darstellung (in mm), und Leukozytenzahl und CRP Werte zum Zeitpunkt der stationären Aufnahme der Patienten.

Ergebnisse: 5458 Patienten wurden in der 10-jährigen Periode wegen des Verdachts auf Appendizitis stationär aufgenommen und 2147 (39%) Patienten wurden appendektomiert. 4468 Patienten (82%) wurden sonographiert, und bei 2402 Patienten (54%) konnte der Appendix im Ultraschall sicher dargestellt werden. Es zeigte sich, dass je mehr sonographiert und je treffsicher der Appendix im Ultraschall identifiziert wurde, desto weniger Patienten aufgenommen und operiert wurden!

Conclusio: Die Ergebnisse dieser Studie zeigen im Verlauf der 10 jährigen Studienperiode eine deutliche Abnahme der wegen des Verdachtes auf Appendizitis stationär aufgenommenen und wegen einer einfachen Appendizitis operierten Patienten. Diese Abnahme könnte durch die Zunahme der Anwendung der Ultraschalluntersuchung bei Patienten mit Verdacht auf Appendizitis und durch die Zunahme der Appendixerkennungsrate im Ultraschall zurückzuführen sein. Unsere Studienergebnisse befürworten eine routinemäßige Anwendung der Ultraschalldiagnostik im Rahmen der präoperativen Untersuchungen der Patienten mit Verdacht auf Blinddarmentzündung.

Abstract

Appendicitis is the most common cause of acute abdomen in childhood. An appendectomy due to a concomitant appendicitis or due to a non-inflamed appendix is generally regarded as a false intervention. Therefore numerous studies attempted to find ways to reduce the number of unnecessary appendectomies.

This study investigated the influence of the development of the diagnostic approach of patients with suspected appendicitis on their treatment over a 10-years period.

Materials and Methods: We performed a retrospective examination of the entire patient population of the University Clinic for Pediatric and Adolescent Surgery Graz from the period 01.01.1999 - 31.12.2008. We included all patients who were admitted to the hospital with suspicion of appendicitis and either underwent a surgery for simple (acute and subacute) appendicitis or where discharged later from hospital without surgery. The following parameters were collected: Gender distribution, age distribution, duration of hospital stay, number of due to a simple appendicitis (subacute, acute) or non-inflamed appendix surgically treated patients on the basis of the discharge diagnoses (total / per year), histological diagnoses of the removed appendices and comparison of these to the discharge diagnoses. Other parameters included the total number of patients admitted for observation but discharged without surgery (total / per year), performance of abdomen ultrasonography with focused appendiceal search (yes / no), sonographically depicted appendix (yes / no), appendiceal diameter in mm at successful sonographic depiction, and leukocyte count and CRP values at the time of hospital admission.

Results: 5458 patients were hospitalized during the 10-years period for suspected appendicitis. Out of these 2147 (39%) underwent an appendectomy, and 4745 (87%) were examined by abdominal ultrasonography, with clear depiction of appendix in 2402 patients (54%).

We found that the higher the number of patients receiving abdominal ultrasound examinations and the higher the appendix depiction rate in ultrasound, the lower the number of patients admitted to the hospital due to suspected appendicitis and the lower the number of patients receiving surgery due to simple appendicitis. .

Conclusion: The results of this study showed a significant decrease in the number of both, patients hospitalized because of appendicitis and those who had undergone surgery due to simple appendicitis during the 10-years study period. This decrease in the number of hospitalized patients and the number of surgically treated patients seems to be due to the increased number of diagnostic abdominal ultrasound examinations and the improvement of appendiceal identification rate in the ultrasound. The results of our study support the routine application of this imaging modality in the pre-operative evaluation of patients with suspected appendicitis.

Contents

1 Introduction

Appendicitis is called the inflammation of vermiform appendix. This condition is mostly accompanied with rapid development of the symptomatic, in the worst cases leading to perforation of the appendix wall, thus spilling out the intestinal content into peritoneum, with clinically consequences of an acute abdomen. There are many studies aiming to find the best approaches to aid diagnosis while the other try to find the most innovative surgical methods in certain patients subsets [44]. Despite many logarithmic score systems, which were developed to support the diagnosis of acute appendicitis, the clinical symptoms, biochemical laboratory findings and imaging diagnostic remains the main important factors in taking decision of the final diagnosis, thus making the therapeutic steps more clearly.

1.1 History of Appendix

The vermiform appendix was described for the first time in the beginning of the 16th century as an anatomical structure [1-3]. It was drawn in Da Vinci´s anatomical books and was called “orecchio” or ear. However, it has been reported for the first time in the official scientific records written by Da Capri [4] (1524) and Vesalius [5] (1543). Until the 18th century, appendicitis was described only in autopsy [1-3]. The First performed appendectomy was recorded by Amyand (1736), in a young male patient presented with a fistula in a hernia [7]. Amyand found appendix in the scrotal sac while exploring the hernia. Later, numerous cases of appendicular abscess were successfully diagnosed and drained with recovery of patients [1-3] escaping the death. The first extraction of a gangrenous appendix was recorded in a London in a patient, Lawson Tait, in 1880, in which the appendix was lying deep within the peritoneal cavity. The patient recovered after the surgery [8].

In 1886, Reginald Fitz [9], professor of medicine at Harvard, described the natural history of the inflamed appendix and coined the term *appendicitis*. He proposed early operation and removal of inflamed appendix as a life-saving decision.

In 1889, Charles McBurney, professor of surgery at Columbia College of Physicians and Surgeons, reported a number of cases of acute appendicitis [10]. In the first case, an acutely inflamed but unruptured appendix was removed in a 19-year-old man. This report [10] described the point of maximal tenderness that bears McBurney's name: "very exactly between a 3.8 cm and 5 cm from the anterior spinous process of the ileum on a straight line drawn from that process to the umbilicus".

1.2 Anatomy and physiology

Embryologically the development of both appendix and caecum starts around the sixth – eighth gestational week as a cone-shaped swelling from the caudal limb of the midgut loop. Some villi are seen in the appendix during the fourth and fifth months, but these disappear prior to birth. Lymphatic nodules are present by the seventh month. This lymphatic tissue continues to increase until puberty and then slowly recedes [2]. The tip of appendix outpouching begins to elongate about the fifth month to achieve the recognized vermiform (wormlike) shape. The appendix maintains its position at the tip of the caecum at the time of birth. Subsequently, unequally enlargement of the lateral wall of the caecum causes the appendix to find its adult position on the posteromedial wall, just below the ileocecal valve. The tip of the appendix can be located anywhere in the right lower quadrant of the abdomen or pelvis. The base of appendix can be located by following longitudinally oriented tenia coli to their confluence at the caecum. The appendix receives its blood supply from the appendicular branch of the ileocolic artery. This artery originates posterior to the terminal ileum, entering the mesoappendix, close to

the base of the appendix [35]. The lymphatic drainage of the appendix flows into the lymph nodes that lie along the ileocolic artery. Innervation of appendix comes from the sympathetic branches of the superior mesenteric plexus (T10-L1), and some afferents from parasympathetic plexus arrive from the vagus nerve [12].

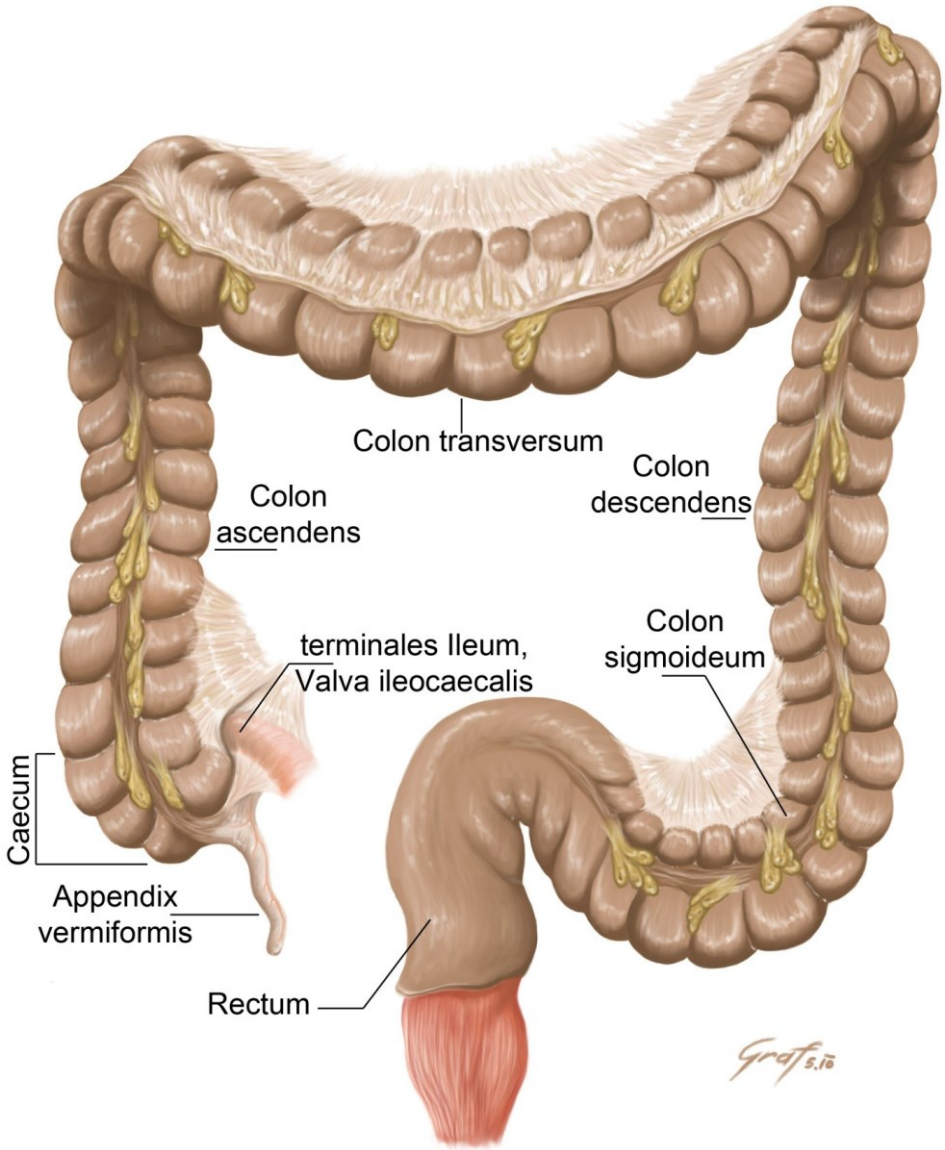

Figure 1.1. Anatomy of the large Intestinal Tract, token from Graf's Anatomy

Recent studies have shown that immune cell population and their response to luminal antigens offer the possibility that appendix may play in the immune surveillance [16, 17]. Although the main role of appendix appears to remain unclear, the mucosa of the appendix, as many other mucosa layers, is capable to produce a bulk of fluids, mucin and proteolytic enzymes. [1] The most recent studies assume the role of appendix as good safe-house for normal gut bacteria [43].

In the 1930s, Dr. Owen Wangensteen at the University of Minnesota measured fluid output and intraluminal pressure generated within the normal human appendix [18, 19]. He found that specimens of normal Appendix secreted fluid in the range of 0.25 to 2 mL/day and acutely generated pressures up to 125 cm H_2O {<100 mmHg}[19]. He confirmed that no such fluid or pressures were generated when mucosa was atrophic.

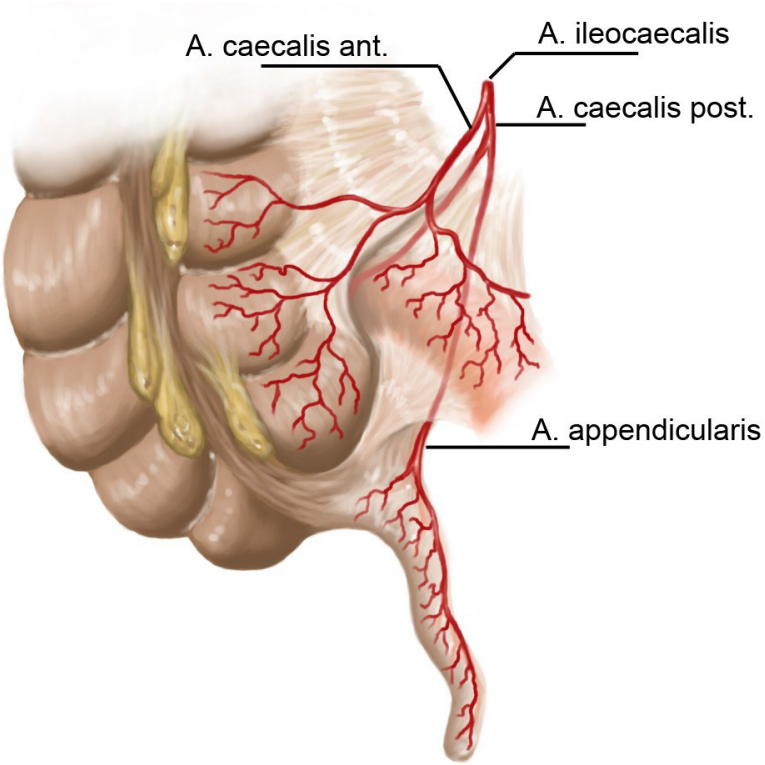

Figure 1.2. Arterial blood supply of the appendix vermiformis. Graf's Anatomy

2 Diseases of Vermiform Appendix

2.1 Acute Appendicitis

2.1.1 Aetiology and Pathogenesis

Appendicitis is called the inflammation of the wall of vermiform appendix.

In the early 1970, Burkitt [20, 21] proposed that the Western diet, notorious for its low levels of fiber and higher content of fat and refined sugar was associated with certain conditions of the bowel. Beside others, Appendicitis was shown as a high frequent condition among people with high fat reached food and less frequent among those with higher fiber consumption, like Africans. Burkitt made an analysis with the sectioned colon due to appendicitis in a various groups of various living areas and he came to the results that the fecaliths were more prevalent at the adults of higher developed countries (Canada) in compare with the patients from developing areas such as Africa. He noted a general association of fecalith with acute appendicitis. He proposed that the low fiber diets contribute to the changes of motility, flora or luminal conditions that predispose the development of fecaliths [1 –3].

2.1.2 Role of obstruction

Wangensteen conceptualized acute Appendicitis as a closed-loop obstruction [35]. He assumed that obstruction may be demonstrated in about half of the cases, and it is usually caused by a fecalith [18-19]. More recently it has become dogma that in the absence of fecalith, many cases of obstruction are caused by hyperplasia of lymphoid tissue in the mucosa and submucosa. In a very small percentage of cases, perhaps 2%, obstruction is caused by neoplasm [carcinoma or carcinoid tumor] or, very rarely, a foreign body [22-24]. In Wangsteen's investigations and experimental studies of subsequent investigators [25-29], typical inflammatory changes of acute appendicitis were observed as consequences of luminal obstruction. The following sequence of events is envisioned [35]: The luminal obstruction leads first to secretion of mucus and fluid, with a consequent rise in the luminal pressure. When the luminal pressure exceeds the pressure within mucosal venules and lymphatics, the outflow of blood and lymph is obstructed. A fact which leads to increased pressure within the appendiceal wall. When capillary pressure is exceeded, mucosal ischemia, inflammation and ulceration may result. Eventually, bacterial overgrowth within the lumen and bacterial invasion into the mucosa and submucosa lead to transmural inflammation, edema, vascular stasis, and necrosis in the muscularis and perforation may follow.

Beside the local changes within the appendix, a second inflammatory response mediated by mesothelium and blood vessels in the parietal peritoneum and serosa of nearby visceral structures is induced. Subsequently, a local inflammatory response and walling-off of the inflammatory mass due to neutrophils and other inflammatory mediators can be seen. As a consequence, the perforated appendix leads to the walled-off, periappendiceal abscess formation. Alternatively, if the surrounding structures fail to wall-off the evolving phlegmon, perforation of appendix may cause a spillage into the

peritoneal cavity, leading to spreading peritonitis, massive third-spacing of fluid, shock and then eventually to death. It has been proved and in a few studies demonstrated that only 25% of appendicitis are caused due to an increased pressure and an evidence of obstruction [35]. Thus obstruction may be only one of many factors that could cause an acute appendicitis

2.1.3 Role of normal colonic flora

The flora of the inflamed appendix is different from that of a normal appendix [35]. About 60% of aspirates of inflamed appendix have anaerobes, compared to 25% of aspirates from normal appendices [30-32].It's been assumed that the lumen is the source of organisms that invade mucosa, when the mucosal integrity is compromised by increased luminal pressure or intramural ischemia. Tissue specimens from the inflamed appendix wall (not luminal aspirates) virtually all culture out *Escherichia coli,* and *Bacteroides species* [31, 32] There are about 10 isolates per tissue specimen. In addition to the usual suspects *(peptostreptococcus, pseudomonas spp., bacteroidessplanchnicus, bacteroidesintermedius, lactobacillus)*, previously unreported fastidious gram-negative anaerobic bacilli have been encountered [32]. In an important study by Piper et al., [31] serum antibody titers to polysaccharide regions in four of the *bacteroides* species were found to be elevated in most patients with gangrenous or perforated appendicitis. These findings indicate that invasion of tissue by *bacteroides* elicits specific humoral responses. Moreover, in many cases in which the acute appendicitis is probable, antibiotic therapy alone can reverse the evolving clinical syndrome and permit individuals to recover without operation. Thus, the normal colonic flora plays a key role in the evolution of acute appendicitis to gangrene and perforation [35]!

2.2 Natural history and Complications

The classical description of the immune response and the immune modulators reacting pathway occurs as follows [35]: acute appendicitis progresses inexorably, from obstruction to mucosal and then transmural inflammation, necrosis and then gangrene with local inflammatory responses from the visceral and parietal peritoneum, to perforation with local abscess formation or spreading peritonitis. One time-honored observation has been that perforation is not common if the symptoms last for less than 24h [33]. It has been shown in many studies that only a small percentage of inflamed appendixes perforate in the early period of the symptoms of appendicitis. This occurs mostly in verbally-challenged patients such as very young children and very old people. Along with cholecystitis and diverticulitis, the acute appendicitis is the main cause of pyogenic liver abscess and septic portal vein thrombosis [33, 34].

2.2.1 Clinical Presentation

2.2.1.1 Symptoms

The preliminary symptoms of appendicitis include a crumply and colicky abdominal pain. This pain is the result of the luminal obstruction of the Appendix as a hollow – lumen organ. In its early phase, the pain is described as diffuse abdominal that may progress to a located periumbilical pain in the later stages of the disease. (This is because the appendix arises from the midgut – related to the innervation form peripheral nervous system around T10) [35]. The patients are typically not able to describe the pain and its severity and its other characteristics do not change with changes in body position nor by other physiological processes. The luminal obstruction is the cause of the luminal distention from the intraluminal edema followed by ischemia and the pain becomes constant. Vomiting is described as an often especially at young patients but is not prominent Symptom. In general, patients with appendicitis mostly show the symptoms of nausea and loss of appetite.

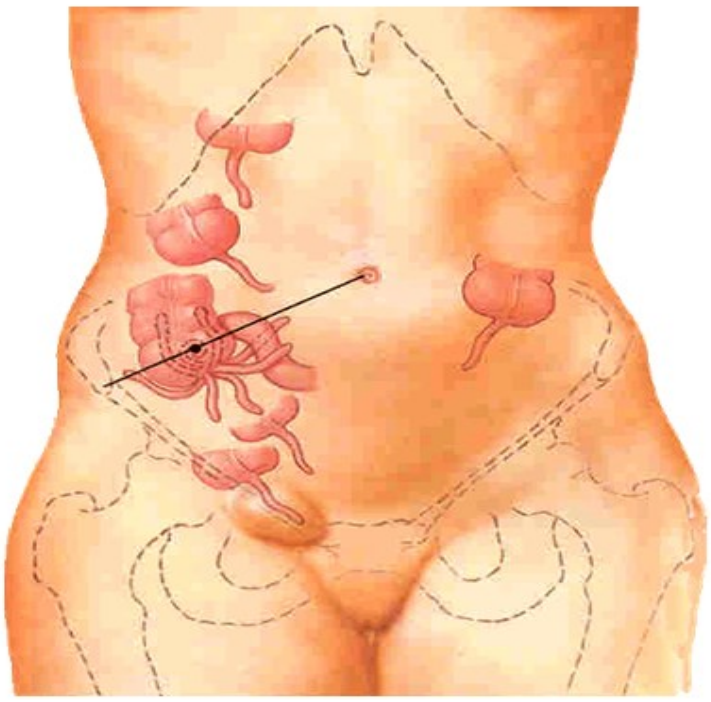

Figure 2.1.Location of McBurney's point, located two thirds the distance from the Umbilicus to the right anterior superior iliac spine AND the possibility of appendixe´s localisation. Taken from www.quizlet.com/Gross II: Abdominal Cavity & GI Tract

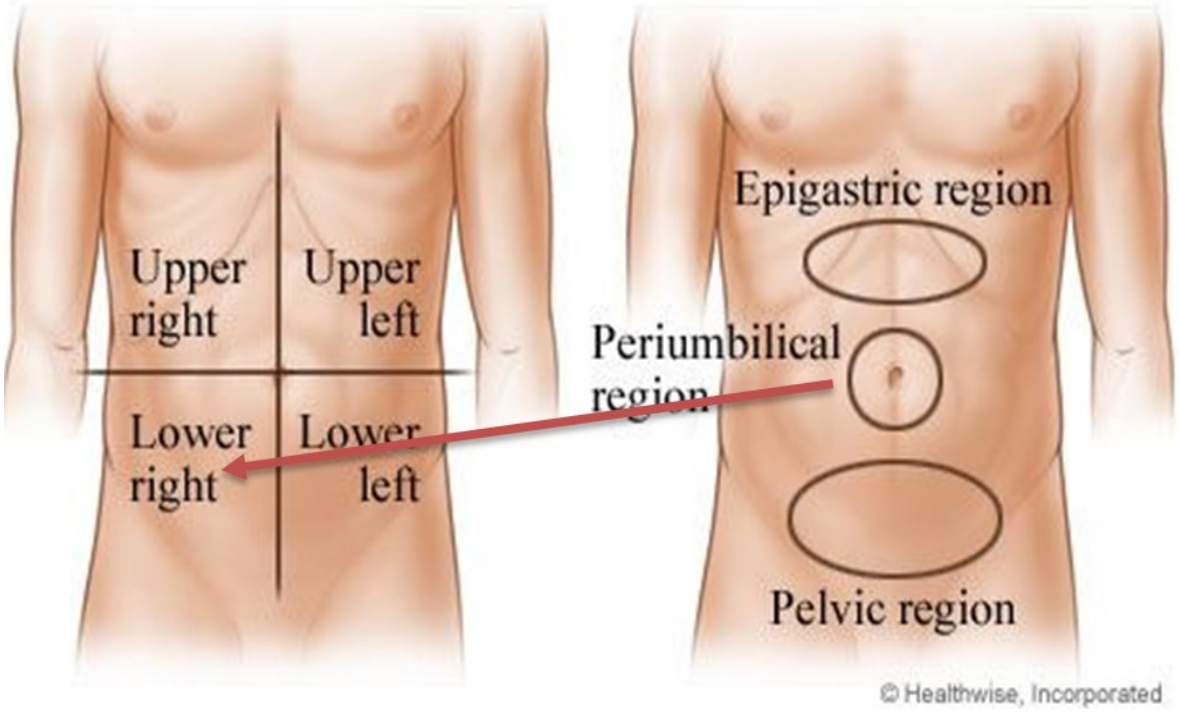

Figure 2.2. Location of abdominal pain by appendicitis and its progression, taken froom www.zadehsurgical.com

2.2.1.2 Signs

The inflammatory response from the bacterial invasion within the appendiceal wall and the surrounding structures leads to the appearance of pain and tenderness to the parietal peritoneum overlying the inflamed tissue (phlegmon), followed by fever above 38,2°C. Later on the periumbilical pain moves down localizing in to the right lower abdominal quadrant. Although its predictive power is disputed [36-38], McBurney's point is supposed to be the place where the appendix lies and therefore the place of maximum tenderness [10,37]. Corresponding to the anatomical position of the appendix the pain can be localized on different areas in lower abdomen or pelvis [35]. Depending on that, the point of maximum tenderness can be localized on different points of abdominal palpation. Theoretically, an acute appendix coming from the true pelvis may be diagnosed by means of rectal examination when the examiner elicits localized tenderness or palates a mass.

In one study [40], rectal examination was useful in identifying a clinical picture of acute appendicitis but in connection with other peritoneal findings i.e. rebound or localized tenderness [35].

Classically, there are three diagnostic maneuvers which may be helpful in the diagnosing of inflamed or perforated appendix in diverse localizations of appendix: ***Rovsing´s sign*** (when pressure applied in the left lower quadrant of the abdomen elicits pain on the right side, reflecting peritoneal irritation), *The* ***Psoas sign*** (by positioning the patient on the left side and extending the right hip produces pain, which reflects irritation of the right psoas muscle and indicates retrocecal and retroperitoneal irritation from a phlegmon or an abscess) and *the* ***obturator sign*** (is produced by positioning the patient supine and then rotating the flexed right thigh internally, from lateral to medial. Pain produced with this maneuver indicates inflammation near the obturator muscle in the true pelvis) [35].

It is noteworthy that none of these single symptoms alone provides reliable means to establish or exclude the diagnosis of acute appendicitis; it is the overall clinical picture that counts.

2.2.1.3 Laboratory findings

Among the common laboratory findings, the elevation of CRP (C reactive protein) value and white blood cells (WBC) plays a major and helpful role, in combination with the clinical symptoms and findings in diagnosing of appendicitis. An elevation on leucocytes count is usually elevated in bona fide cases of appendicitis, however it should not be deemed as the only important parameter on diagnosing of appendicitis, because a number of patients suffering from appendicitis show no elevation on WBC. Often in retrospect, a normal WBC count proves as an attribute of the early stage of the illness, and elevation might have been anticipated as the illness progressed. For this reason, serial measurements of the WBC count would undoubtedly improve the accuracy of the test, and this has been shown [41].

Depending on the clinical sings, three types of labor analysis should be performed routinely: Urine analysis to exclude any ureteral stone or any possible urinary tract infection (UTI) which appears with lower abdominal pain. The lower UTI are very common in the young female patients with acute appendicitis. In addition, the liver and pancreas parameters should be measured to exclude a lever – gallbladder or a pancreatic inflammation, particularly in patients with pain on the right upper abdominal quadrant [44, 45] (most common in the elderly appendicitis patients). Another important parameter to be taken into account in teenagers/children (+16 Years old females) is the level of serum β –HCG to exclude any possible ectopic or concurrent pregnancy [35].

2.2.1.4 Imaging Studies

There are five different imaging modalities to facilitate the diagnosis of acute appendicitis:

Modality	Key findings	Sensitivity (%)	Specificity (%)
Plain abdominal film	Fecalith loss of fat stripe Sentinel loop/ Ileus	30	50-80
Barium enema	Non-filling of appendix; cecal wall irregularity/ mas effect	85	95
Ultrasound	"Target" sign abscess; loss of motility	80	90
CT Scan	Phlegmonabscess	95	90
MRT Scan	Wall thickness, wall structural changes, abscess.	96	92

Table 1. Imaging Modalities in the Diagnosis of Appendicitis [35]

When the appendicitis was the indication for surgery, fecaliths were present in half of the patients according to Brukitt and associates [21] Study. In young patients the low likelihood of finding a fecalith suggests that obtaining plain films is not cost-effective. If such films are conducted, it is best to obtain a complete series of plain films, including flat and upright views. A barium enema as well as other modalities can be helpful in this regard.

Ultrasonography is a relatively old method which is nevertheless helpful in diagnosing the thickened and inflamed wall of the appendix. In Europe – (Austria), the usage of ultrasonography is almost a routine pre-examination in

the diagnosis of suspected appendicitis. This method is valuated with a relative high specificity (47-98%) and sensitivity (85-98%). It is useful in all patients regardless of age and has no radiation risk. In the early 80's, every appendix case diagnosed in ultrasonography was deemed pathologic. In our days however, due to the sophisticated methods and increase of number of preoperative ultrasonography, there is a high tendency to determine the pathological appendix for each single case. However the efficacy of US may vary due to high dependence how experienced the examiner is.

In the beginning of the 90's, the computed tomography took an important place among the different commonly applied techniques in USA in order to diagnose appendicitis in both old and young population. Generally, it has been accepted as a non-invasive gold standard method to diagnose appendicitis. In combination with the orally applied contrast fluid, the production of a thickened appendix wall can be precisely observed ensuring the diagnosis of an inflamed appendix. Although the high accuracy rate of CT scanned patients, there is a relatively high rate on radiation, therefore among young patients, the application of CT scan is only preferred in very highly suspicious and ambiguous symptomatic cases.

Although CT is complimentary to sonography, it is associated with greater cost, exposure to ionizing radiation and exposure to contrast agents.

It is essential to have a correlation between the imaging findings and the patient's symptoms [36].

Required details	• Non-compressible • Threshold diameter > 6mm (blind-ending tubular structure at the point of maximum discomfort) • Definite periappendiceal abscess
Features suggestive of appendicitis	• Appendicolith, faecalith, echogenic foci within the lumen with clean acoustic shadowing. • Echogenic submucosa with fluid-filled lumen • Circumferential hyperemia using Doppler sonography • Echogenic perienteric fat and omental wrapping • Sympathetic thickening of adjacent ileum, caecum, ascending colon • Fluid collection

Table 2. Positive diagnostic criteria used to analyze ultrasonography reports [36]

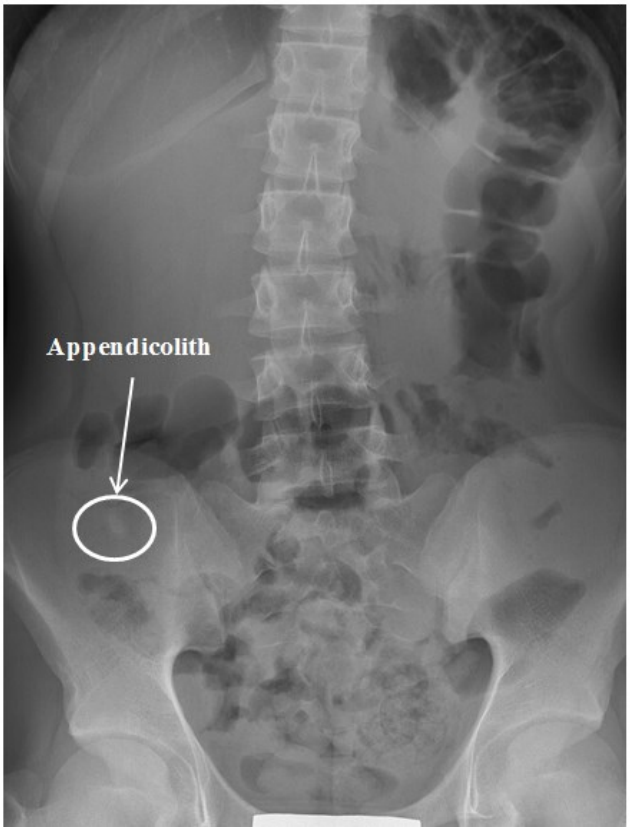

Figure 2.3. Plain abdominal film of an appendicolith (Haxhija et al. 2011)

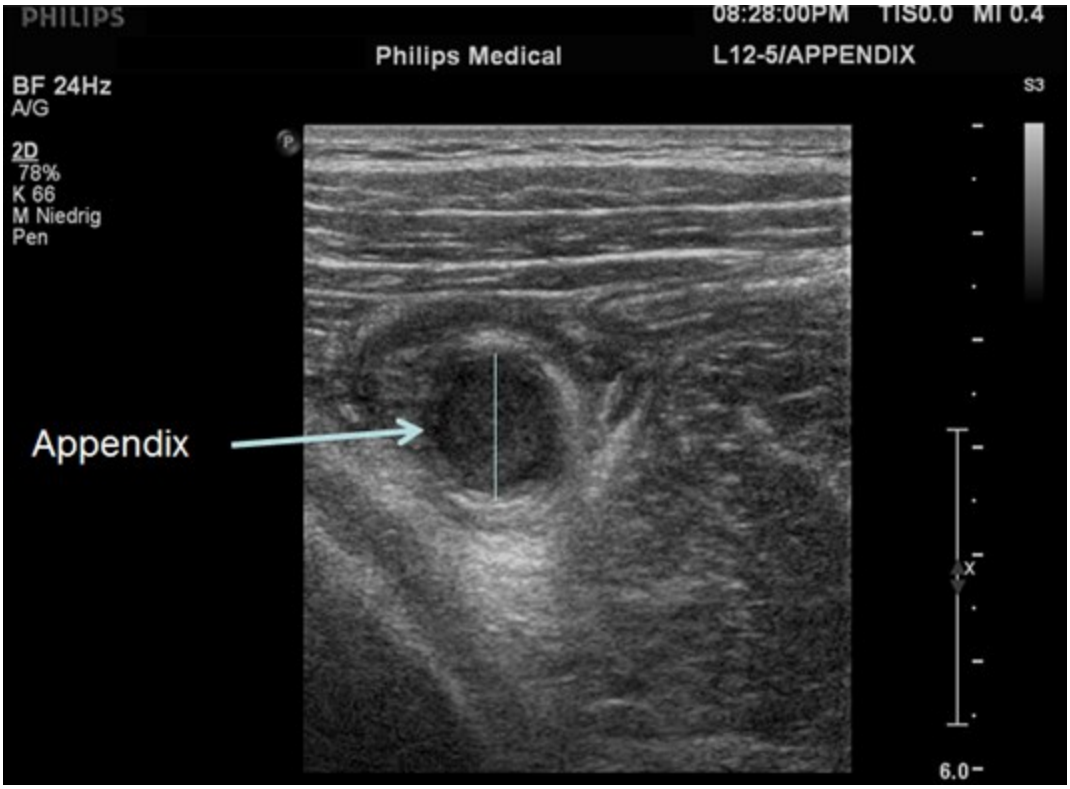

Figure 2.4. Visible appendix in ultrasound (diameter 15 mm). (Haxhija et al. 2011)

2.2.2 Examination and Management of Cases

A structured flow and a meaningful organization of a patient with acute appendicitis play a significant role in the accuracy, accelerating the coming up steps, processing a correct management plan [49].

Symptoms / signs	• Classic history of pain (onset, quality, location, radiation, associated symptoms) • Pain shift to right lower abdomen quadrant • Pain with cough / movement • Facial flush • Tenderness at McBurney´s point • Guarding at McBurney´s point • Rectal exam: increased pain on right • Pelvic exam: absence of discharge/ adnexal tenderness • Temperature • Urinalysis: glucose, WBCs, RBCs, β-HCG • Blood test: Hematocrit / hemoglobin, WBC Count, CRP, left shift. • Indication for surgery clear indications uncertain indications • Operation Date/time/surgeon; Postoperative diagnosis, Findings; Operation performed.

Table 3. Shows the structured placement of symptoms of diagnosing of acute Appendicitis

2.2.2.1 Differential diagnoses

The most often cause of pain in the right lower abdominal quadrant among young patient is appendicitis. An inflamed Meckel's diverticulum with similarity on history and pathogenesis as appendicitis is an uncommon rarity in the childhood. Common enteritis or diarrhea as well as Crohn's disease should also be considered on diagnosing of appendicitis.

Appendix position	Symptoms
Above the cecum:	• Cholecystitis • Inflamed or perforated duodenal ulcer • Perinephric abscess • Hydronephrosis • Kidney / upper ureteral stone / urinary tract infection • Omental torsion • Pneumonia with pleurisy • Hepatitis • Pancreatitis
In iliac position:	• Inflamed or perforated duodenal ulcer • Crohn´s disease • Cecal carcinoma • Lymphoma • Ureteral stone • Yersinia, CMV, tuberculosis infection • Inflamed Meckel´s diverticulum • Psoas abscess • Rupture or hematoma of the rectus abdominis muscle • Cecal ulcer • Typhoid fever
In pelvic position:	• Intestinal obstruction / obstipation • Diverticulitis of the colon • Perforation of a typhoid ulcer • Gastroenteritis
In women:	• Ectopic pregnancy • Ovarian cyst ruptured or twisted on its pedicle • Pelvic inflammatory disease • Ruptured ovarian follicle or corpus luteum cyst

Table 4. Most possible differential diagnosis at appendicitis [35]

2.2.2.2 Immediate Management

Principally the patients with an acute abdomen can be triaged in to those [35] who:

A) are sick and are getting worse,

B) are not really sick and getting better and

C) in whom the evolution of symptoms and signs is not certain.

The group A patients need to receive an immediate first care such as intravenous access with the sequent intravenous fluid supply to replace the loss of electrolytes and fluid and to prevent the possible future fluid deficiency due to inability to take water orally. If the diagnosis of appendicitis is clear, it would be advisable to begin with the antibiotic therapy and pain relievers, offering the patient a comfort while awaiting the definitive management. The next steps on diagnosis and therapy should make the surgeon [35].

For the patients of group B it should be kept on mind if the improvements of symptoms are only temporary or not? Meanwhile the relief of patient from discomfort may disguise a perforation of gangrenous appendix. In case of disappearance of the acute abdominal pain within few hours and the accompanied findings such as local tenderness, leukocytosis, increased CRP, fever, anorexia etc., the patient may safely be discharged from the diagnosis of appendicitis but if there is a recurrence of the symptoms, than further investigations should be performed.

Careful investigation and observation are needed in the group with the patients who do not show any recovery or any progression from the symptoms. Intravenous access and fluids can be ensured and a watchful waiting over 6 – 24 h should be performed. During this time of observance, patients undergo further imaging studies, in early phases. In younger patients, particularly in girls after puberty, the usage of ultrasound can be indispensable

on diagnosing a possible gynecological process. Ultrasound in combination with an exact history and clinical examination may reduce the number of unnecessary laparotomies or laparoscopies.

2.2.2.3 Indications for operation, operative procedures and postoperative management

Depending on the history and examination outcomes, sometimes on imaging studies as well, the surgeon decides to operate or not the patient with suspicious appendicitis. If the diagnosis of appendicitis has been made clearly and with reasonable degree of certainty, operation is indicated, except in any unusual circumstances such is at a patient who just passed the acute illness but after that came to a complicated situation with formation of a well-circumscribed abscess [35]. In such cases the CT is an excellent help at therapy decision [44]. In some cases the use of antibiotics can help on mass resolving, in others, the CT guided percutaneous drainage can expel abscess, decreasing the intraperitoneal pressure and relieving the symptoms, in this way a laparotomy can be avoided to over bridge the inoperable state of patient [44]. Some studies [42] showed that on time application of antibiotics at early appendicitis has positive influence. Recently there have been used different clinical criteria, which predict the diagnosis of acute appendicitis. A good sample for this is the Alvarado Scoring System. Below is shown the Alvarado Scoring System for predicting clinical diagnosis of acute appendicitis:

Alvarado Scoring System predicts the clinical diagnosis of acute appendicitis [41].

Features	Points
Localized tenderness in the right lower quadrant	**1**
Leukocytosis (WBC > 10,500/mm^3)	**1**
Migration of pain after onset	**1**
Shift of differential count to the left	**1**
Fever > 38°C (100,5°F)	**1**
Nausea – vomiting	**1**
Anorexia	**1**
Ketones in urine	**1**
Rebound	**1**
Guarding	**1**
• Low (≈ 5%) likelihood of appendicitis – may be discharged with instructions to return if symptoms evolve	**0 – 4 criteria**
• Intermediate (≈ 40% – 50 %) likelihood of appendicitis – should be admitted for observation or imaging studies	**5 – 7 criteria**
• High (>80%) likelihood of appendicitis – should be taken to the operating room.	**8 – 10 criteria**

Table 5. Alvarado Scoring System[41]

After the establishment of the diagnosis and when the surgery as the right therapy management is chosen, it has to be ensured that the patient feels comfort with pain medication and in those cases where the disease becomes severe, cover with the antibiotics such are second generation cephalosporin

alone or in combination with a broad-spectrum antibiotic (metronidazole) should be provided.

The antibiotics are thought to be given in order to reduce the incidence of any potential wound and deep peritoneal infections that may occur after operation and they should prevent against the consequences of bacteremia.

After the properly preoperative management, the right surgical approach should be chosen by the surgeon. Depending on this verity of appendicitis, the surgeon should make the decision, whether the patient has to undergo a right-side-laparotomy or a laparoscopy associated appendectomy.

Based on the most recent publications, it seems to be a reduction on postoperative hospitalization at those patients, who undergone a laparoscopy assisted appendectomy [36]. These patients had generally lower wound infection rate, less postoperative pain and could return earlier to normal activity comparing with those patients who undergone a conventional opened appendectomy. Laparoscopy assisted appendectomies played an important esthetic and consequently psychic role too, particularly at teenagers [35].

The laparoscopic approach could offer a significant advantage at the circumstances when the diagnosis is in doubt, such as at the young women. In those cases an explorative laparoscopy may be helpful, although presently it aims to be avoided through imaging studies (ultrasonography or CT).

Once identified, whether with laparoscopy or opened appendectomy, the appendix should be amputated close to the base. In the circumstances when the local tissue inflammation does not allow identifying the appendix or abscess formation precludes safe dissection, it is recommended to place a close suction drain near into the cavity, thereby preventing abscess or fecal material accumulation inside the peritoneal cavity [35].
Finally, the choice of laparoscopic or open appendectomy is best decided by

the surgeon based on personal experience, institutional capabilities, severity of disease, body habitus, and other factors.

If the diagnosis of appendicitis fails to be revealed, it has to be undertaken an exploration into the neighbor organs excluding a possible Meckel's diverticulum, Cron's disease, ileitis or mesenteric adenitis. In patients over the 40's, the ileum, the cecum, and the sigmoid colon should be examined for malignancy as well as pelvic organs at the women excluding any extra- or intrauterine pathology. If there can be no source localized, there are three reasons for removing the appendix, and even if it appears normal with naked eye[35]:

1. *Presence of a scar and history of exploration for the diagnosis may lead future care providers to assume the appendix has been removed.*
2. *If the pain returns, removed appendix decreases the number of differential diagnoses, and*
3. *In the early inflammation phases of appendicitis, the appendix may appear in normal size, but microscopically have been noticed early intramural or serosal inflammatory changes (periappendicitis).*

The last intraoperative decision is whether the wounds should be left open or they can be closed primarily. This decision should be made individually, depending on patient's condition.

Postoperatively, at the uncomplicated cases, the patients may take fluid and then within 24 h begin with slight calorie diet. Only those patients with complicated appendicitis such as with peritonitis or abscess formation need a longer course of antibiotics for 5 – 7 days.

2.2.2.4 Special remarks

There should be considered that different patient groups show different features and outcomes at appendicitis. Depending on the clinical features and the outcome, adequate therapy and illness management should be chosen. A very careful treatment is indicated in patients with advanced age, pregnancies and immunocompromised patients. A particular attention should be given two micro specimens *campylobacter jejuni and yersinia enterocolica*[37], which are responsible for a small percentage of cases of acute appendicitis.

2.2.2.5 Operations decision character

Once the suspicion for an unclear appendicitis exists, we should always remember that the decision for operation should be made based on the balance between the risk and cost of delay (rupture and complications) versus the risk and cost of negative appendectomy. In those uncertain diagnosed cases, the decision should generally be on favor of operation [35].

2.3 Chronic appendicitis

Chronic right side pelvic pain, among many differential diagnoses can be attributed to chronic appendicitis. In the literature, it has been recognized an initial acute episode that may have triggered the inflammation process of chronic appendicitis [35]. However, the recurrent cases of acute relapsing now are well documented. Not rare in literature have been written the cases of removing appendicitis in patients with recurring pain in right low quadrant, if there no other source can be identified [38].

Among the elder patients, who present symptoms of chronic appendicitis, the possibility of appendixes' neoplasms or cecum tumors should be always kept on mind.

3 Materials and methods

In this retrospective study we collected and analyzed the data from all patients admitted at the Department of Pediatric and Adolescent Surgery of Medical University Graz due to suspected appendicitis or simple appendicitis in the time period from 1999 to 2008. The data were collected out of the discharge letters, outpatient notes, surgical reports, laboratory results, and ultrasound reports performed by the staff of the Pediatric Surgery Department.

The following parameters were assessed:

- gender
- age distribution in 4 age groups:
    - Age group I 0-3 years old,
    - Age group II 4-8 years old,
    - Age group III 9-13 years old and
    - Age group IV 14-19 years old.
- Number of patients who had undergone surgery due to a non-inflamed or a simple appendicitis (sub-acute and/or acute) based on the discharge diagnoses in the discharge letters (total / per year),
- histological diagnoses of removed appendices and comparison of these with the discharge diagnoses noted in the discharge letter,
- number of patients admitted in the hospital for observation and discharged without surgery (total/per year)
- number of ultrasound examinations of the abdomen performed due to suspected appendicitis

- number of appendices visualized during the ultrasonography
- diameter of visualized appendices in mm
- laboratory values concerning leukocyte numbers and CRP (mg/l)
- the mode of surgery (open or laparoscopic)

According to their clinical diagnoses, the patients were separated in three major groups:

a) Acute appendicitis group
b) Subacute appendicitis group
c) Observed and not operated group

Ultrasound reports were reviewed to determine whether the appendix was identified. Ultrasonography results were classified in a binary manner as either “positive” or “negative”. Once the Appendix was seen in ultrasonography, we evaluated that as positive. Negative reports included those in which the appendix could not be identified in ultrasound. Furthermore, we compared the ultrasonography data with the clinical discharge diagnoses.

The admission of patients to the hospital was done on the basis of the clinical findings, as to whether they suffered from an abdominal pain that required an immediate surgical intervention or necessitated medical therapy. Based on the emergency situation, the patients either underwent immediately a surgical intervention or stayed in hospital under observation for an appropriate period of time. The observed patients were discharged from the hospital either after a definitive diagnosis had been made and the treatment was initiated or completed, or the patient had no longer abdominal complaints. Intraoperative diagnosis made by the surgeon was taken as discharge diagnosis in surgically treated patients. The histopathology results of the removed appendices were

usually available 1-week after the patients were discharged and were assessed from the outpatient notes. According to this aspect, we compared the intraoperative diagnoses made by the surgeons with the final histopathology results of the removed appendices for each individual case.

4 Results

4.1 Total number of patients

During the period from 1999-2008, 5458 patients between 0-19 years of age with symptoms of simple appendicitis (acute, subacute, in observation) were admitted for treatment at the Department of Pediatric and Adolescent Surgery of Medical University of Graz.

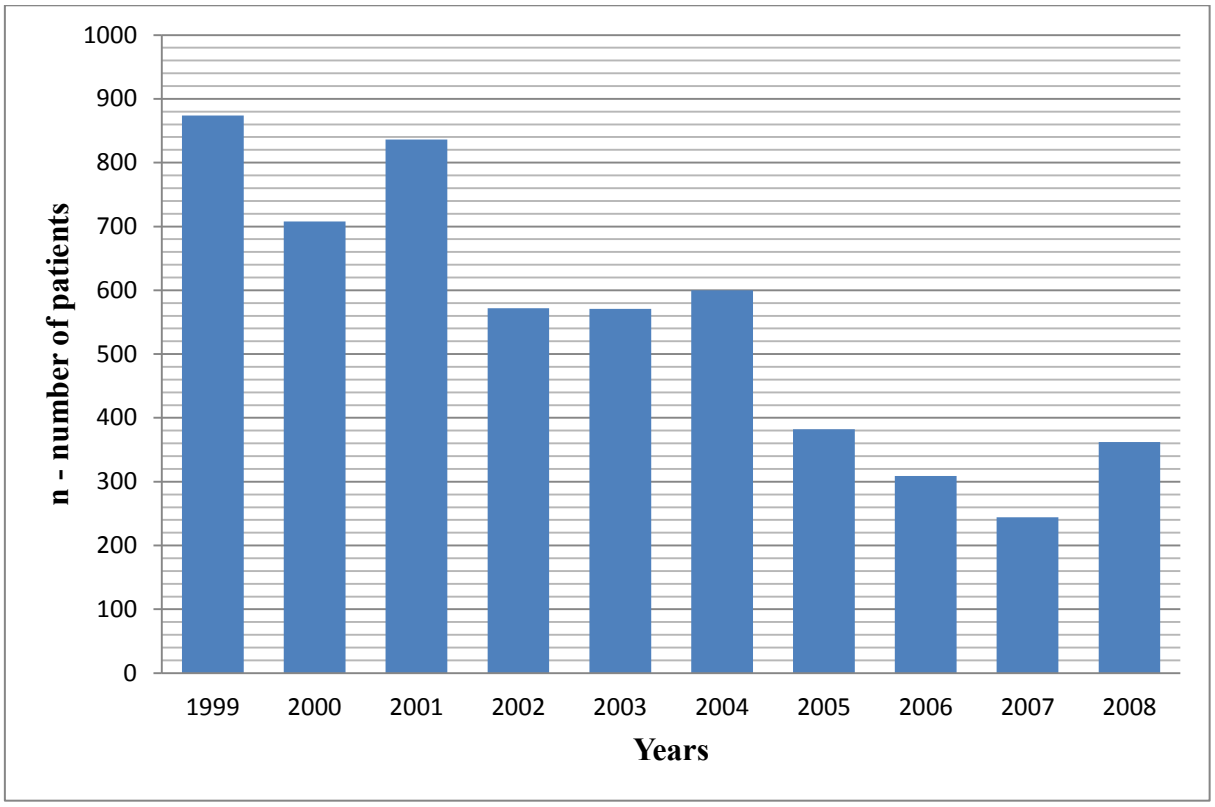

Diagram 1. Number of patients admitted to the hospital due to simple appendicitis or for an observation period due to suspected appendicitis from 1999 – 2008

Diagram 1 shows that during the study period there was a steady decrease in the total number of patients admitted to the hospital for simple appendicitis, or for observation.

We then analyzed to gender distribution of the hospitalized patients.

Diagram 2 shows that throughout the study period more female patients were admitted to the hospital than male patients. Furthermore, the admission rate shows a similar decrease for both genders throughout the study period.

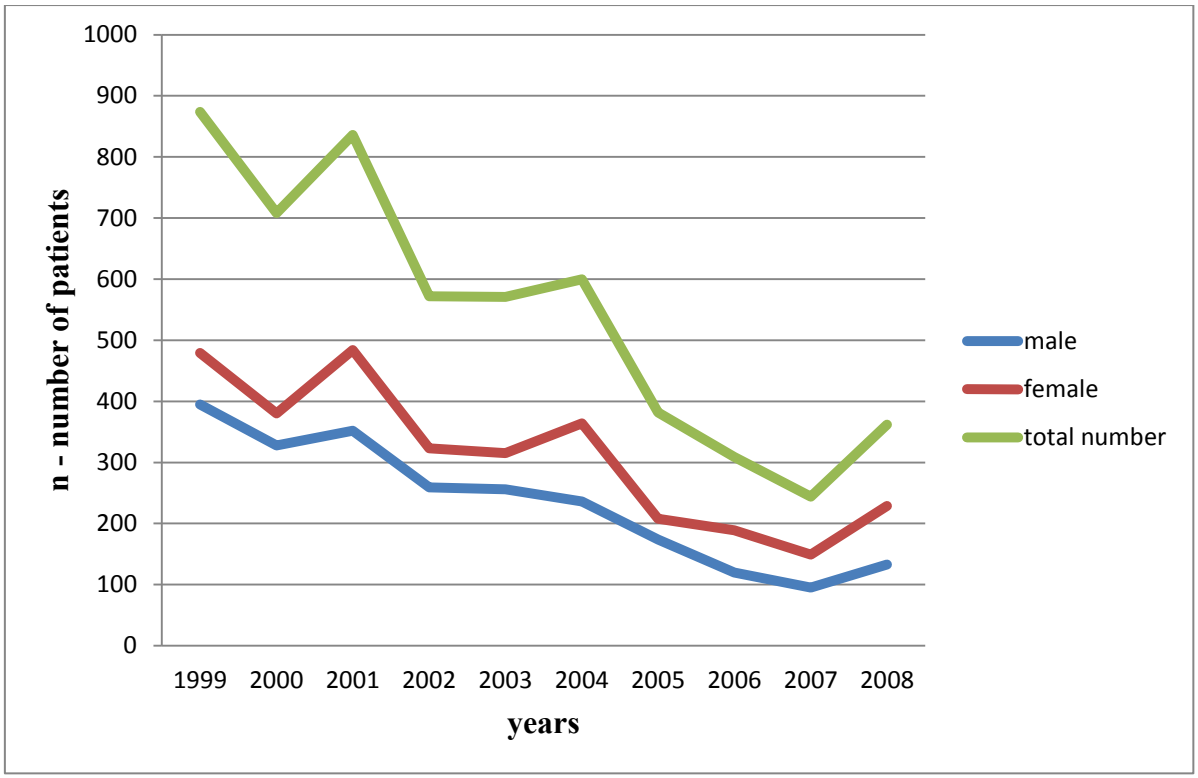

Diagram 2. Number of patients admitted to the hospital due to simple appendicitis or for an observation period due to suspected appendicitis from 1999 – 2008 altogether and separated for gender

Diagram 2 shows the total number of the admitted patients for both genders. Generally seen, more female patients were admitted than male patients. The admission rate for both genders descends similarly through years 1999 - 2008.

4.2 Age groups distribution over years

Because the incidence of appendicitis varies with age we separated the patients into 4 age groups. Diagrams 3 and 4 depict the distribution of patients in age groups over years for both genders together. As shown in the diagrams, patients between 9-13 years of age make up the biggest group of patients 46% (n=2500), followed by those between 4 - 8 years old 27% (n=1458), and the group of patients over 14 years of age 25% (n=1376). On the other side, there were very few patients hospitalized for appendicitis in the age group of 0 – 3 years of age 2% (n=124).

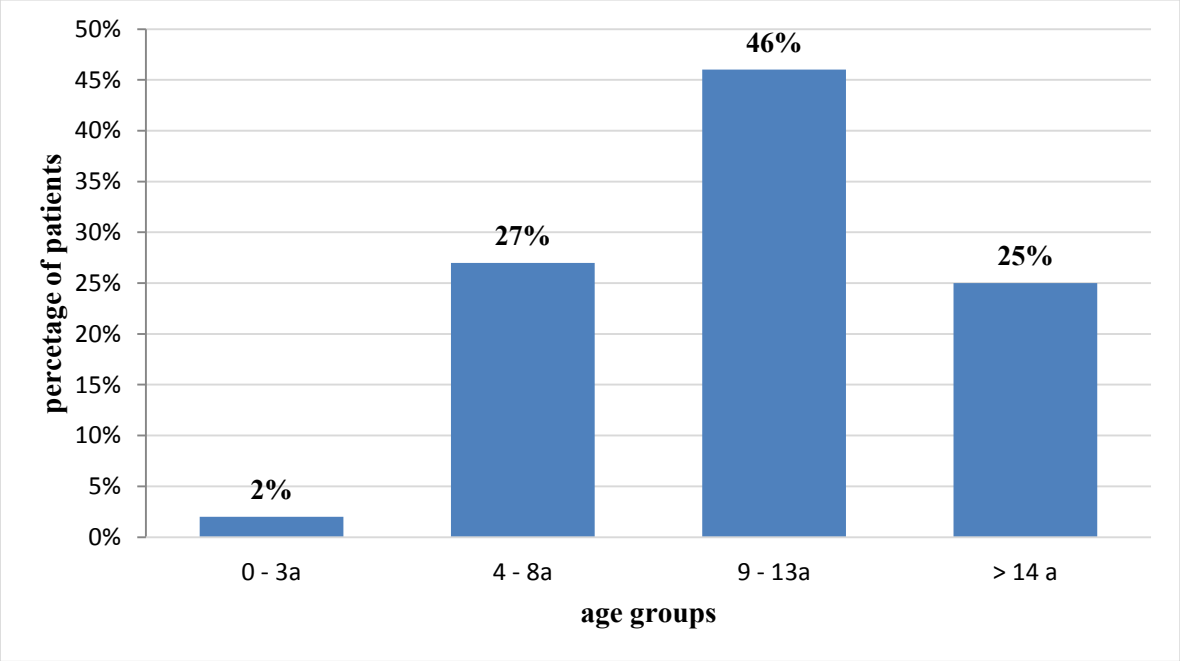

Diagram 3. Age groups distribution of patients admitted to the hospital due to simple appendicitis or for an observation period due to suspected appendicitis from 1999 – 2008

The following diagram 4 shows that the decrease of the number of hospitalized patients over the study period concerned all age groups, but that this decrease was especially marked in the age groups of less than 13 years of age.

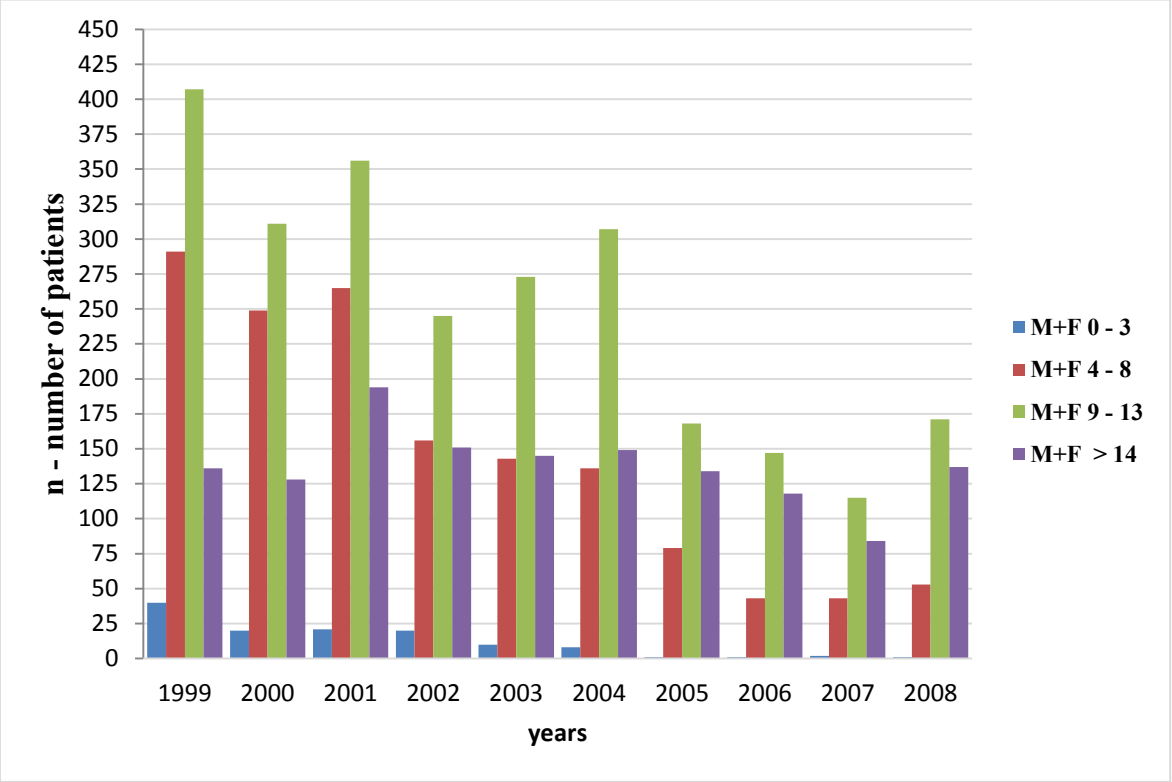

Diagram 4. Number of patients admitted to the hospital due to simple appendicitis or for an observation period due to suspected appendicitis from 1999 – 2008 divided in 4 age groups

4.3 Gender distribution in age groups per years

During the study period 3130 (57%) girls and 2328 (43%) boys were hospitalized for suspected appendicitis or for simple appendicitis (Diagram 6).

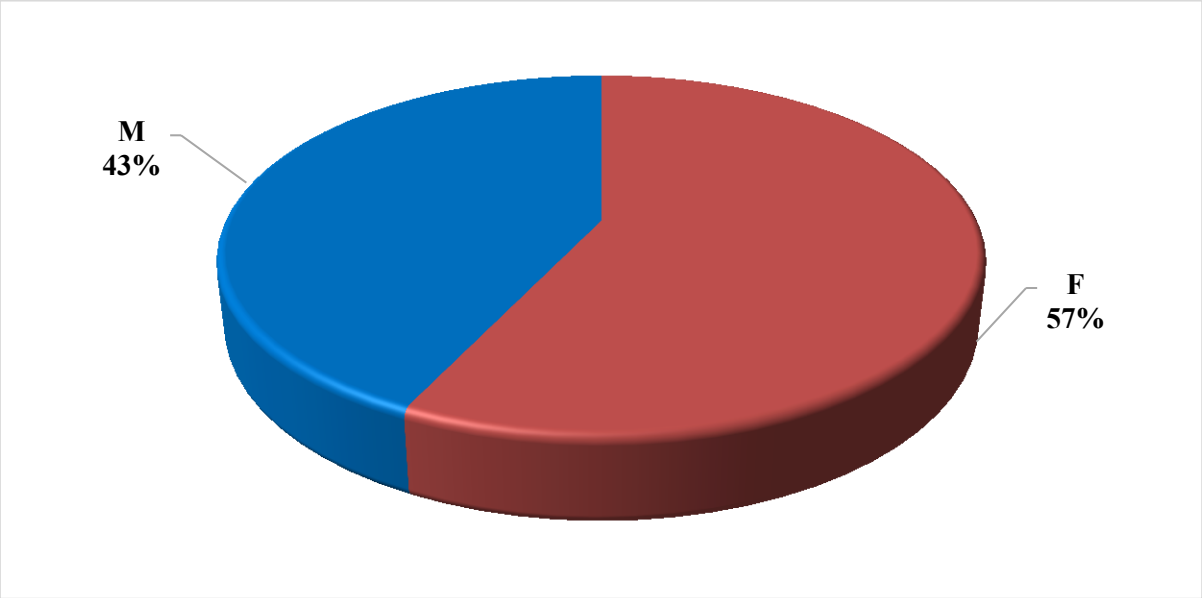

Diagram 5. Gender distribution of patients admitted to the hospital due to simple appendicitis or for an observation period due to suspected appendicitis from 1999 – 2008

The following diagrams show the gender distribution in different age groups.

In the group of patients between 0 – 3 years of age there was an obvious decrease in the number of patients admitted to the hospital due to appendicitis for both genders during the study period (Diagram 6). The total of 52 girls (42%) and 72 boys (58%) were hospitalized for suspected or simple appendicitis in this age group during the whole study period.

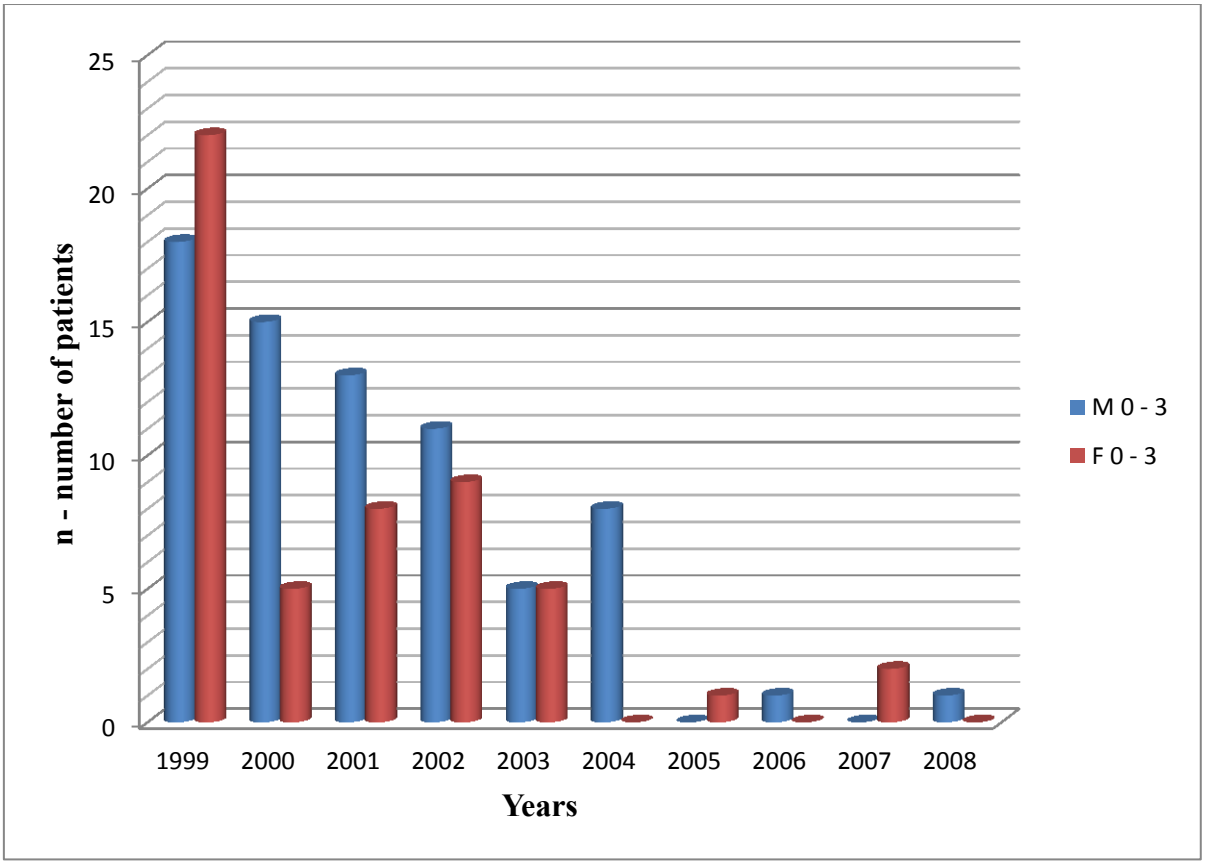

Diagram 6. Number of patients in the age group of 0-3 years divided by gender during the study period

Also, in the age group of 4 - 8 years of age there was a continuous decrease in the number of patients for both genders during the study period (Diagram 7). The total number of patients in this age group is much higher than in the group of patients of 0 – 3 years of age. The total of 702 girls (48%) and 759 boys (52%) were hospitalized for suspected or simple appendicitis in the age group of 4-8 years during the study period.

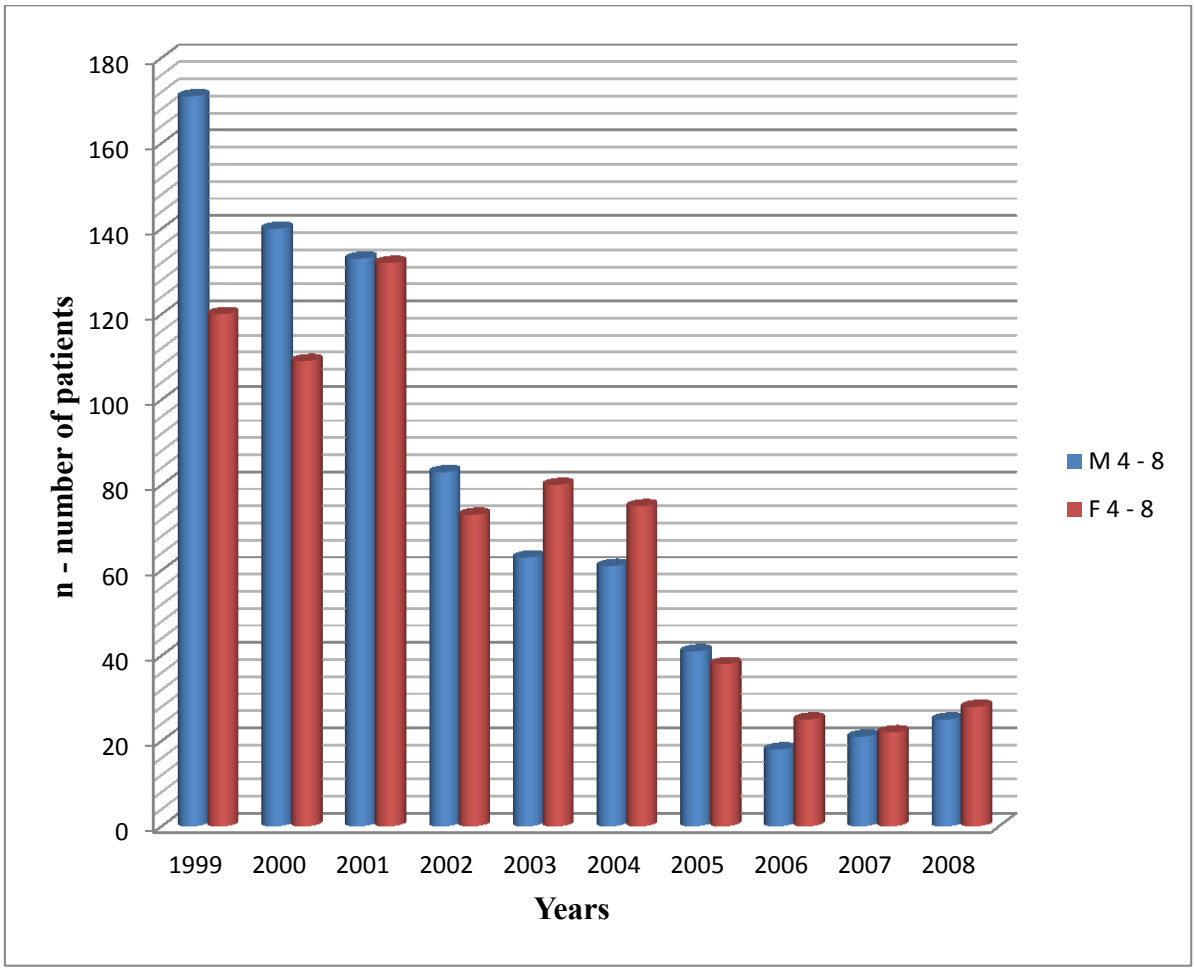

Diagram 7. Number of patients in the age group of 4-8 years divided by gender during the study period

The group of 9 – 13 years old patients showed a slight dominance of female patients. Also, in this age group a trend towards the reduction of number of hospitalized patients during the study period was found (Diagram 8).

The total of 1433 girls (57%) and 1067 boys (43%) were hospitalized for suspected or simple appendicitis in the age group of 9 - 13 years during the study period.

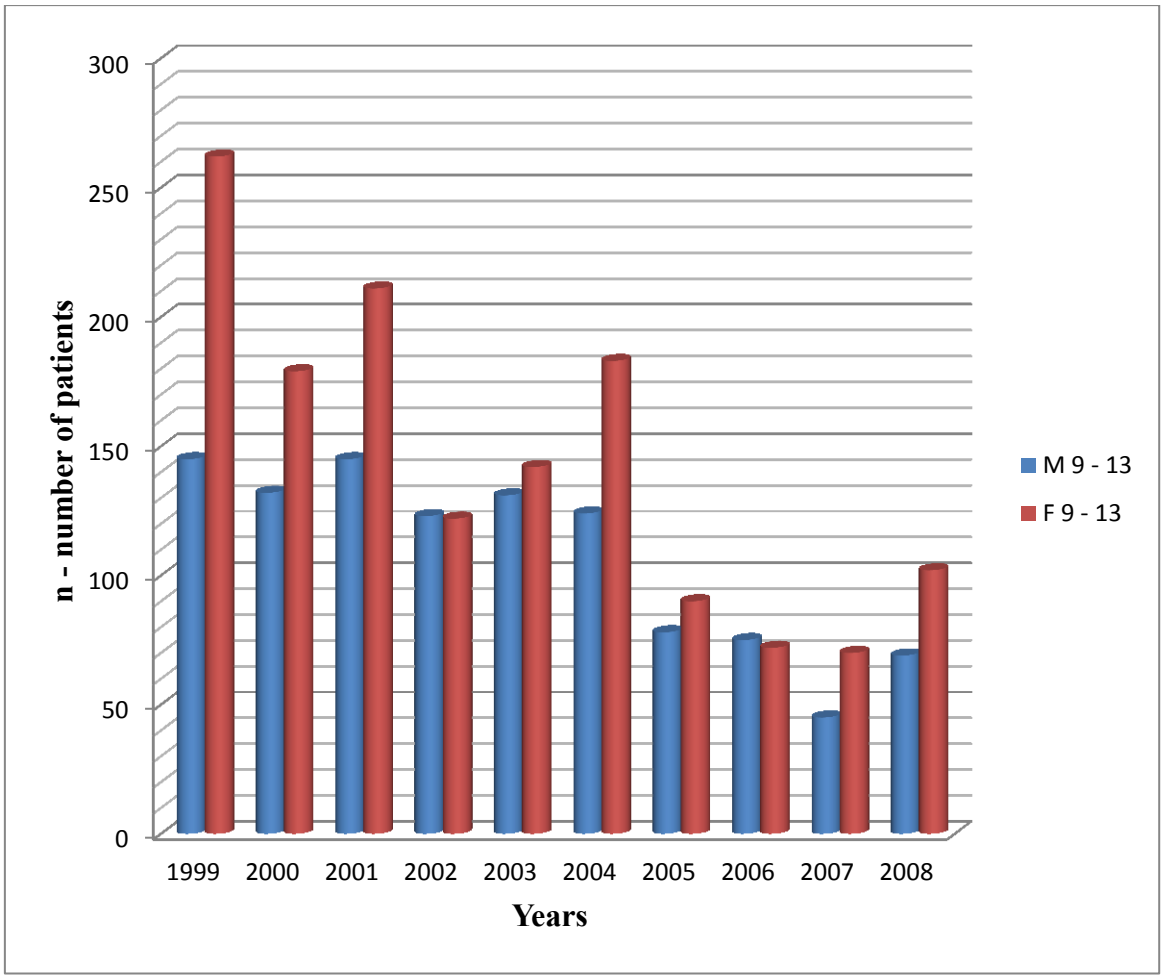

Diagram 8. Number of patients in the age group of 9-13 years divided by gender during the study period

Interestingly, in the group of patients of age >14 years we found a markedly higher number of females than males and also, we did not see a real trend toward the reduction of numbers of hospitalized patients during the study period (Diagram 9). In contrary, the number of admissions to the hospital remained in a steady state over the 10 years period.

The total of 943 girls (69%) and 433 boys (31%) were hospitalized for suspected or simple appendicitis in the age group of over 14 years old patients during the study period.

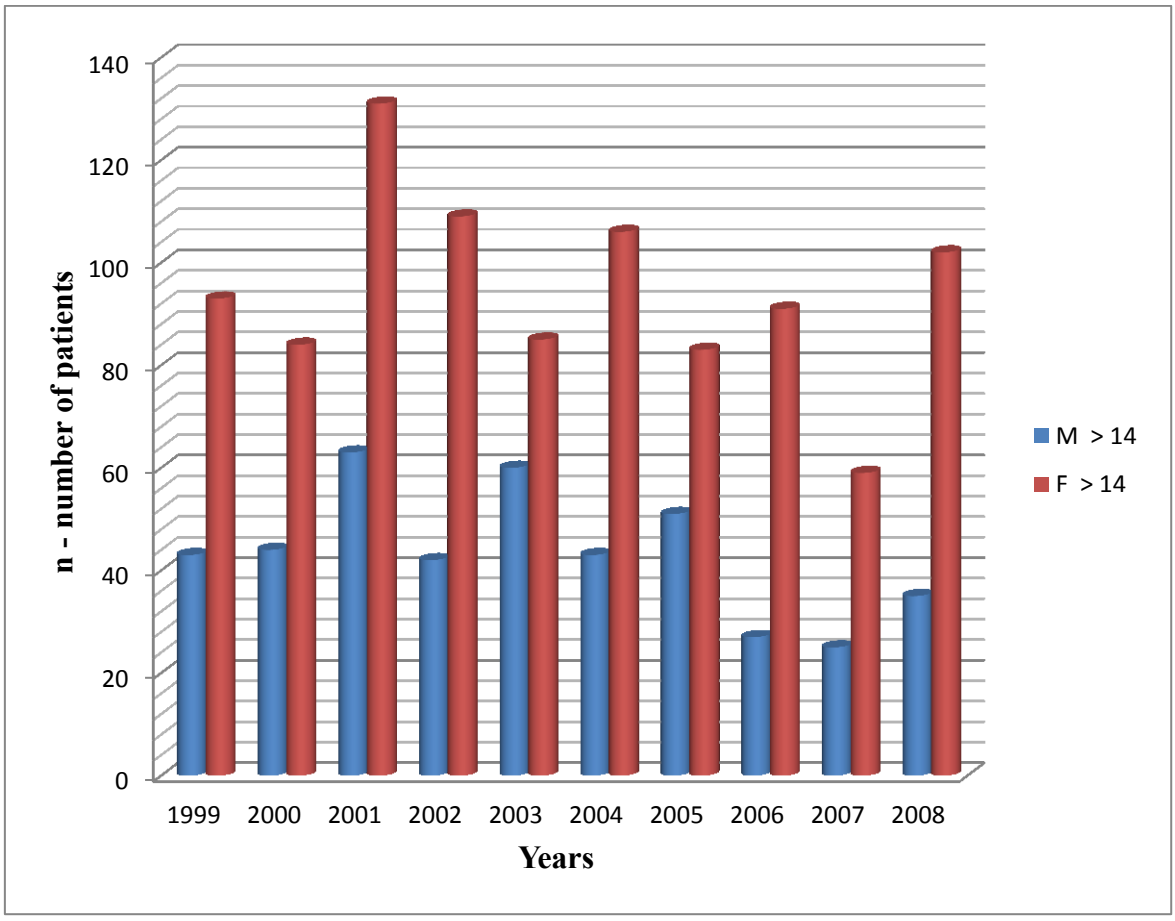

Diagram 9. Number of patients in the age group of >14 years divided by gender during the study period

In the age group of over 14 years old, the number of admitted patients over the years remains approximately similar, with an slightly dominance of female patients.

4.4 Discharge diagnosis

Next we evaluated the number of patients during the study period according to the discharge diagnoses in dismissal letters (Diagram 10). The largest group of patients were admitted to the hospital with unclear symptoms and stayed under observation for a few days. The most of these patients were finally discharged without surgery.

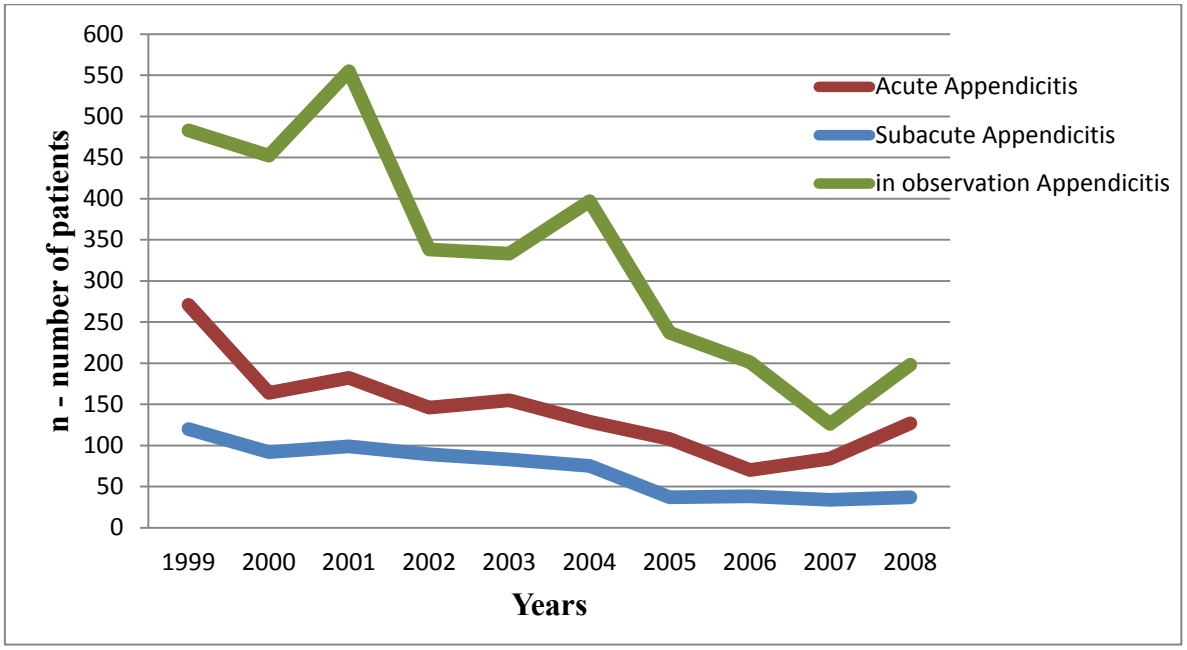

Diagram 10. The number of patients according to discharge diagnoses over the study period

The second largest group of patients underwent surgery for an acute appendicitis, followed by the smallest group of patients who underwent surgery for a subacute appendicitis. The latter group of patients was classified by surgeons in the operating room when the appendix did not show clinical signs of inflammation. Diagram 10 shows that the greatest decrease in the number of admitted patients to the hospital during the study period occurred in the observed group of patients, but the decreasing numbers of patients were found also in both groups of patients who underwent surgery. According to this diagram, there is an almost 70% reduction in admission rate of observed patients in the years 2007/2008, compared to the years 1999/2000.

4.5 Laboratory parameters of inflammation

The two standard laboratory parameters of inflammation assessed regularly in the frame of the evaluation of patients hospitalized for suspected appendicitis were CRP and Leukocyte count.

4.5.1 CRP –values

CRP values higher than 5 mg/l were found in 1971 patients (36%) out of the overall number of 5458 patients in the present study, i.e. 64% of all hospitalized patients had unremarkable CRP values. Table 6 shows the number of patients with elevated CRP values divided in four age groups and separated in the 3 different diagnosis groups.

	Total - n	< 3a	4 - 8a	9 - 13a	> 14a
Acute	559 (1435)	6 (13)	118 (205)	285 (739)	150 (450)
Subacute	167 (704)	6 (9)	41 (105)	76 (395)	44 (186)
Observation	1245 (3319)	62 (106)	568 (1175)	442 (1375)	173 (664)

Table 6. The number of patients with CPR-value higher than 5 mg/l divided in four age groups and three clinical diagnoses groups. The overall number of patients in the appropriate groups is given in parenthesis.

Diagram 11 shows the percentage of patients who had elevated CRP-values over 5 mg/l in different age groups and divided in three different diagnosis groups. The percentage of children with elevated CRP values was higher in the groups of children less than 8-years of age, as compared to the two groups of children over 8 years of age.

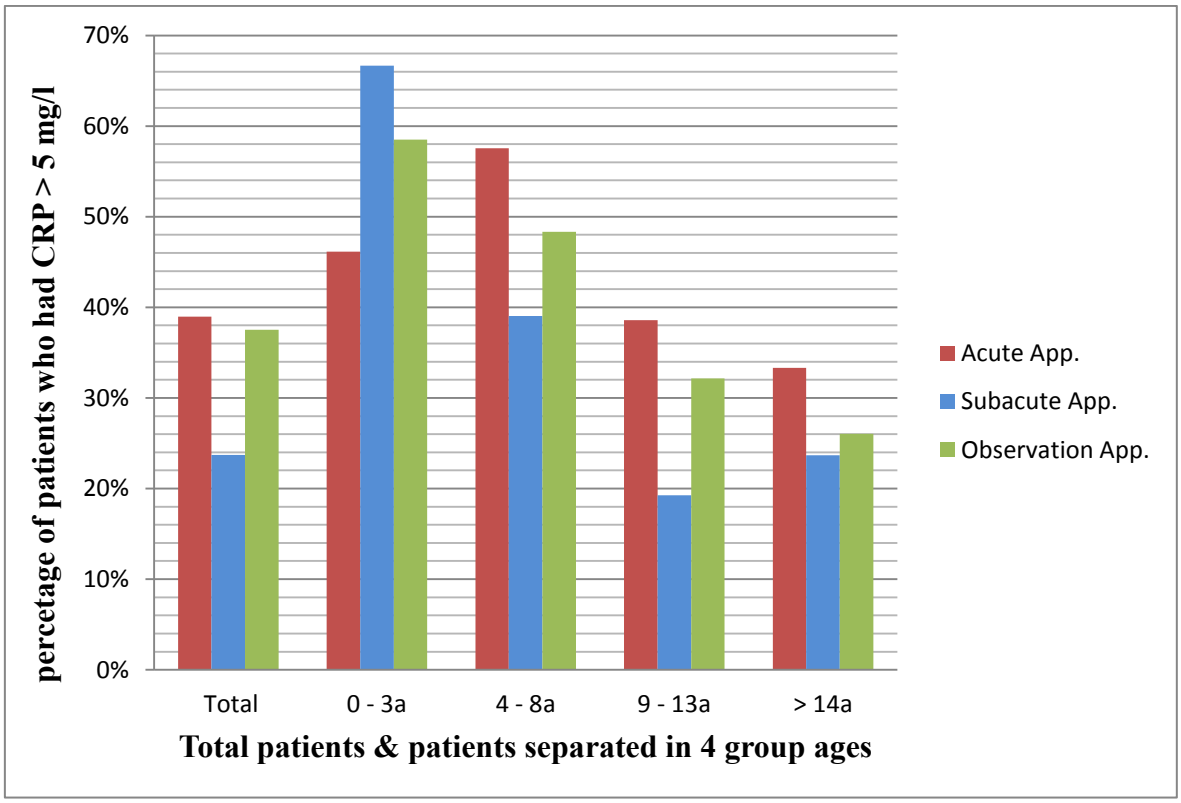

Diagram 11. The percentage of patients with CPR-value higher than 5 mg/l divided in four age groups and three clinical diagnoses groups.

The results shown in both, table 6 and diagram 11, confirm that the CRP-value is not a relevant parameter in diagnosis of simple appendicitis, as only one third of patients with appendicitis showed an increase of CRP-value higher than 5 mg/l in our study, and that such an increase was also found in the group of patients who did not receive surgery for appendicitis, but were only observed.

Furthermore, nearly the half of patients with elevated CRP values had a minor CRP elevation of up to 20 mg/l (Table 7), and what is most striking looking at every level of CRP increase the most patients with CRP elevations were in the observed group of patients.

CRP Values (mg/l)	Acute (n)	Subacute (n)	Observation (n)	Total number (n)	Total percentage (%)
5 – 10	137	41	285	463	22%
10 – 20	167	44	350	561	26%
20 – 30	73	21	206	300	14%
30 – 40	60	20	164	244	11%
> 40	161	67	326	555	26%

Table 7. The number of patients with increased CRP values higher than 5 mg/l, according to the level of CRP increase divided in 3 different diagnosis groups

Table 8 shows the average CRP values for patients with increased CRP values divided for the three different clinical diagnoses. One can see that there were no marked differences in average CRP values between different groups.

Diagnosis	Average	SD	Median
Acute	35	38,75	19,5
Subacute	41,78	46,36	25,7
Observation	33,63	36,36	21

Table 8. The average level of CRP increase in patients with increased CRP values higher than 5 mg/l, divided in 3 different diagnosis groups.

4.5.2 Leucocytes count

In our study, out of 5458 patients, 1686 patients (31%) were found to have a leukocyte count of over 10000 leukocytes – per microliter blood at admission.

Table 9 shows the average level of leukocyte count in patients with values over 10.000 leukocytes per microliter blood. There were no marked differences in average leukocyte numbers between different groups.

	Average	SD	Median
Acute App.	15823	9077,4	14600
Subacute App.	16152,8	8143,6	14000
Observation App.	16058,7	5644,4	14700

Table 9. The average number of leukocytes in patients with increased leukocyte count of >10.000 per mcl blood, divided in 3 different diagnosis groups.

Table 10 shows the average level of leukocyte count in patients with values over 10.000 leukocytes per microliter blood divided in four age groups and separated in the 3 different diagnosis groups. There was no difference in the average leukocyte numbers in patients of different diagnosis groups.

Leukocytes count > 10000	Acute (n)	Subacute (n)	Observation (n)	Total - n	Total - %
10000-20000	417	142	878	1437	86,1%
20000-30000	44	13	147	204	12,2%
> 30000	5	5	18	28	1,7%

Table 10. The prevalence of children with Leukocytes count over 10,000 pro microliter blood, in the base of the leukocytes number, for three clinical diagnoses

	Total	<3	4-8a	9-13a	>14
Acute	478 (1435)	5 (13)	118 (205)	227 (739)	128 (450)
Subacute	149 (704)	7 (9)	42 (105)	61 (395)	39 (186)
In Observation	1059 (3319)	28 (106)	461 (1175)	385 (1375)	185 (664)

Table 11. The number of patients with leukocyte values higher than >10.000/mcl blood divided in four age groups and three clinical diagnoses. The overall number of patients in the appropriate groups is given in parenthesis.

Diagram 12 shows the percentage of patients who had leukocyte counts over 10.000 leukocytes per microliter blood divided in different age groups and divided in three different diagnosis groups. The percentage of children with elevated leukocyte numbers was higher in the groups of children less than 8-years of age, as compared to the two groups of children over 8 years of age.

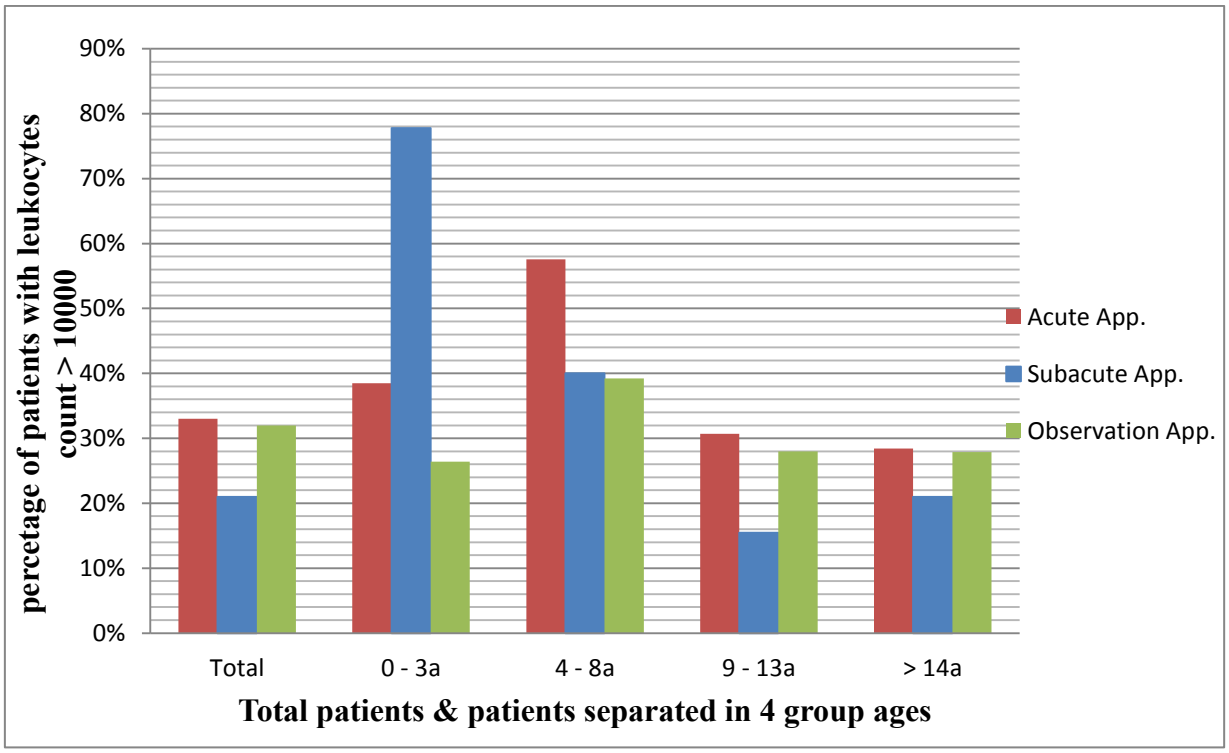

Diagram 12. The percentage of patients with leukocyte values higher than >10.000/mcl blood divided in four age groups and three clinical diagnoses groups.

Similarly to the analysis of the CRP values, the results shown in both table 11 and diagram 12 confirm that the leukocyte count is also not a relevant parameter in diagnosis of simple appendicitis, as again only one third of patients with simple appendicitis showed an increase of leukocyte count >10.000/mcl blood and that such an increase was also found in the group of patients who did not receive surgery for appendicitis, but were only observed.

4.6 Ultrasound studies

During the study period there was a continuous increase in the use of abdominal ultrasound in the frame of the clinical evaluation of children with abdominal pain suspected to have appendicitis (Diagram 13). Furthermore, a marked increase in the visibility of the appendix in ultrasound was noted over the years. In the literature, the normal maximal outer diameter of the appendix is less than 6 mm, and the normal mural thickness is less than 2 mm in diameter [40].

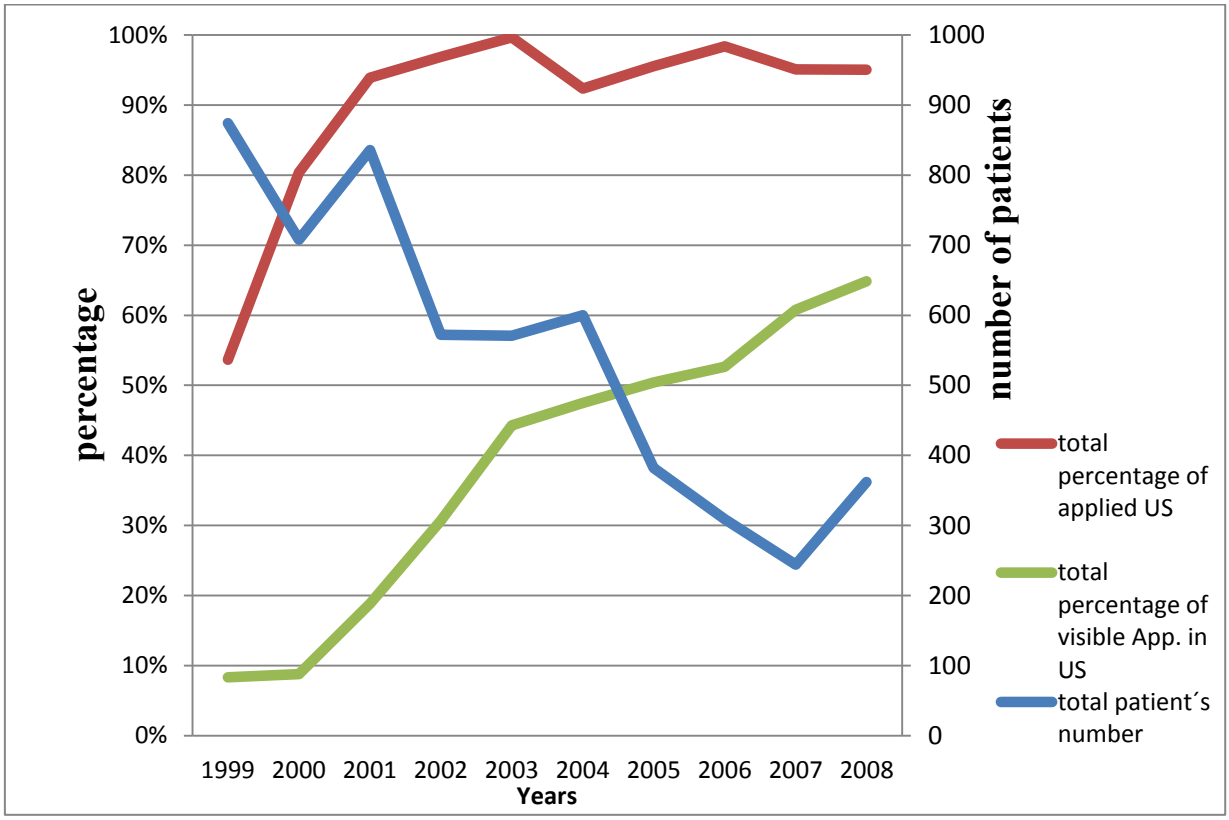

Diagram 13. This diagram shows the comparison between the total number of patients hospitalized due to simple appendicitis or observed for appendicitis (blue line) with the percentage of patients receiving an abdominal ultrasound examination at admission to the hospital (red line) and the overall percentage of patients in whom the appendix could be visualized during the abdominal ultrasound examination (green line) over the study period.

The application of sonography in the diagnosis of an inflamed appendix at the Dept. of Pediatric and Adolescent Surgery in Graz began in the early 1990. The first visible success was accomplished by the start of the new millennium, keeping to increase exponentially ever since. The spot of success on diagnosing appendicitis with ultrasound began in 2003, continuing until present. The use of ultrasound resulted in a significant reduction in the admission rate of patients with simple appendicitis.

Diagram 14 shows that while in 1999 only 13% of appendices in patients with acute appendicitis could be identified by ultrasound, 10 years later almost 80% of acute appendices could be visualized by ultrasound.

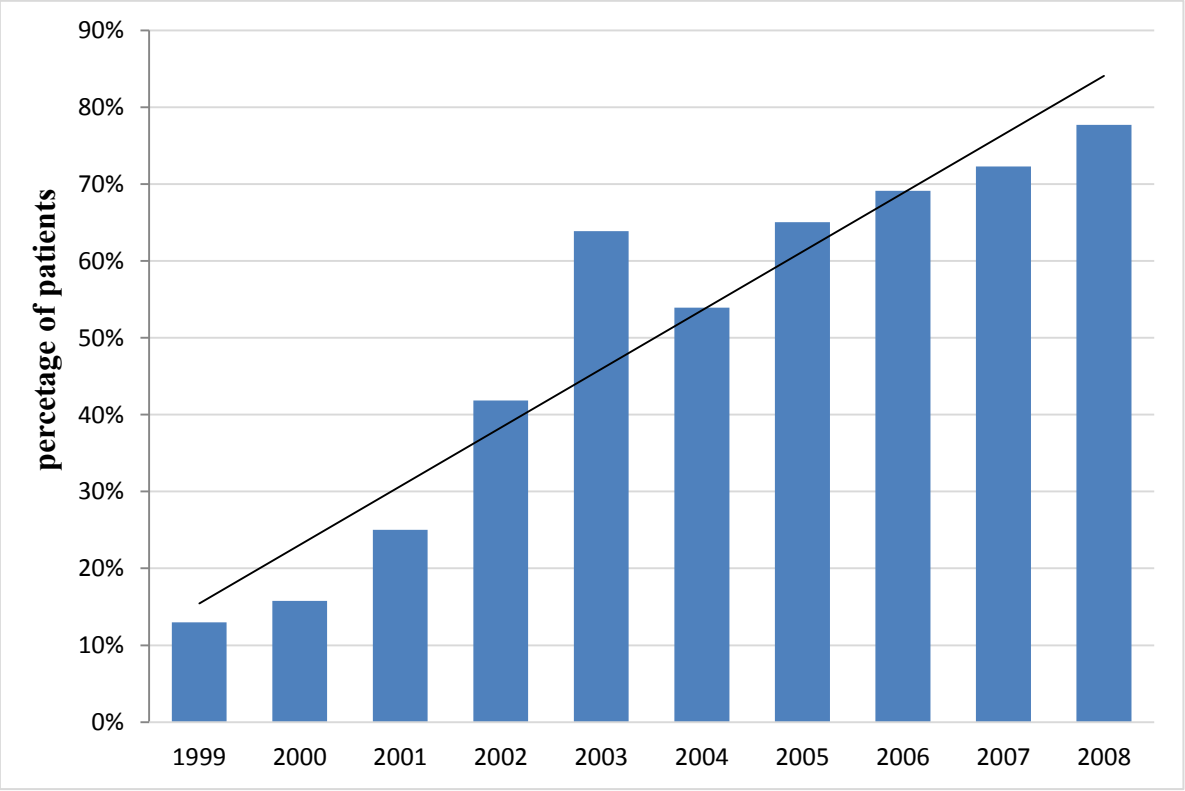

Diagram 14. Visibility of the appendicitis by ultrasound in the group of patients with acute appendicitis increased continuously during the study period.

Diagram 15 shows that during the study period there was also a substantial increase in visualization rate of appendices in the group of patients with subacute appendicitis. However, this rate reaches the value of only 60% in 2008, which is markedly lower than the value of nearly 80% for visualized appendices in the group of patients with acute appendicitis.

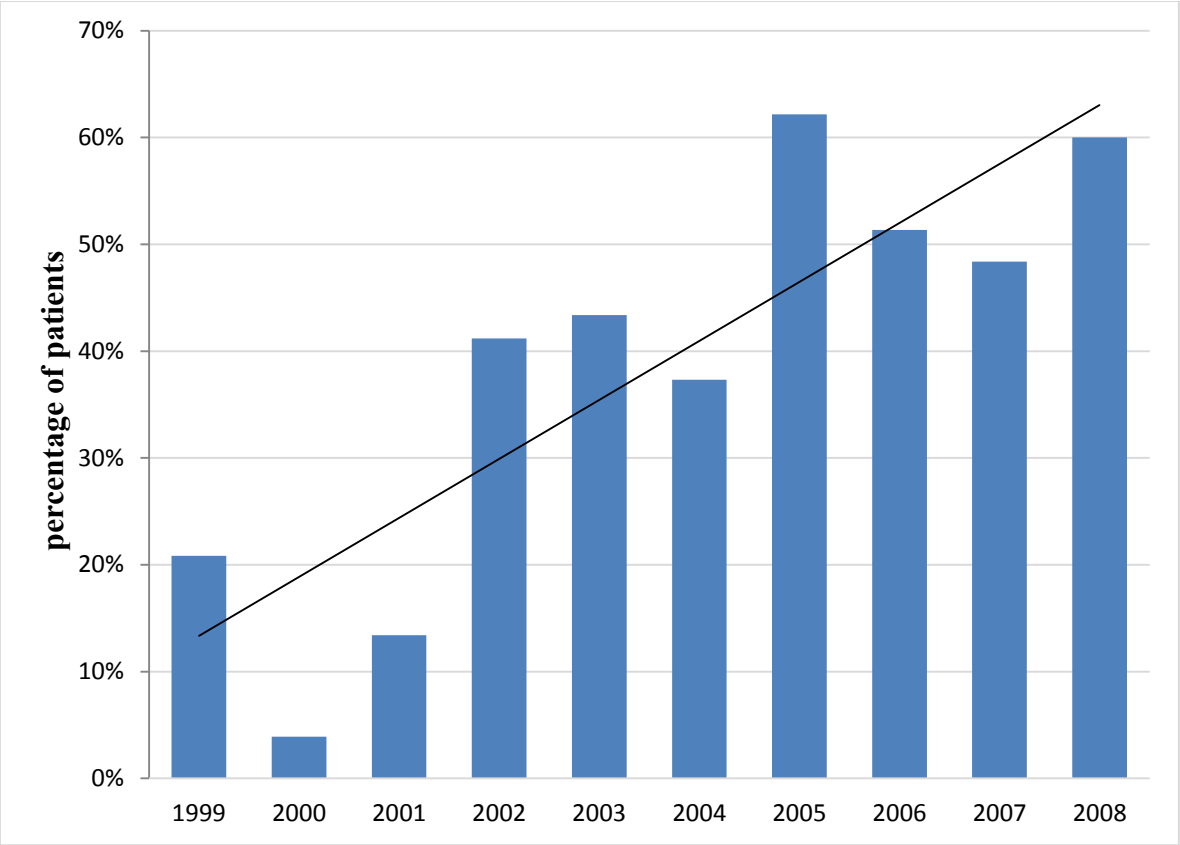

Diagram 15. Visibility of the appendicitis by ultrasound in the group of patients with subacute appendicitis increased continuously during the study period.

Diagram 16 shows the development of the visualization rate for appendices in patients observed for appendicitis during the study period. There is a clear increase in the visualization rate of non-inflamed appendices; however this rate reaches the value of 57% in 2008, which is lower than both, the visualization rates for acute and subacute groups in 2008, respectively.

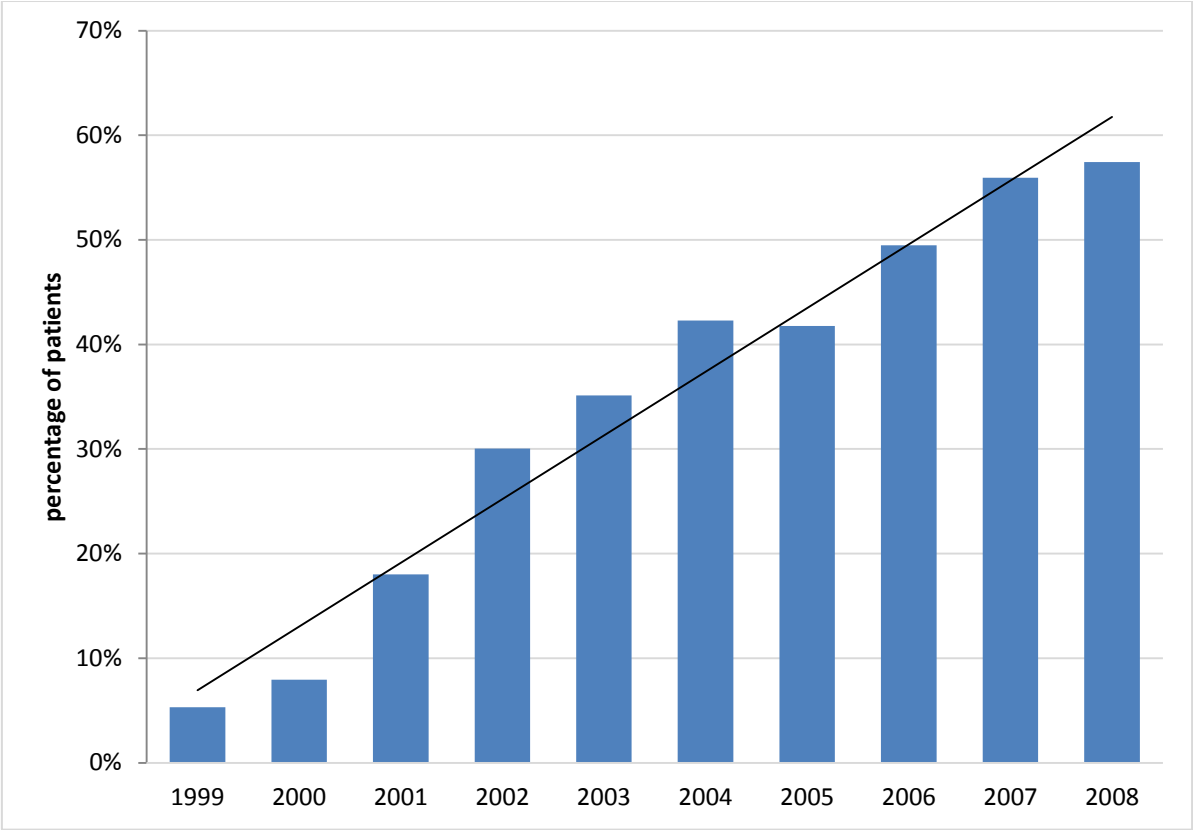

Diagram 16 The visibility of appendices by ultrasound in the group of patients observed for appendicitis increased continuously during the study period.

4.7 Mode of surgery

Next, we analyzed the surgical approach in patients receiving surgery for simple appendicitis.

Diagram 17 shows that over the study period there was a continuous decline in the number of surgeries for simple appendicitis per year.

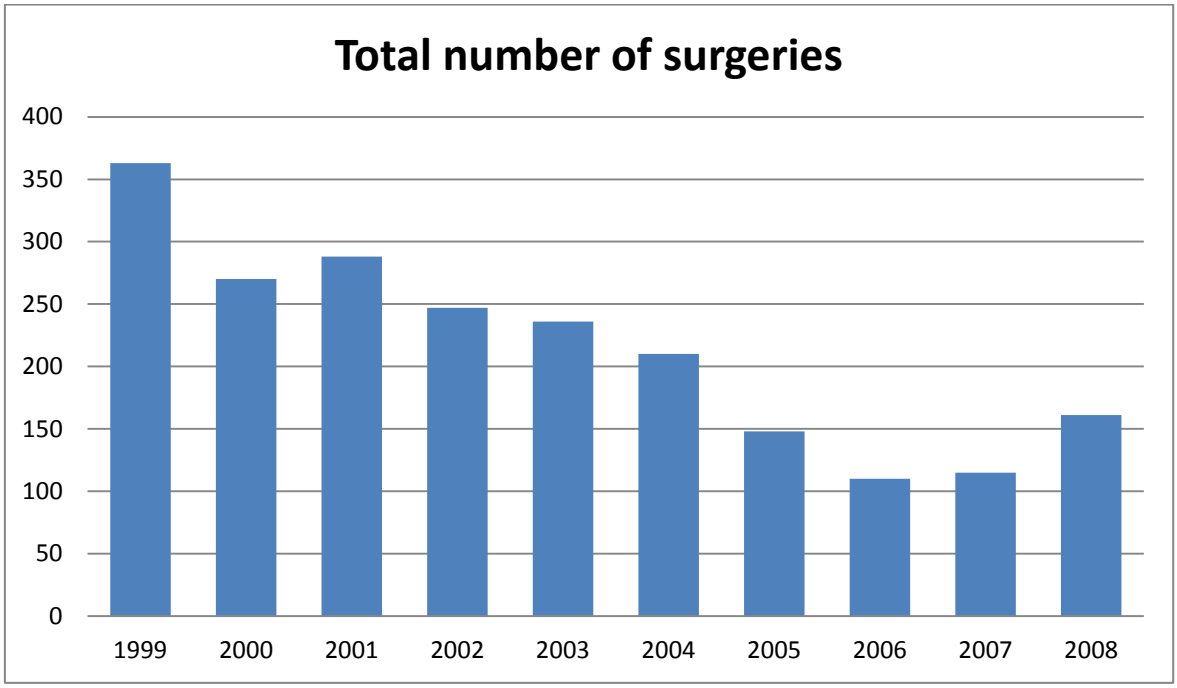

Diagram 17. Total number of surgeries for simple appendicitis during the period 1999-2008

From 2005 a more intensive application of laparoscopy has been seen, while it was still conducted in significantly lower numbers as compared to laparotomies. Laparoscopy was applied mostly in female patients of two age groups: 9-13-years old and over 14-years old. Male patients of these age groups had also a higher application of laparoscopy as compared to the patients of other age groups. The laparotomy remains yet the main surgical approach for appendectomy, while laparoscopy shows increasing numbers, especially in the teenage female patients. The laparotomy consisted mainly in buttonhole Mc Burney approach in the right lower quadrant of the abdomen.

Diagram 18 shows that overall the majority of surgically treated patients were treated by the conventional surgical approach.

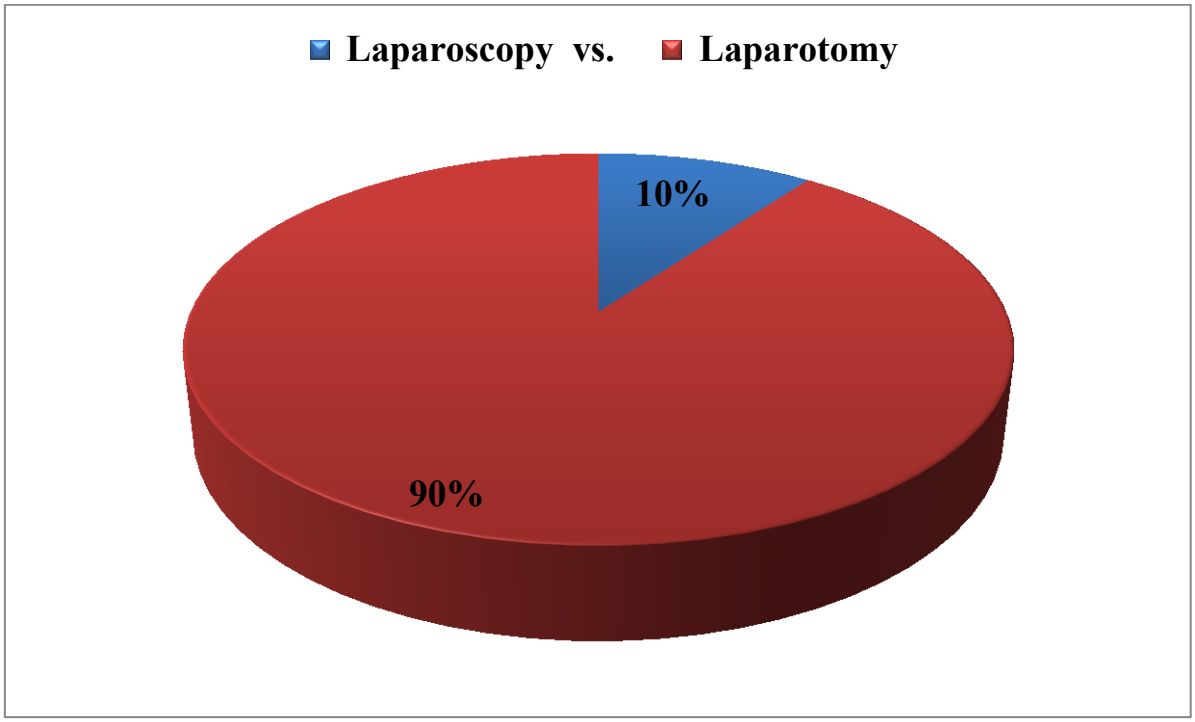

Diagram 18. Mode of surgical treatment of patients with simple appendicitis over the study period 1999-2008

4.8 Histological outcomes

We next analyzed all histo-pathological results of the appendix specimens and compared these with the clinical diagnoses (discharge diagnoses) according to surgeons' intraoperative judgments.

Diagram 19 shows that almost ¾ of the clinical diagnoses of acute appendicitis were confirmed by histo-pathology. However in 28% of cases another histo-pathological diagnosis was made for specimens sent in as acute appendicitis.

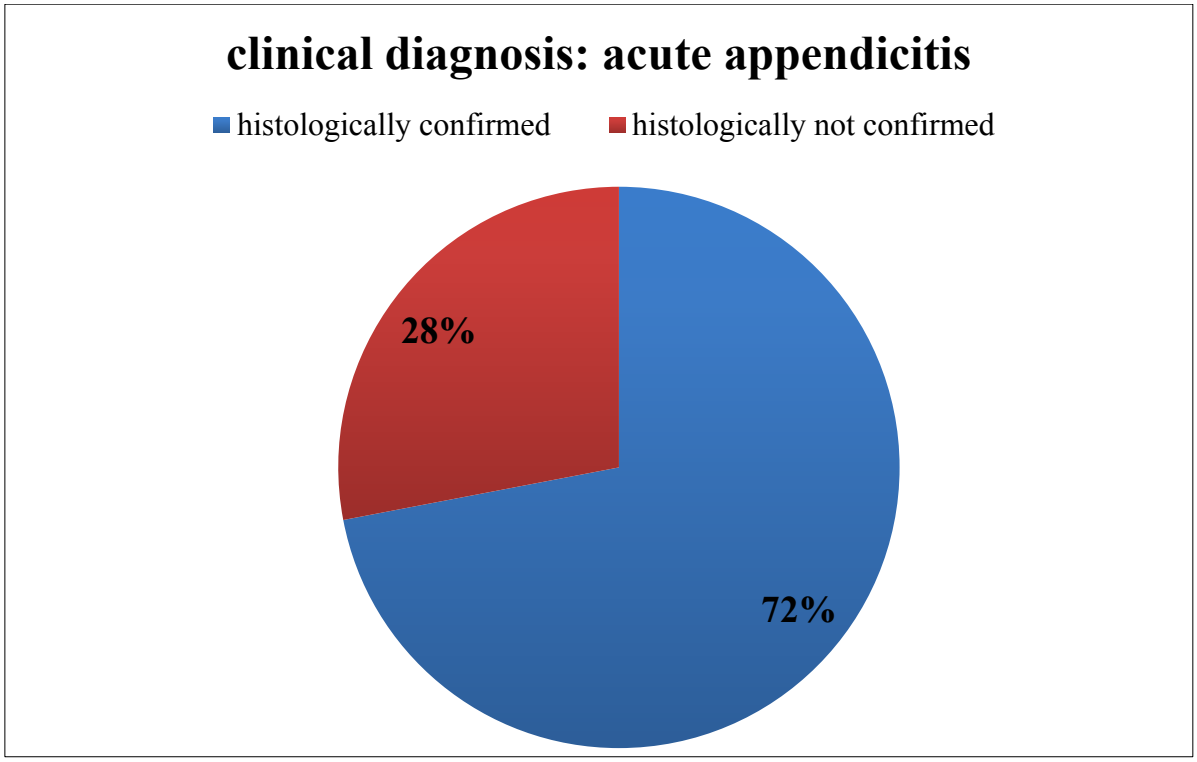

Diagram 19. Histo-pathological diagnoses (confirmed/ non confirmed) of specimens sent in for analysis under the clinical diagnosis of an acute appendicitis during the period 1999-2008

Diagram 20 shows that in the majority of histo-pathologically not-confirmed clinical diagnoses of acute appendicitis, surgeons were underestimating the degree of inflammation of the appendix.

Overall taken only 10% of patients with clinical diagnosis of acute appendicitis had a histo-pathologically less severe inflammation, resulting with the diagnosis of subacute appendicitis.

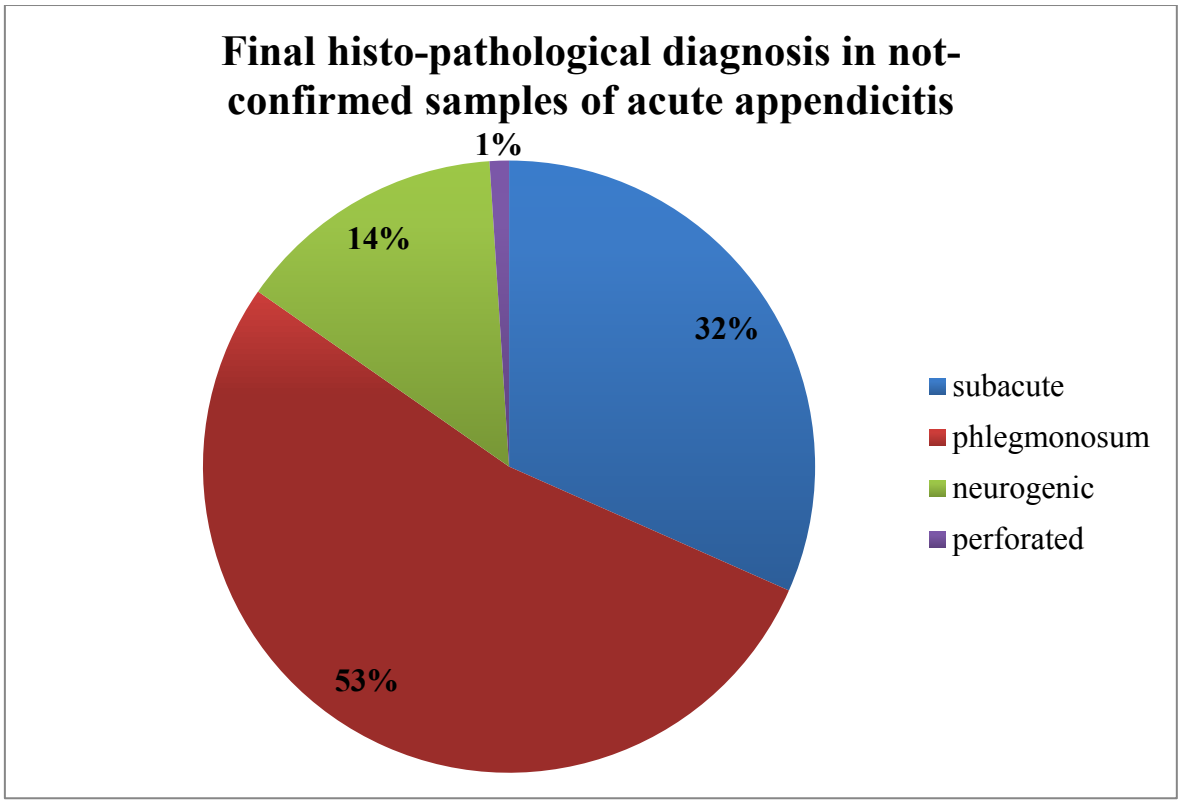

Diagram 20. Final histo-pathological diagnoses of specimens sent in for analysis after a clinical diagnosis of acute appendicitis and not confirmed by histopathology during the period 1999-2008

Diagram 21 shows that 65% of the clinical diagnoses of subacute appendicitis were confirmed by histo-pathology. However in 35% of cases the histo-pathological diagnosis differed from the clinical estimation of surgeons.

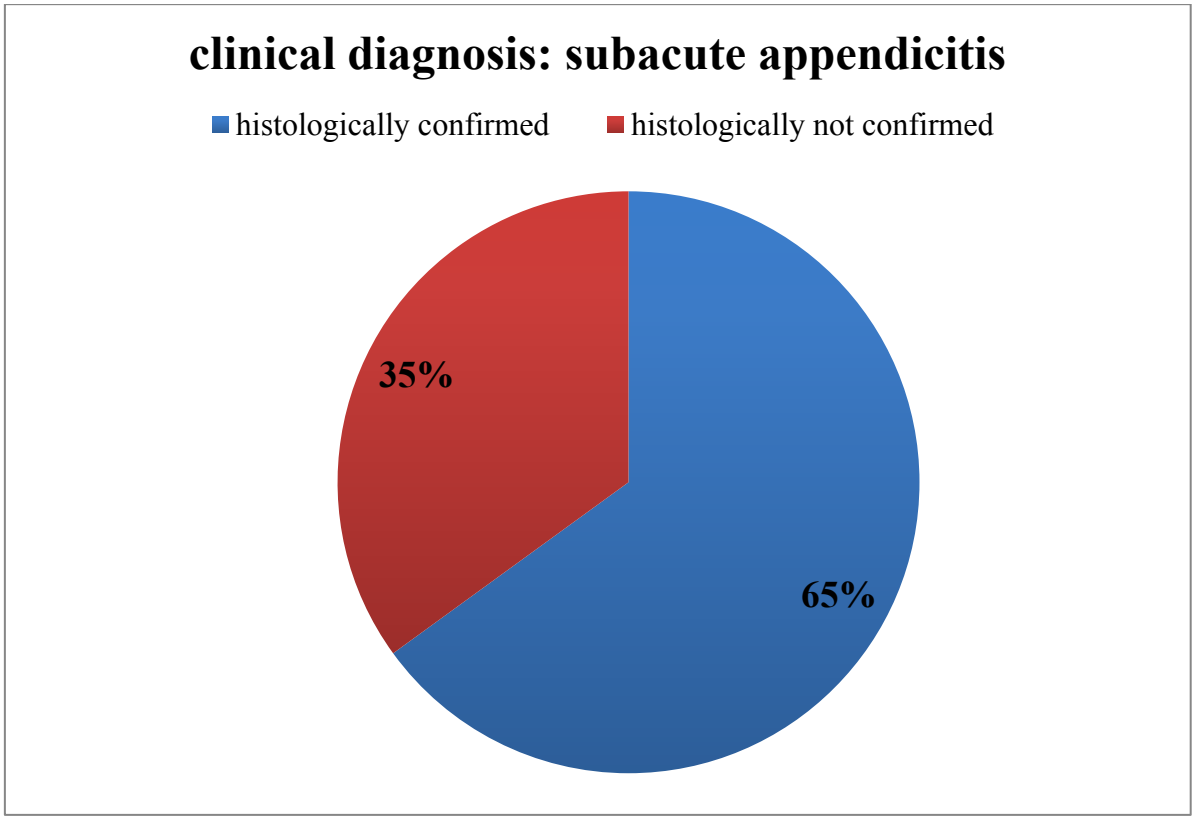

Diagram 21. Histo-pathological diagnoses (confirmed/ non confirmed) of specimens sent in for analysis under the clinical diagnosis of subacute appendicitis during the period 1999-2008

Also in this case the surgeons were prone to underestimating the degree of inflammation of appendix. Diagram 22 shows that in the majority of histo-pathologically not-confirmed clinical diagnoses of subacute appendicitis the final histo-pathological result was acute appendicitis, i.e. a higher degree of inflammation than clinically judged by surgeons.

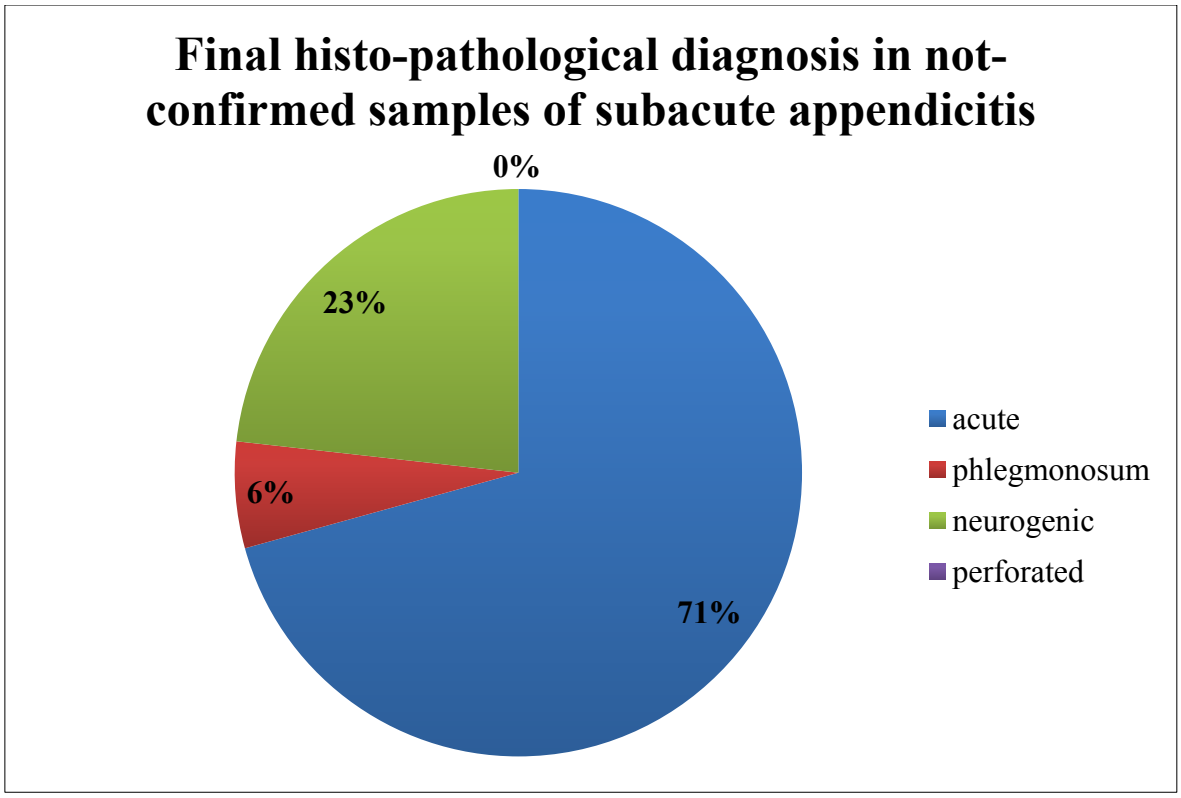

Diagram 22 Final histo-pathological diagnoses of specimens sent in for analysis after a clinical diagnosis of subacute appendicitis and not confirmed by histopathology during the period 1999-2008

4.9 Duration of stay in the hospital

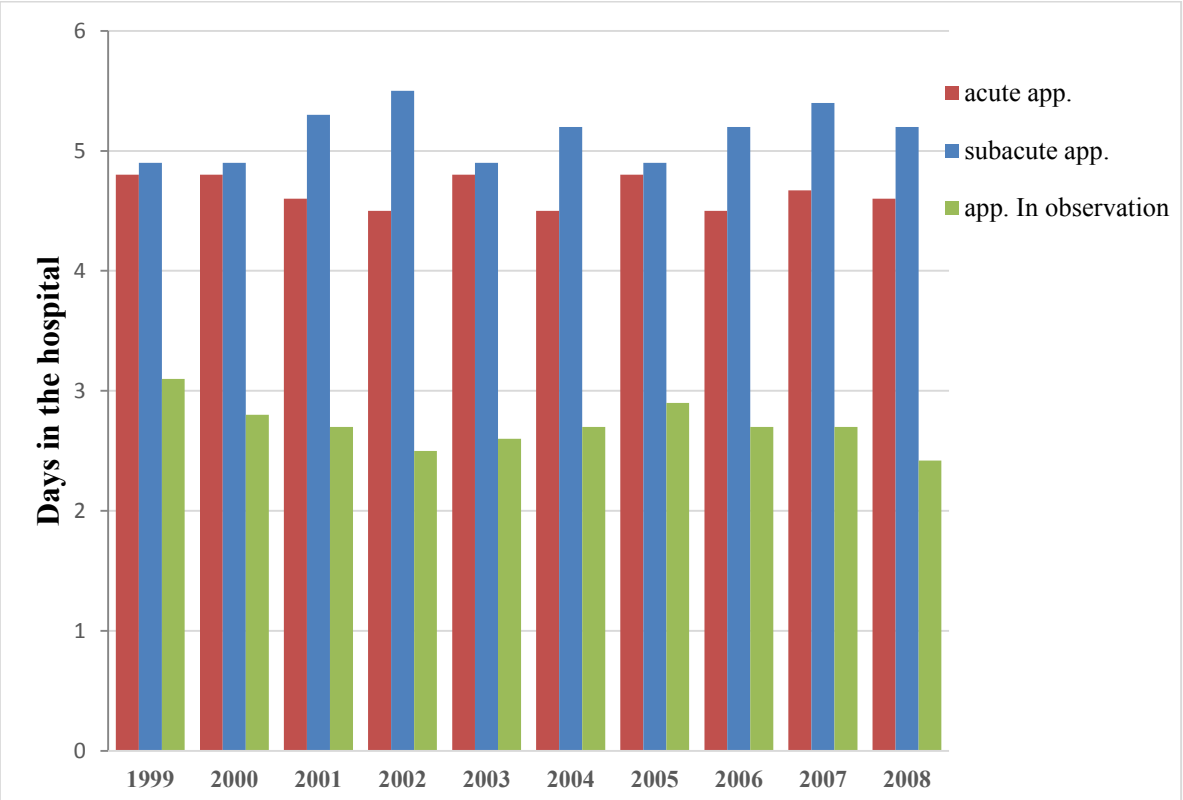

Diagram 23. Duration of stay in the hospital for observation due to suspected appendicitis or after surgery for a simple appendicitis during the study period 1999-2008

According to Diagram 23 patients with subacute appendicitis stayed somewhat longer in the hospital as compared to the patients of the other two groups. This can be explained by the fact that these patients are usually initially observed for 1 day and then the decision for surgery after failure of clinical improvement was made. Patients with an acute appendicitis where discharged from the hospital on the 4th postoperative day according to the hospital policy concerning the duration of post-operative stay in the hospital in patients with acute appendicitis. Patients under observation were usually discharged on the 3 day after admission to the hospital.

5 Discussion

The diagnosis of simple appendicitis continues to be difficult due to variable development of the disease in few different forms and lack of authentic diagnostic tests.

Lot of studies attempt to find out the easiest ways and the simplest methods in detection and managing of simple appendicitis, nonetheless the diagnosis of simple or sub-acute and acute appendicitis remains in the literature, a difficult challenge for the surgeons.

The present study was conducted in more than 5400 patients suffering from simple appendicitis and shows a highlight of the development of diagnostic approaches in diagnosing of simple appendicitis for the period of time 1999 – 2008, in our clinic.

Within the genders, female patients are dominant, particularly those of the age group > 9 years old. Although the application of ultrasonography for this patients' population was made regularly, the number of admitted girls remain similar over the years (patients of this age are more grown, they have more subcutan fat tissue than the younger children). That could be related to other differential diagnoses in the females of this age group (begin of the first menstruation and the accompanying symptoms may resemble the symptoms of appendicitis).

In the early phase of the study (years 1999/2000), the total number of admitted patients with uncertain diagnosis was 1582, whereas in the last two years (2007/2008) the number of the admitted patients had decreased to 606. Comparing these periods we can see a 62% reduction on admitted patient´s number, which to our opinion is the main result of this study.

Among three main clinical diagnosis groups (acute = 1, subacute = 2 and for observation hospitalized patients = 3). Generally, there is a reduction in the admission rate of all patients, especially of those who stayed under observation (65%) in years 2007/2008 compared to the admission rate of years 1999/2000. This may be in correlation with the progress of the examiner´s experience with ultrasonography, applying it often and regularly as pre surgically diagnostic modality, thus enhancing the quality and detection rate of inflamed appendix in the ultrasound over the years.

Furthermore, the average value for CRP and leukocytes count was evaluated for all patients with regard to the three different diagnose groups, the four age groups and for both genders. Our study support the idea that the white blood cell count and C-reactive protein levels are both irrelevant predictors and are therefore not of high importance at excluding acute inflamed appendix and showing objectivity [36].

The CRP value and leukocytes count showed an increase by 36% respectively 31% of admitted patients with suspicion of appendicitis. Generally, patients with a simple illness development showed similar high CRP Value and WBC count.

A total of 4745 (87% of admitted patient´s number) targeted abdominal ultrasounds were applied to identify the appendix in the hospitalized patients during the 10-year period.

In 2402 patients (54%) of conducted ultrasounds, the appendix could be visible. There is an increasing trend to detect appendices in all three diagnosis groups.

The main advantage of ultrasonography is the reduction of radiation exposure in children. This is in contrast to the leading approach taken by American

surgeons which favors the use of CT scan for the preoperative diagnosis of appendicitis in children [39].

In the early phase of application of abdominal ultrasound as a the diagnostic tool for detection of appendicitis in children and adolescents at the Department of Pediatric and Adolescent Surgery in Graz there was a relatively low rate of appendix detection. Over the years, ultrasonography has been applied more intensely which resulted in the increase of the quantity and quality of the detection rate, decreasing drastically the total number of patients who needed hospitalization due to suspected appendicitis or surgery for simple appendicitis.

The success rate to detect inflamed appendix using ultrasonography in the acute patients group was only 13% in 1999, comparing with 78% in 2008, giving an enhancement of detection rate of acute appendicitis for 85% over years. The subacute appendicitis diagnosed using ultrasound was as low as 21% in 1999. This number was 60% in 2008, preceding a progress of 65% in the visualization rate of subacute appendicitis.

Patients who stayed under observation due to suspicion of appendicitis in the beginning had the lowest detection rate of appendix using the ultrasound (5 %). In 2008, the identification rate of appendicitis for this group using ultrasound reached 57 %, which is a 90 % improvement that the examiners had made harnessing ultrasonography over the years. As a result, the duration of hospital stay was cut, especially for those patients who were released without operative therapy. Most studies demonstrate sensitivity greater than 85% and specificity greater than 90[36].

Such a significant decrease of admitted patients' number during the last years is achieved thanks to the regularly ambulatory application of abdominal ultrasonography in patients with suspected appendicitis.

Moreover, 2147 patients (40%) underwent surgery for appendicitis during the study period. Out of these, 1930 patients (90%) underwent an open surgical approach, while only 217 patients (10%) underwent appendectomy by laparoscopic approach. In general, young female patients underwent laparoscopy more frequently (72%) than their male counterparts (28%).

Furthermore, the surgeons' ability to correctly diagnose the intraoperative appendix specimens was evaluated by comparing the discharge diagnosis with the final histo-pathological diagnosis.

Taken together, the results of this study yield a satisfactory outcome with regard to the ability of the surgeons to correctly conduct intraoperative diagnosis. Here could be seen a relatively low grade on diagnosis mismatch, with only 24% overestimation, respectively 27% underestimation.

Patients with subacute appendicitis used to stay longer in hospital compared to the patients of the other two diagnose groups. This is due to the delay in the determination of surgical approach. The period of hospital stay of the patients with an acute appendicitis was shorter than the subacute group while the patients under observation had the shortest stay of three days only. The total average value of the hospital stay for all three groups was approximately 4 days, to which the patients in observation phase contributed 2. 7 days while the share of the acute and subacute patients groups were 4. 6 and 5.1 days, respectively.

6 Conclusion

Diagnosis of appendicitis was made in the study population in the first place clinically and supported by the ultrasound findings of an experienced pediatric surgeon. Laboratory parameters such as CRP and leukocyte count incorporated with clinical features correlating with the severity and the breakup of the inflammation may also be in the normal range.

Summary results of our study provide a progress of our clinic in the quality of primary and secondary medical staff, all this contributing on the improvement of treatment quality, improving all healing process stages of appendicitis and on the shortening of postoperative hospitalization. Ultrasonography is used liberally to aid in the decision making process of simple, equivocal and complicated cases of appendicitis and it has achieved good measures of accuracy. Since the regularly application of ultrasound on diagnosing of appendicitis, there has been an exponential drop of the number of admitted and operated patients over years, decreasing the stationary admission rate by patients which stayed in observation because of doubt to an appendicitis who by inconspicuous medical findings, were immediately discharged at home and been pleased for reappointment in the clinic, if the symptoms would recurrence.

In this addition, except of the benefit for the patients and the less stressful for their families at the same time is represented a huge potential for savings in

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Abbreviations

CRP = C reactive Protein

WBC = White blood cells

US = Ultrasound

CT = Computed tomography

MRT = Magnetic resonance tomography

g = Gram

l = Liter

mm = Millimeter

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