Management of Acute Appendicitis in Ambulatory Surgery: Is It Possible? How to Select Patients?

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INTRODUCTION

Appendectomy for acute appendicitis (AA) is a common surgical procedure. Actually, it requires in most cases at least a one-night hospitalization. While several studies have shown that cholecystectomy can be safely performed as an outpatient procedure [1], only few studies have reported their experience of outpatient appendectomies [2-11]. This may seems paradoxical because this procedure is most often performed in young and healthy people, with an operating time inferior to one hour and with mastered risks. Therefore ambulatory's conditions are met. Yet, appendectomy still continues to be carried out during a conventional hospitalization. Ambulatory surgery (AmbSurg) is defined as an hospital stay inferior to 12 hours without overnight hospitalization. Ambulatory appendectomy is not yet performed routinely because it requires most of the time the deferral of surgery to the next morning. The main obstacle for this type of care is the fear of missing a complicated appendicitis or meeting unexpected operating difficulties. However, we believe that, in selected patients, emergency laparoscopic appendectomy (LA) may be feasible in ambulatory surgery. Unfortunately, data on clinical, biological and radiological preoperative criteria that could predict the success of this type of care are missing.

The aims of this study were to determine preoperative criteria associated with discharge at day-1, to validate them on a prospective series and apply them to select patients for ambulatory surgery.

MATERIALS AND METHODS

Retrospective study and creation of the score

All records of patients who underwent appendectomy between January 1, 2010, and December 31, 2012 were reviewed retrospectively. We included patients who underwent

emergency LA after diagnosis of AA based on CT- or US-findings. Patients who underwent interval appendectomy after medical emergency treatment (antibiotic treatment of appendicular plastron or radiological drainage of appendicular abscess), those who had appendectomy by laparotomy and those with stump appendicitis were excluded.

Univariate and multivariate analysis of preoperative variables were performed to create the score.

Prospective study, validation of the score and ambulatory care.

Patients and surgical management

Between January 1 and December 15, 2013, all patients with a diagnosis of AA were prospectively included. Diagnosis was always supported by CT-scan or ultrasound (appendicular thickening greater than 6 mm and periappendicular fat stranding). The calculated score was used before admission.

For a score superior or equal to 4, AmbSurg was considered. If ambulatory operating room was available and in the absence of exclusion criteria (history of pelvic surgery, pregnancy, severe comorbidities, severe sepsis, excessive pain, no accompanying person, home located over one hour transport, insufficient understanding), LA in AmbSurg was proposed to the patient. If accepted, the day of surgery depended on the time of diagnosis. Between 7:00 and 13:00 AM, the patient was directly admitted in AmbSurg unit. After 13:00 AM, the operation was delayed until the next morning. If the operation was postponed to the next day, the patient returned home with oral antibiotics (amoxicillin plus clavulanic acid, 3 g per day) and analgesics. In case of refusal, LA was performed in a conventional surgery (ConvSurg) unit.

For a score inferior to 4, patients were systematically admitted in a ConvSurg ward. In case of uncomplicated AA on CT or US-scan, the time until surgery depended on the hour of admission and the choice of each surgeon. If appendectomy was postponed to the next day, patients received intravenous antibiotics during the waiting period. Patients with clinical or radiological evidences of abscess or peritonitis were immediately operated.

Operative technique

The surgical technique did not differ according to the type of support. Since January 1, 2013, except if patients had a history of laparotomy, appendectomy was systematically performed by laparoscopy. A standard laparoscopic operative technique was used. A 10 mm optic trocar was introduced at the umbilicus, by an open technique, and was used for insufflation of pneumoperitoneum. If possible, low-pressure pneumoperitoneum (9-mmHg) was used. Then a 5 mm suprapubic port and a 5 mm left iliac fossa port were placed under direct vision. A bipolar plier was used to coagulate the mesoappendix. If healthy, the appendical base was tied with a preformed suture loop. The appendix was then placed in a bag and retrieved through the optical port. Intraperitoneal abcess were simply aspirated. Peritoneal lavage was used only in cases of peritonitis. No drainage was routinely placed. Each trocar was systematically infiltrated with 5 mL of Ropivacain 7.5%. Patients with mild appendicitis just received a single intraoperative dose of antibiotics (2 g of amoxicillin plus clavulanic acid).

Postoperative management

Patients undergoing ConvSurg were monitored for few hours in the recovery room and then returned to the surgical ward. Patients without severe comorbidity were routinely discharged from hospital at day-1, i.e. the morning following appendectomy, if they

tolerated feeding, had pain controlled by usual analgesics and no fever. In case of vomiting, fever, excessive pain, hospitalization was prolonged.

Patients who underwent LA in AmbSurg unit were monitored in the recovery room until full awakening and a light meal was given. In the absence of fever, pain, nausea or vomiting, the patient was discharged directly from the recovery room.

The follow-up evaluation was performed 30 days after surgery for all patients.

Data collection

For both retrospective and prospective studies, clinical data collected were: age, gender, ASA score, Body Mass Index (BMI), delay of pain before consultation, temperature. Biological data collected were: C-reactive protein (CRP) and white cell count (WCC). Radiological findings collected were: appendix diameter, presence of an appendicolith, signs of perforation (defined by the presence of collection, free peritoneal fluid, pneumoperitoneum or ileus). Operative data collected were: time between admission and surgery, severity of appendicitis, operative time, conversion. Postoperative data were: length of the postoperative stay, morbidity (defined as any complication within 30 days of operation), mortality, rehospitalization, reoperation, pathological report.

Statistical analysis

Descriptive analyses are presented as median (range) or mean +/- standard deviation for quantitative data and as number of patients (percentage of patients) for categorical data. The correlation between the early discharge and the variables of interest was studied by univariate analysis (Chi-square). All tests were two-sided, and a p-value <0.05 was considered to be significant. The multivariate analysis was performed using a backward stepwise logistic regression model that included all variables with a p-value <0.1 in univariate analysis. Results of this multivariate analysis are shown as odds ratio (OR); [95 percent confidence interval]. All analyses were performed using JMP9 (SAS Institute

Inc, Cary, NC, USA).

RESULTS

Retrospective study and creation of the score

Patients

Between 2010 and 1012, 560 emergency appendectomies were performed in our hospital. Ninety-two patients (16%) were excluded for: open approach (n=85), stump appendicitis (n=4) or missing files (n=3). Finally, 468 (84%) patients were included in the study. Details about the overall study population are given in table 1.

Predictive factor analysis of early discharge

One hundred eighty-one patients were discharged at day-1 (39%). In univariate analysis (table 2), 7 factors associated with early discharge were: BMI<28 kg/m^2 (p=0.0016), ASA score<2 (p=0.0223), duration of pain<2 days (p=0.0001), WCC<15.0 per µL (p=0.0369), CRP<30 mg/L (p<0.0001), no radiological signs of perforation (p<0.0001) and appendix diameter≤10 mm (p<0.0001). In multivariate analysis, 5 independent factors were identified: BMI<28 kg/m^2, WCC<15.0 per µL, CRP<30 mg/L, no radiological signs of perforation and appendix diameter≤10 mm (Table 2).

Saint-Antoine's score

The 5 factors associated with the patients' conditions were used in a score ranging from 0 to 5, according to the presence of these criteria (Table 3). The rates of discharge at day-1 ranged from 0% to 72% for a score of 0 or 5, respectively (p<0.0001). The rates of complicated AA was also significantly influenced by the score from 0% to 100% for a score of 5 or 0 (p<0.0001)(figure 1).

Prospective study, validation of the score, ambulatory appendectomy

Patients

During the study period, 191 AA were diagnosed (84% by a CT-scan) and 7 patients (0.4%) were excluded because they had medical treatment or laparotomy (Figure 2) leaving 184 patients included. Clinical, operative and postoperative data for the prospective study population are listed in table 1. Among them, 103 (56%) had a score superior or equal to 4. After appendectomy, pathological confirmation was observed in 181 specimens (98%).

Conventional surgery and validation of the score.

Finally 146 patients underwent LA in ConvSurg and 58% were discharged at day-1. The rate of discharge at day-1 was significantly associated with the score ranging from 0% to 92% for a score of 0 or 5, respectively (table 3). The St-Antoine's score was therefore validated on this prospective series ($p<0.0001$). As for the retrospective group, the rate of complicated appendicitis was associated with the score ($p<0.0001$) (Figure 1).

Ambulatory surgery group

Thirty-eight patients underwent ambulatory LA. Among them, 22 (58%) were directly admitted to AmbSurg unit, with a mean time between diagnosis and surgery of 2.9h ± 2.1. For the remaining 16 patients (42%), LA was postponed to the next day. The mean time between diagnosis and surgery was 15.5h ± 3.8 for this group of patients. All patients were directly discharged from recovery room, except one patient (2.6%) who had to be admitted for the night in ConvSurg unit due to insufficient awakening. The mean time between surgery and discharge was 4.5h ± 6.6 and the mean hospital length of stay was 8.4h ± 6.9h.

The AmbSurg group (n=37) was compared with the 65 patients with a score≥4 hospitalized in ConvSurg unit (table 4). One patient operated in AS was excluded because he had a score of 3 points due a wrong estimation of the appendicular size (11

mm). The 2 groups were comparable regarding age, sex ratio, score distribution, surgical postponing, time between diagnosis and surgery and operative data (except operative time significatively shorter in the AS group). Time between surgery and discharge and length of hospital stay were significantly longer in ConvSurg group ($p<0.0001$). The rates of unplanned consultation, rehospitalization and surgical morbidity were similar in the 2 groups.

DISCUSSION

The laparoscopic approach is now widely used for appendectomy. Indeed, several studies have shown its benefit over conventional appendectomy in reducing postoperative pain and enabling faster return to normal activities, with a lower incidence of wound infection, even if it has been identified a higher incidence of pelvic abscess. Moreover, it has been shown that the laparoscopic approach reduces the length of hospital stay [12]. That's why we routinely use it in the management of AA in our department.

While outpatient procedure has become the standard of care for elective cholecystectomy [1], only few studies have reported their experience of outpatient appendectomies [2-11]. Some retrospective studies have shown the feasibility of LA for AA during an hospitalization inferior to 24 hours [2-7]. They reported an overall success rate ranging from 57 to 75%, a very low morbidity ranging from 0 to 6.4 % and no mortality. Sabbagh et al. showed in a prospective study that 52% of laparoscopic appendectomies can be achieved during a hospital length of stay inferior to 24 hours [8]. This percentage rises to 73% after exclusion of patients with medical or social contraindications to outpatient procedure and complicated appendicitis.

To our knowledge, only 3 prospective series are dealing with same-day discharge after LA [9-11]. In these different studies, definitive inclusion of patients was made during

surgery, after exclusion of complicated AA. Dubois et al. found, in a prospective study of 161 patients, that same-day discharge was feasible in 45% of cases. This percentage rises to 66% considering only uncomplicated AA [9]. In matched comparison, there was no significant difference in complications or reoperation rates between the study cohort and the historical cohort. Cash and colleagues were able to raise the success rate of same-day discharge for uncomplicated AA from 35 to 85% due to the implementation of a protocol, without increasing morbidity (8.4 *vs*. 5.2%) [10]. In a prospective study of 158 children (mean age 12 years), Alkhoury et al. reported a success rate of 80% and a satisfaction rate of 87% of same-day discharge following LA [11]. These three studies reported a median postoperative length of stay ranging from 2.8 hours to 4.8 hours. The length of hospital stay was not reported in any of these studies. In the study of Cash [10], some patients underwent LA during the night, while in the study of Alkhoury [11], children diagnosed with appendicitis during the night were admitted to the inpatient surgical ward and underwent LA the following morning. These studies show that it is possible to shorten the postoperative monitoring after appendectomy without increasing morbidity. However, a classic hospitalization is still needed while we are living in a time of cost-cutting budgets and reduction of the number of available beds in surgical wards. Moreover, these study do not meet the strict definition of AmbSurg.

Indeed, AmbSurg is defined by a hospital length of stay of less than 12 hours without overnight hospitalization. This implies that LA must be performed during the daytime, so that surgery must often be postponed to the next day and that the patient has to return home for the night. Moreover, in our department, as it is often the case, the ambulatory operating theatres are different from the classical theatre and patients are discharged directly from recovery room. So, the choice of an ambulatory surgery needs to be taken prior to admission. Surgical hazards (complicated AA, conversion) must be anticipated to

decrease the risk of unexpected overnight admission. That's why we thought that selection of patients must be based on preoperative criteria only and not on peroperative findings. That's because predictive factors of success for this type of support are lacking, that we analyzed in a preliminary retrospective study which preoperative criteria were associated with discharge at day-1, assuming that patient discharged at day-1 could have been discharged at the same day of surgery. It allowed us to establish a predictive score of early discharge, based on five preoperative criteria. The prospective study confirmed that this score was safe and valid. Moreover, if the score was applied to AmbSurg, it allowed us to reach a success rate of 97%. We also showed that AL performed in AmbSurg did not increase morbidity, even if 42% were postponed to the next day. Of note, the mean time between diagnosis and surgery was 15.5 hours if patients were reconvened to the next day. Studies are contradictory regarding the impact of delaying appendectomy on the rate of perforated appendicitis in adults [13-17]. In the largest study based on the American College of Surgeons National Surgical Quality Improvement Program database, including 32,782 patients [13], Ingraham et al. found that delay of appendectomy after admission does not adversely affect postoperative outcome. In a retrospective study of 389 patients, Abou-Nukta et al. showed no statistically significant differences in the length of stay, rate of advanced appendicitis or complications between patients who underwent appendectomy 12 and 24 hours after presenting to the emergency department compared with less than 12 hours [14]. Others have demonstrated a negative impact on outcomes associated with a delay in appendectomy. Busch et al, in a prospective study of 1675 patients, found that the rate of perforations at the time of surgery was statistically associated with a delay of more than 12 hours after admission (29.7 % vs. 22.7%; p=0.01) [15]. Kearney et al. showed that overall duration of symptoms prior to operation was independently associated with the risk of perforation [16]. In-hospital

waiting time was not a predictor for perforation. This is in accordance with the findings of Ditillo et al. who suggests that prehospital delay in presentation contributes more significantly to worsening pathology compared with in-hospital delay [17]. So it appears that it is possible, especially in patients selected according to the five criteria above, to postpone appendectomy to the next morning without increasing morbidity. Indeed, the score was also associated with the rate of complicated AA. On a small number of patients, we did not find complicated AA, even if delay before surgery was extended.

One could ask whether CT-scan is not sufficient to select patients. In a retrospective series of 244 patients, Bixby et al. showed that the presence of ileus, extraluminal gas or abscess were highly specific of perforation [18]. On the other hand, the sensitivities of these findings were disappointing, ranging from 34 to 53%. They concluded that, unless abcess or extraluminal gas is present, multidetector CT cannot enable the diagnosis of perforation. Our score, by adding clinical and biological criteria to radiological criteria allowed us to obtain a probability of ignoring complicated AA of only 8 and 3% for scores of respectively 4 and 5.

Different prospective randomized trials comparing antibiotics and surgery to treat uncomplicated AA found comparable treatment efficacy [19-21]. In our study, most of patients with a score≥4 would probably have been treated successfully with antibiotics alone. Medical treatment could further reduce the costs of care provided that patients are not hospitalized. In the first two studies [19,20], among patients who initially improved without surgery, 15% had recurrent appendicitis at a median of 1 year. In the study of Vons [21], this percentage raises to 29%. This difference is probably due to a low rate of lost to follow-up but also to the fact that diagnosis was always supported by a CT-scan, in contrast to other two studies. It's because of this high rate of recurrence that emergency appendectomy for AA remains the standard of care in our institution.

One criticism that could also be done is that this score is too restrictive. It is true that only about one half of patients met criteria for ambulatory care but our very low unexpected overnight admission rate was achieved through a strict selection of patients. Finally, 21% of the overall LA could have been performed in AmbSurg. This low rate was mainly due to logistical problems. The main obstacle identified was the difficulty to dispose of available operating room in AmbSurg unit. Indeed, in our institution, the AmbSurg unit is open only eleven hours per day and is closed on Saturday and Sunday, which reduces the possibility of support for surgical emergencies. So efforts should be made in the future to facilitate the management of gastrointestinal surgical emergencies in AS, especially AA which concern 80,000 patients per year in France.

CONCLUSION

We identified five preoperative criteria associated with discharge at day-1 after LA. It allowed us to establish a simple predictive score of early discharge which was validated on a prospective cohort. When applied to ambulatory surgery, it allowed us to select patients eligible for this type of care with a success rate of 97%. We didn't note increasing morbidity after LA performed in AmbSurg even if it was postponed to the next day. Our study is the first one to report the experience of ambulatory care in the management of AA. This type of care needs to be validated on a largest cohort.

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Figure Legends:

Figure 1. Rate of complicated appendicitis according to the score for both studies.

Figure 2. Flow of patients included in the prospective study.

Table

Table 1. Clinical, operative and postoperative data for patients included.

Variables	Retrospective study	Prospective study
	n=468	n=184
Women	227 (48.5%)	85 (46.2%)
Age (years)	34 ± 14 (16-89)	37 ± 15 (15-82)
ASA 1 score	404 (86%)	156 (84.8%)
Time between diagnosis and surgery (h)	7.7 ± 8.3 (0.3-113)	7.0 ± 6.8 (0.3-35.5)
Operative time (min)	69 ± 34 (15-355)	56 ± 29 (14-180)
Complicated appendicitis	107 (22.8%)	56 (30.4%)
Conversion	25 (5.3%)	13 (7.1%)
Time between surgery and discharge (h)	47.1 ± 55.4 (6.7-902)	41.8 ± 59.0 (3.4-354)
Hospital length of stay (h)	54.8 ± 56.6 (11.0-923)	49.3 ± 59.4 (5.0-357)
Surgical morbidity	34 (7.3%)	24 (13.0%)
Surgical site infection	24 (5.1%)	11 (9.2%)
Rehospitalization	25 (5.3%)	16 (8.7%)

Table

Table 2. Uni- and Multivariate analysis of factors associated with discharge at day-1 after LA.

Patients characteristics	**Univariate analysis** Discharge at day-1 n (%)	*p*	**Multivariate analysis** *p*	OR IC95%
Gender male	88/227 (51.4)	0.9686		
female	93/241 (48.6)			
Age < 30 y	93/227 (40.9)	0.3227		
> 30 y	88/241 (36.5)			
ASA < 2	163/400 (40.8)	**0.0223**	0.1482	
≥ 2	18/68 (9.9)			
BMI < 28 kg/m^2	161/386 (41.7)	**0.0016**	**0.00557**	**1.71 (1.17-2.51)**
> 28 kg/m^2	13/61 (21.3)			
Clinical criteria				
Duration of pain < 2 d	143/324 (44.1)	**0.0001**	0.1997	
≥ 2 d	35/138 (15.4)			
Temperature < 38°C	160/399 (40.1)	0.1092		
> 38°C	17/58 (29.3)			
Biological criteria				
WCC < 15.0 per µL	126/298 (42.3)	**0.0369**	**0.0109**	**1.39 (1.08-1.80)**
> 15.0 per µL	55/169 (32.5)			
CRP < 30 mg/L	116/237 (48.9)	**<0.0001**	**0.00354**	**1.32 (1.02-1.72)**
> 30 mg/L	52/204 (25.5)			
Radiological criteria				
Signs of perforation (-)	178/403 (44.2)	**<0.0001**	**0.00161**	**2.72 (1.44-5.14)**
(+)	3/64 (4.7)			
Appendix diameter ≤10 mm	122/256 (47.7)	**<0.0001**	**0.00843**	**1.37 (1.08-1.74)**
>10 mm	55/193 (28.5)			
Appendicolith (-)	145/349 (41.5)	0.0778		
(+)	33/107 (30.8)			

Table

Table 3. Saint-Antoine's score and results for patients operated with conventional surgery.

Variables	
BMI < 28 kg/m^2	1 point
WCC < 15000 per μL	1 point
CRP < 30 mg/L	1 point
No radiological signs of perforation	1 point
Appendix diameter ≤ 10 mm	1 point

Saint-Antoine's score	**Retrospective study** n=468		**Prospective study** n=146	
	n	**Day 1 discharge**	**n**	**Day 1 discharge**
0 point	6 (1.3%)	0 (0%)	3 (2%)	0 (0%)
1 point	34 (7.3%)	0 (0%)	14 (9.6%)	2 (14%)
2 points	73 (15.6%)	14 (20%)	27 (18.5%)	8 (30%)
3 points	161 (34.4%)	63 (39%)	37 (25.3%)	23 (62%)
4 points	134 (28.6%)	60 (45%)	41 (28.1%)	29 (71%)
5 points	60 (12.8%)	43 (72%)	24 (16.4%)	22 (92%)
Chi^2 Test		p<0.0001		p<0.0001

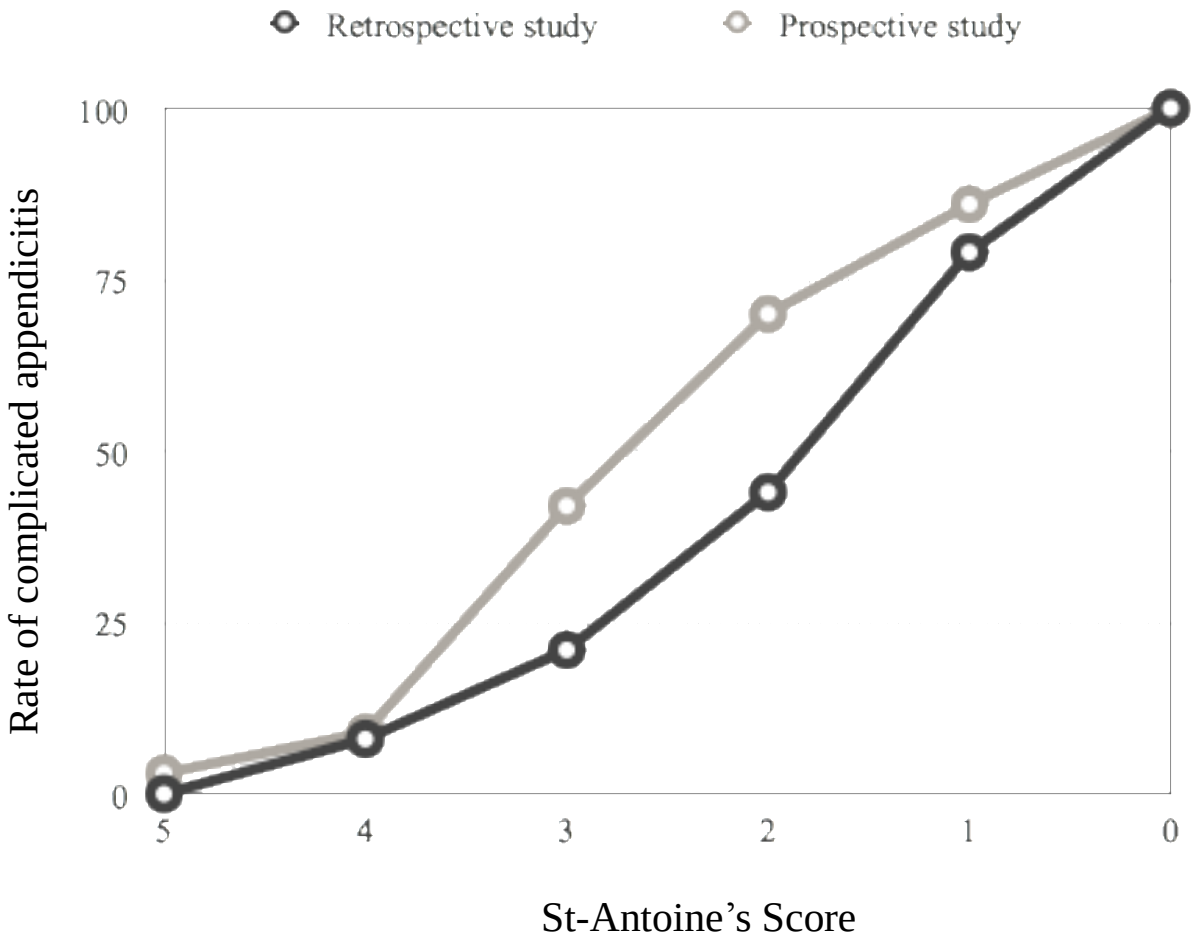
Table

Table 4. Comparison between AmbSurg group and ConvSurg group's patients with a score ≥4

Patients characteristics	**AmbSurg group n=37**	**ConvSurg group n=65**	**P**
Women	18 (47)	26 (40)	0.3971
Age (years)	32 ± 10	35 ± 13	0.0926
ASA 1 score	36 (97)	55 (85)	**0.0471**
St-Antoine's Score distribution			
Score = 4	23 (63)	41 (63)	
Score = 5	14 (37)	24 (37)	0.9628
Preoperative characteristics			
Deferral to the next morning	16 (42)	23 (35)	0.467
Time between diagnosis and surgery (h)	8.4 ± 6.9	7.6 ± 7.1	0.7056
Operative characteristics			
Operative time (min)	41 ± 14	49 ± 25	**0.0229**
Complicated appendicitis	0 (0)	6 (9)	0.0568
Conversion	0 (0)	3 (5)	0.185
Postoperative characteristics			
Time between surgery and discharge (h)	4.5 ± 6.7	25.6 ± 16.4	**<0.0001**
Length of hospital stay (h)	8.5 ± 6.9	33.2 ± 18.2	**<0.0001**
Surgical morbidity	3 (8)	6 (9)	0.829
Surgical site infection	1 (3)	3 (5)	
Unplanned consultation	2 (5)	5 (8)	0.661
Rehospitalization	1 (3)	4 (6)	0.438
Pathological confirmation of appendicitis	38 (100)	62 (95)	0.177

Figure

Figure 1. Rate of complicated appendicitis according to the score for both studies.



Figure

Figure 2. Flow of patients included in the prospective study.