Four decades of laparoscopic appendectomy. does it have the same role in the management algorithm of a postappendectomy abscess?

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Background/Objective
Postappendectomy abscess (PAA) is the most controversial complication after appendectomy. We aimed to identify the actual incidence of PAA and to compare the success rate of different lines of treatment both in adult and pediatric age groups in our institute.
Methods
A prospective study was conducted on patients who had a radiologically confirmed PAA. They were subdivided into adults (group A) and children (group B). A stepwise approach was used for the management of the PAA. The success rate of each line of treatment was recorded and compared between both groups.
Results
Five hundred twenty appendectomy patients were included in this study (321 adult and 199 pediatric patients). In group A, 14 (4.36%) patients had a PAA in comparison to 9 (4.52%) children in group B. In group A, the success rate of both the medical and surgical treatment was 66.7%, whereas the radiological drainage was successful in the three cases. In group B, medical treatment was successful in 83.3% and the patient who failed medical treatment was drained laparoscopically. The remaining three cases were radiologically drained.
Conclusion
This is the first trial to compare the success rate of different lines of treatment of PAA between adult and pediatric patients. Our results conclude that there is no statistically significant difference between the success rate of each line of treatment.

Keywords:
abdominal drainage, intra-abdominal collection, laparoscopic appendectomy, postappendectomy abscess, post-appendectomy complications

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Introduction

Charles McBurney was the first to do an open appendectomy via its contemporary gridiron technique in 1889 [1]. This technique remained the gold standard technique till the innovation of laparoscopy in Germany by Dr. Semm in 1983. Since that, scientists have been studying and comparing both laparoscopic appendectomy (LA) and open appendectomy (OA), especially in cases of complicated appendicitis (CA) [1,2].

Acute appendicitis (AA) is the most common cause of acute abdomen in adults with approximately 17.7 million patients diagnosed with AA worldwide in 2019 [2]. The overall time risk is 7–9% in USA and Europe [3,4]. Appendectomy is the most accepted line of treatment for AA [3].

Postappendectomy abscess (PAA) is the most serious complication occurring after appendectomy. It occurs in 0.8–1.7% after simple appendectomy in comparison to 14–24% of those suffering from complicated AA [4–9]. However, a recently published trial from Taiwan [10] reported a much lower incidence of about 2.3% after CA. Despite the high incidence of AA and the passage of four decades since the emergence of LA, there is no consensus on a standardized approach for managing PAA in both adults and children [8] making it a hotly contested topic for scientific research up till now.

In this setting of conflicting published research, this study aimed to identify the actual incidence of PAA and to compare the success rate of different lines of treatment both in adult and pediatric age groups.

Methods

To that purpose and as mentioned ahead, this prospective study was conducted between January 2021 and December 2022 on patients who had PAA after both simple and CA presented to us at the Ain Shams University Hospitals, Cairo, Egypt. PAA is defined as an intraperitoneal accumulation of purulent exudative fluid in a walled-off space after appendectomy detected by an ultrasound study or computed tomography (CT) scan associated with clinical and laboratory signs of infection [7,8,11]. This trial was done in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans and after approval of the local ethical committee of our institute.

Different intraoperative classification scoring systems have been proposed and investigated, such as LAPP (Laparoscopic Appendicitis Score) [12], the Gomes *et al.* grading system [13], the World Society of Emergency Surgery (WSES) 2015 grading score [14], the American Association for the Surgery of Trauma (AAST) grading score [15], and the Sunshine Appendicitis Grading System Score (SAGS) [16]. In this series, we used the AAST EGS (emergency general surgery) anatomic severity score [17] which differentiates between simple appendicitis (grade I) and complicated appendicitis (grade II, III, IV, and V). Based on these definitions, CA represents up to 35% of cases [4]. Severe peritonitis is defined as the presence of pus in more than two abdominal quadrants [11].

The enrolled patients were subclassified according to age into group (A) (adults, >16 years) and group (B) (pediatric, <16 years). We expressed the results of both groups separately, trying to detect if there is any age-specific difference in the response of PAA to different lines of treatment. The primary endpoint for this study was the incidence of PAA in each group, while the secondary endpoint was the determination of the success of each line of treatment in both pediatric and adult patients.

All postappendectomy patients presented with a clinical picture suspicious of PAA were meticulously examined. Some laboratory investigations were ordered such as complete blood count (CBC), and C-reactive protein (CRP). In addition, they were scanned by pelviabdominal ultrasound, checking for the presence of collections with a special comment on the number of collections, the echogenicity (turbidity) of the fluid, the maximal three-dimensions, the estimated volume, the accessibility to be radiologically drained, and if possible, aspiration of a sample of the fluid. In some cases, and according to the radiologist's opinion, a CT scan with IV and oral contrast may be ordered (Fig. 1).

For those confirmed to have PAA in both groups, we start with medical treatment unless the general condition is bad and/or the maximal dimension of the abscess is more than 7 cm. The protocol of antibiotics included IV ceftriaxone 1 gm twice daily and IV metronidazole 500 mg every eight hours. Continuous monitoring of the patients was done over the first 48 h. If the patient is not improving and was having a large accessible collection, radiological drainage is our preferred choice. If the patient was not improved and his collection was not accessible, the patient is prepared for laparoscopic exploration.

The demographic, clinical, and radiological data were collected and recorded. Intraoperative data (especially the AAST EGS grade) were checked. The postoperative course and subsequent follow-up were documented.

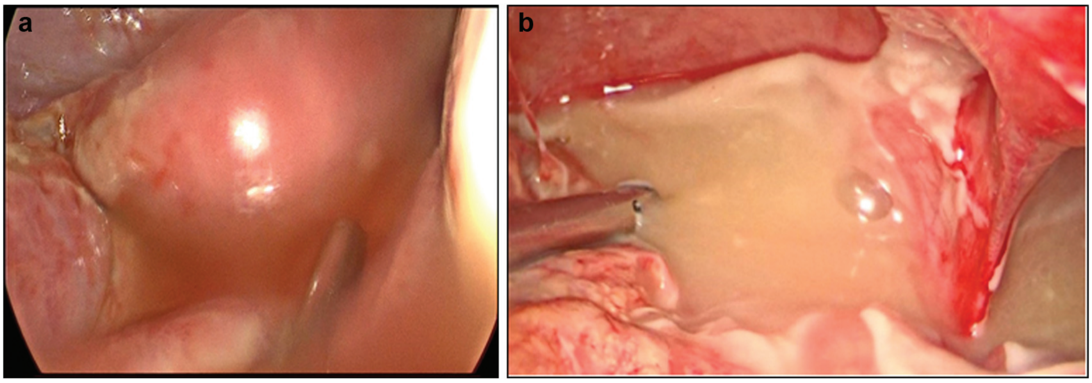
Surgical technique for laparoscopic drainage

After cutting off the wound stitches, cautious introduction of the index finger to exclude any herniation. Introduction of the ports and insufflation

Figure 1

Computed tomography scan showing a multiloculated postappendectomy abscess in the rectovesical pouch extended to the Rt iliac fossa.

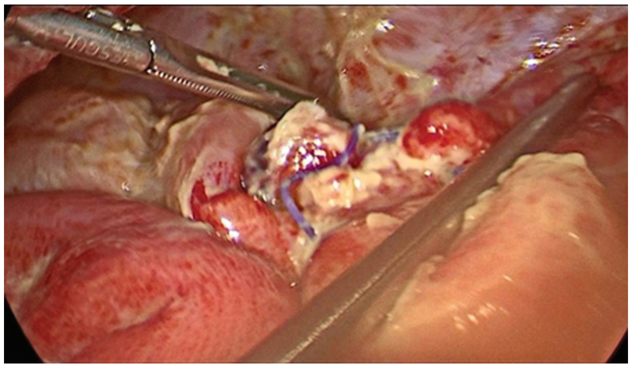
Figure 2



(A and B): Laparoscopic drainage of a pelvic postappendectomy abscess.

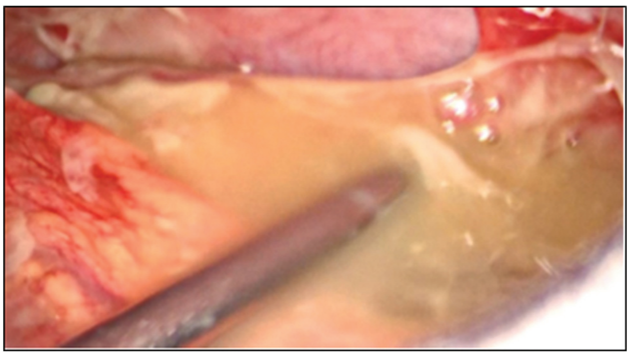
of the abdomen in a supine reverse Trendlenberg's position. Formal diagnostic laparoscopic exploration of the whole abdomen, searching for the site of collection (especially the right and left subphrenic regions, right paracolic gutter, and pelvic areas) (Fig. 2a and b). The appendicular stump was checked for the possibility of a fecal leak (Fig. 3). If the PAA was surrounded by intestinal loops or were multiple abscesses, meticulous dissection of the intestinal loops either by the suction catheter (Fig. 4) or by atraumatic instruments. We tried as much as possible not to grasp loops to diminish the risk of bowel perforation. Opening of closed pockets was done followed by pus suction and in some cases, a wide bore tube drain was left (Fig. 5).

Figure 3



Laparoscopic view showing intact appendicular stump ligated with a stitch.

Figure 4



Laparoscopic view showing drainage of right iliac fossa postappendectomy abscess.

Statistical analyses

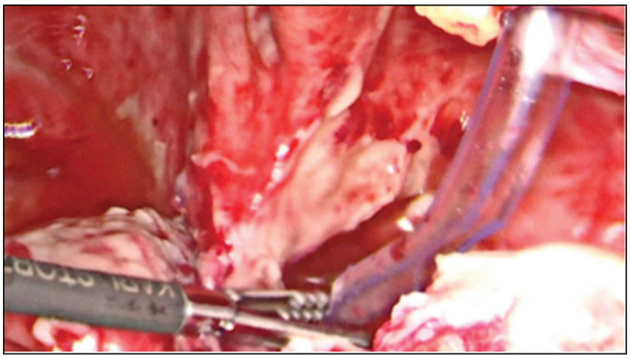
The demographic, clinical, and surgical data were analyzed by standard descriptive statistics. The quantitative variables with a normal distribution were expressed as mean ±SD, whereas the qualitative data with binary variables were expressed as frequency and percentage.

To unveil the real difference between the success rate of each line of treatment between the two groups, relevant statistical tests were used such as Z-test for comparing two independent proportions [18], and Z test for comparison of 95% confidence interval [19]. Confidence interval of a proportion including continuity correction. During sample size calculation, beta error accepted up to 20% with a power of study of 80%. An alpha level was set to 5% with a significance level of 95%. Statistical significance was tested at *P* value less than 0.05. Data were analyzed using the statistical package for social sciences, version 25 software package (SPSS Inc., Chicago, Illinois, USA).

Results

During the defined period of the study, 520 appendectomy patients were included in this study. Out of 325 adult cases, 4 cases were proved to be Crohn's disease and were excluded, with a net result of 321 cases who were enrolled in this trial and assigned as

Figure 5



Laparoscopic view of drain placement.

group A. Out of them, 14 (4.63%) cases (Fig. 6) developed PAA with their baseline characteristics shown in Table 1.

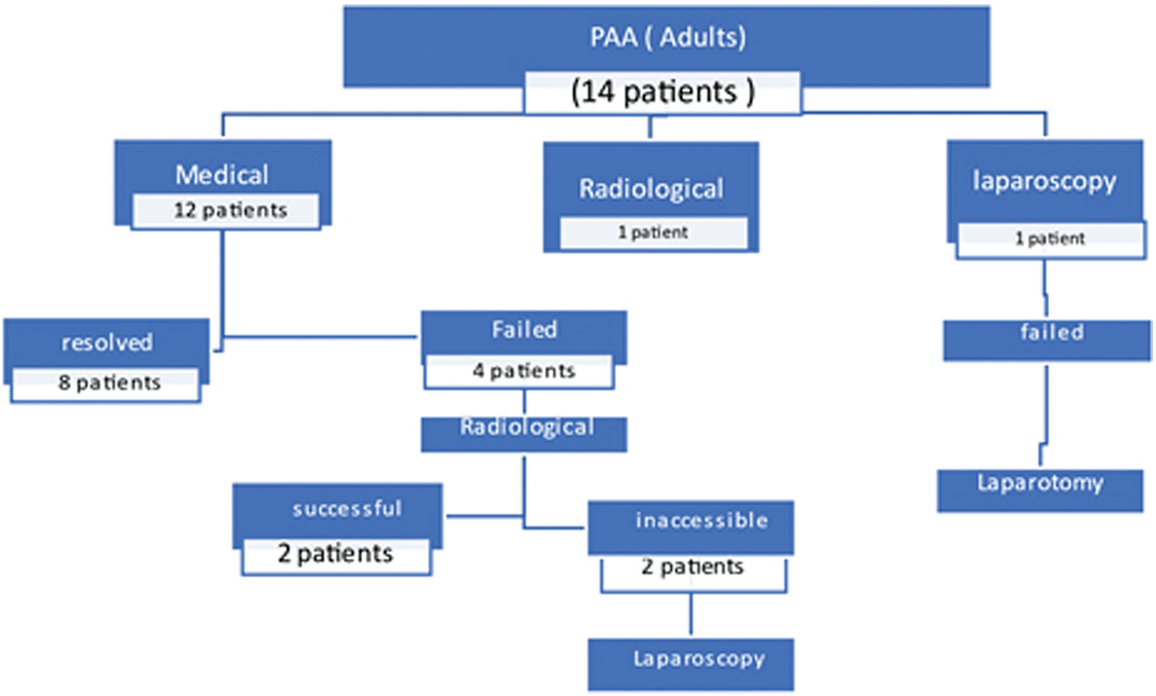
Medical treatment was offered for 12 cases with complete recovery for 8 (66.7%) only six patients of them were CA. The remaining four cases were scanned by ultrasound, and the radiological drainage was successful in two patients while the other two had no safe access for the radiologist, therefore, they had laparoscopic drainage. One patient who presented with a high-grade fever (39.4), with a PAA of 8.2×4.6 cm had an immediate successful radiological drain and was discharged after 3 days. The last patient presented with a bad general condition and by ultrasound scan, the collection was radiologically inaccessible, therefore, he had laparoscopic drainage. However, he had a recurrence of symptoms with a recollection of pus in the rectovesical pouch which necessitated laparotomy after 8 days. Surprisingly, this case suffered from a recurrence of symptoms and recollection, and it was successfully managed by conservative treatment.

Regarding group B, 199 appendectomy cases were included (after the exclusion of eight cases due to refusal to participate), 134 were having the diagnosis of simple AA while 66 were CA. Nine cases were presented with PAA (All were after CA). The detailed management was illustrated in (Fig. 7). The comparative statistical analysis between the two groups is illustrated in Table 2.

Table 1 Baseline characteristics of patients

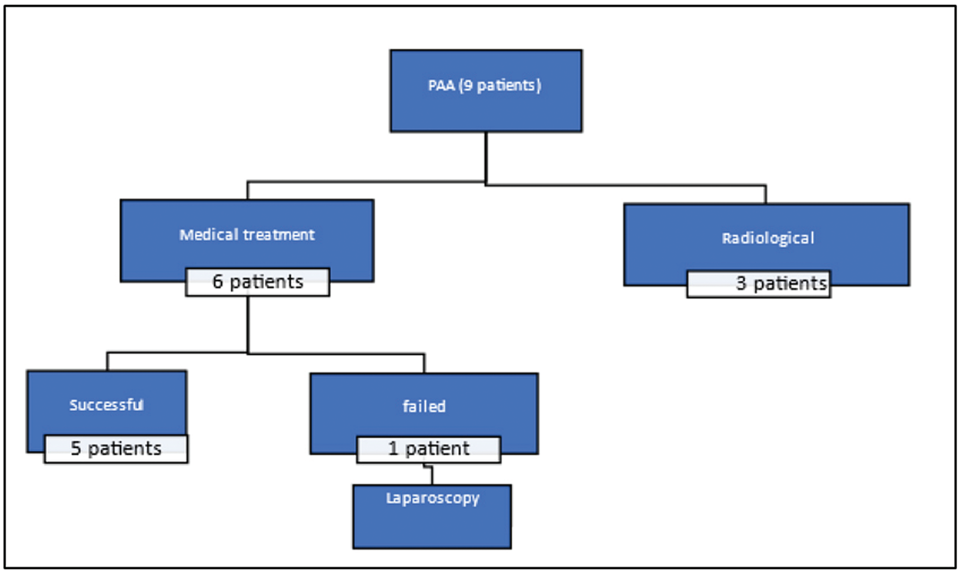
Variable	Outcomes (group A)	Outcomes (group B)
Age (mean)	21.4 years	7.9 years
Male: female	8 : 6	5 : 4
CA	12/14 (85.7%)	9/9 (100%)
Temperature (in Celsius)	38.2-39.7 (39.1)	38.5-39.6 (39)
Time of appearance after appendectomy	7.3 days (4-13)	6.9 days (5-11)
CRP	155 (30-255)	168 (48-270)
Hospital stay (days)	6.7 days (2-14)	7.5 (3-12)

Figure 6



Flowchart of management in group A patients.

Figure 7



Flowchart of management in group B patients.

Table 2 Comparative statistical analysis between the two groups

	Group A (*n*=321)	Group B (*n*=199)	Test of significance (*P* value)
Postappendectomy Abscess			
Number (%)	14 (4.36%)	9 (4.52%)	
95% CI of the percentage	2.50-7.37%	2.22-8.68%	
Medical			
Number (%)	12 (85.71%)	6 (66.67%)	Z_a=0.744, *P*=0.459
Success	8 (66.67%)	5 (83.33%)	Z_b=0.744, *P*=0.228
95% CI of the percentage	35.44-88.73%	36.48-99.12%	Z_a=0.744, *P*=0.459
Failure	4 (33.33%)	1 (16.67%)	Z_b=0.744, *P*=0.228
95% CI of the percentage	11.27-64.56%	8.80-63.52%	
Radiological			
Number (%)	3 (21.43%)	3 (33.33%)	NA
Success	3 (100.00%)	3 (100.00%)	NA
95% CI of the percentage	31.00-100.00%	31.00-100.00%	
Failure	0	0	
95% CI of the percentage	0.00-69.00%	0.00-69.00%	
Surgical			
Number (%)	3 (21.43%)	1 (11.11%)	Z_a=0.667, *P*=0.502
Success	2 (66.67%)	1 (100.00%)	Z_b=0.000, *P*=0.500
95% CI of the percentage	12.53-98.24%	5.46-100.00%	Z_a=0.667, *P*=0.502
Failure	1 (33.33%)	0	Z_b=0.000, *P*=0.500
95% CI of the percentage	1.76-87.47%	0.00-94.54%	

CI: Confidence interval, 95% CI of the proportion was calculated using the continuity correction, Z_a: Z test for comparison of 2 independent proportions [18], Z_b: Z test for comparison of 95% CI [19]. NA, Nonapplicable statistics (exact match). *Statistically significant ($P<0.05$).

Discussion

The literature review showed heterogeneous data regarding the rate of PAA ranging from 3.4% to 6% after OA, and from 3.7 to 8% after LA [20–23]. This relatively higher incidence of PAA after LA was the focus of certain studies [24,25] which recommended reduction of the pneumoperitoneum pressure. However, a more recent trial [26] concluded that LA for CA is not associated with any increase in PAA formation.

Peritoneal lavage was previously a point of debate [3,27–29]. In this study, we did not study this issue because we used only suction and sometimes gauze wiping of exudate according to the last available evidence (level 1B) [3].

Interestingly, drain use failed to decrease the incidence of PAA formation as shown by Alleman *et al.* [1], and confirmed by many recent studies [4,10,30–32]. The World Society of Emergency Surgery issued its evidence-based guidelines in 2015 [33] discouraging the use of drains even after CA. This concept is confirmed after the Nijemegen consensus conference (The Netherlands, 2019) [3]. This could be explained by the fact that PAA usually develops on top of missed unevaluated fluid collection rather than in the well-evacuated abscess cavity [1].

The old surgical doctrine addressed that pus collection necessities drainage is dated back to the Hippocratic era when they drained empyema thoracis with a simple knife [32]. This rule does not apply for all surgical disorders such as the appendicular abscess which is managed successfully by the conservative protocol despite the presence of the case of inflammation. This success encourages the surgical community to evaluate the role of conservative treatment in PAA (where the cause of inflammation is removed). In 1991, a Spanish team headed by Dr. San-Roman confirmed the efficacy of medical treatment on PAA in children under 10 years [34]. This issue was further evaluated by extensive research managing this complication as a hot topic up till now [4,7,35–37].

Inspired by the previously published work, the Surgical Society of the Netherlands recommended the conservative treatment of PAA in children in contrary to the radiological drainage for adults [34]. At that time, only a 3 cm PAA was amenable for nonoperative treatment [38,39]. Collins *et al.* [37] published in 2020 the largest Australian retrospective study which enrolled 4901 appendectomy patients. They set a 4 cm maximal diameter as a cut-off value for medical treatment. Their results were not completely in accordance with the outcomes of two previously published series [7,35] which successfully had larger abscesses of 6–7 cm with antibiotics only.

Two years later, Bough *et al.* [8] advocated the use of the volume of collection instead of the maximal diameter as a more representative indicator of the success of nonoperative treatment. They considered 2 ml/kg as a new cut-off value. The antibiotics used in the conservative treatment should be triple parenteral bactericidal antibiotics that cover the anaerobic organisms as well [35].

In Fact, there is an important issue unaddressed in the literature as a possible cause of failure of the nonoperative treatment which is the type of microorganism and its resistance potential. We should bear in mind that the success of treatment of any inflammatory process depends on the balance between the body's defense mechanisms and the offending microorganism (its virulence and its concentration). Therefore, the resistance to the antibiotics could be the underlying cause of failure and could be much more important than the absolute volume (or the maximal diameter) of PAA.

The percutaneous drain was first tried at Tufts University in 1976 with an 86% success rate [40]. This success paved the way to radiologists to try the transvaginal and transrectal routes for drainage with good outcomes [35]. The success depends on the sum, site, and size of the PAA [7]. The surgical drainage is reserved for those who had bad general condition, and/or large multiple collections [35,41]. Retained fecolith is a relative indication of laparoscopic drainage.

In this study, regarding the adult group (group A), PAA developed in 14 out of the 321 cases (4.4%). This is in range with the recently published research (0.9–8%). Of those, 8/12 patients responded completely to the medical treatment (66.7%). Radiological drainage was successful in three cases, while laparoscopic exploration and drainage succeeded in two of the three cases. The third patient needed laparotomy through a lower midline incision due to persistent fever after the laparoscopic intervention.

Collins *et al.* [37] presented the least incidence of PAA published in the literature (0.9%) which could be attributed to the high incidence of negative appendectomy (36%) enrolled in their series. They reported 42 PAA patients, 26 had medical treatment and 16 patients had radiological drainage. The medical treatment was successful in all cases while the radiological drain failed in four cases that had surgical drainage.

Regarding group (B), it included 199 appendectomy patients. Nine (4.5%) patients developed PAA which is nearly the same as in group (A). The location of PAA was variable, four cases had pelvic collections, three cases in the right iliac fossa, one in the subhepatic area, and one in the right subdiaphragmatic space. Seven out of the nine patients had complete resolution with nonoperative treatment over a 7-day course of triple antibiotics. Interestingly, the distribution of the collection of patients who responded to medical treatment was one subhepatic collection, three multiple small collections, and one large-sized collection. It is worth mentioning that 1 case (9 years old) needed radiological drainage and pigtail insertion. Only 1 case (10 years old) had a laparoscopy for a missed fecolith and was discharged 2 days later with a smooth recovery.

Forgues *et al.* [35] from the University Hospital of Montpellier stated in their retrospective study a rate of 3.3% (26/783 patients) for PAA formation. The included children had a single PAA (23 cases) and 3 had multiple PAA. They have a remarkably high success rate of an 8-day course of medical treatment (92.3%) of PAA which included 22 cases of an isolated PAA and 2 cases of multiple PAA. The remaining four patients had surgical drainage.

To further elaborate, in a retrospective trial on 60 PAA patients, Bough *et al.* [8] reported that non-operative treatment was sufficient in 38/44 patients (86.3%). Those who failed the medical treatment improved with radiological drainage only (five patients) or had a laparoscopy (one case). They did not offer surgical drainage as a first-line treatment except if bad general condition along with inaccessible PAA by the radiologists. In this group of surgical drainage (five cases), one of them had recurrent symptoms and needed radiological drainage.

Additionally, in a Dutch comprehensive study addressing the management of PAA in children, Gorter *et al.* [7] have shown an incidence of 6.7%. Nine (36%) out of them were treated conservatively without any intervention and 16 (64%) cases were treated either by percutaneous drainage or invasive surgical drainage.

In this study, the success rate of each line of treatment was shown in Table 2. Going deeply through these figures, and by statistical analyses, we can understand some important points. Firstly, given the high success rate of the medical treatment, in both adults and Pediatric patients, it should be tried first for all patients unless a bad general condition or the maximal dimension of the collection is more than 7 cm. This could be explained by the fact that the medical treatment needs some time (latent period) for its effect to be full-blown. This lag could not be awaited in the previous two conditions.

Secondly, the radiological percutaneous drainage of the collection is to some extent described as a simple procedure, with an astonishingly high safety and success rate. Thirdly, laparoscopic exploration and drainage seem to be efficient and safe.

In this study, and by differential analysis of the data, we herein can observe that the success rate of medical treatment is higher in the pediatric group, however, this difference is statistically non-significant. The limitations of this study are the relatively small number of PAA patients due to its relative rarity.

Conclusion

To our best knowledge, this is the first trial to compare the success rate of different lines of treatment between adult and pediatric patients. There is no statistically significant difference between the success rate of each line of treatment of PAA between adult and pediatric patients.

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Conflicts of interest

No conflicts of interest for all authors to disclose.

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