Annals of Medical Research
DOI: 10.5455/annalsmedres.2018.05.090 2018;25(3)410-5

Original Article

When is free air a sign of complication on abdominal plain radiography after laparotomy in pediatric patients?

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Abstract

Aim: Postoperative free air in the abdomen may not be harmful for the patient, it may be innocent, but it may also be an important indicator or marker of an operation-related complication. In this study we aimed to find out retrospectively when post-operative free air in the abdomen disappears in pediatric patients undergone laparotomy.

Material and Methods: From January 2009 to April 2018, records of all pediatric patients under 17 years of age undergoing laparotomy were reviewed. The data of 1570 patients who underwent laparotomy were obtained. Among these patients, 101 patients who complained of vomiting on the first postoperative day were identified. On the first postoperative day, 101 patients with vomiting complaints were found to have abdominal plain radiographs (APR). Among these patients, those who were re-operated were identified. Both groups were statistically analyzed in terms of the disappearance time of free air and demographic information in the APR film.

Results: The free air in the group of re-laparotomy continued to be seen for a longer time. We found that free air was lost in APR in 28.7% of patients in 1 day, 60.3% in 2 days, 7.9% in 3 days and 2.9% in 4 days.

Conclusion: In our study, we found that free air continued to be seen in APR for 2 days after laparotomy in children. We claim that surgical intervention should be considered as a primary consideration if free air is present in the APR after 3rd postoperative day.

Keywords: Laparotomy; Postoperative; Free air; Radiograph.

INTRODUCTION

Intestinal perforation is a condition that requires immediate surgical intervention and is fatal if not treated (1). The most important sign of intestinal perforation in a patient is the free air, which is seen under the diaphragm in plain radiography. Free air on the abdominal plain radiography can be related with intestinal perforations, as well as postoperatively in any patient undergoing intra-abdominal surgery (2).

Postoperative free air may not be harmful for the patient, it may be innocent, but it may also be an important marker of an operation-related complication (2). The free air usually disappears after a period (3). The first study involving the presence of free air on abdominal plain radiography was performed by Kelling in 1902, for a reason requiring surgical intervention (4). Later, in a study by Popper, it was emphasized that the free air seen on plain radiography is a sign of gastric perforation (5). Studies have been carried out since the 1940s on the disappearance of postoperative free air (6).

Despite the fact that there is a lot of talk about the time of the disappearance of the post-operative free-air, the scientific literature on this subject is limited (2). That issue becomes more important in pediatric patients, which are sometimes limited to self-expression (1). For that reason, in this study we aimed to find out retrospectively when post-operative free air in abdomen disappears in pediatric patients.

MATERIAL and METHODS

Study protocol

The study began after the ethics committee's decision was approved by the ethics committee of scientific research and publications of Inonu University. From January 2009 to April 2018, records of all pediatric patients who underwent intra-abdominal laparotomy under the age of 17 years were reviewed at the pediatric surgery department of the Inonu University medical faculty. The data of 1570 patients who underwent laparotomy were obtained. Among these patients, 101 patients who complained of vomiting on the first postoperative day were identified.

Received: 17.05.2018 **Accepted:** 31.05.2018 **Available online:** 04.06.2018
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A total of 1570 patients underwent laparotomy, but only 101 patients were thought to be potentially a problem and a plain abdominal X-ray was taken to find a solution to the patient's problem. On 1st postoperative day, 101 patients with vomiting complaints were found to have abdominal plain radiographs (APR). It was determined that these abdominal plain radiographs were continued to be displayed every day until the disappearance or re-operate of abdominal free air, followed by clinical physical examination findings. Abdominal radiographs of some patients on postoperative 1st day are shown in Figure 1-3.

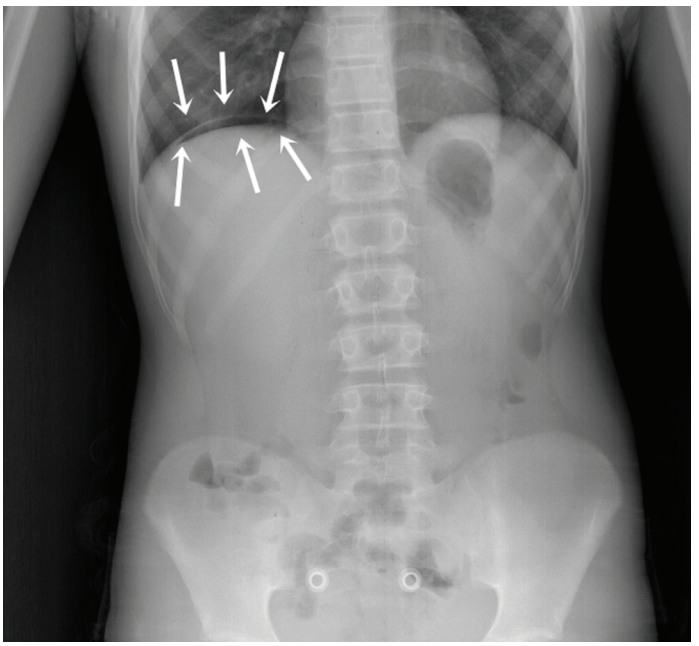

Figure 1. The appearance of a 1-day plain abdominal x-ray of a 12-year-old female patient who was operated on for appendicitis. Free air on the right liver (Arrows).

Figure 2. A 1-day-old male baby operated for perforated appendicitis on the first postoperative day of abdominal plain graphy. Right and left free air (Arrows).

Figure 3. Postoperative second day abdominal plain radiography of the same baby. Free air is lost (Arrows).

In laparotomy group (LG) (n = 101) of patients, postoperative disappearance of free air time to the age, sex, and WBC count were detected and diagnosed preoperatively (Table 1). Re-laparotomy group (RLG) (n: 9) was identified among the LG group patients, requiring reoperation. In RLG patients, age, number, sex, preoperative WBC count, intra-operative findings, type of surgery performed, and clinical findings were found (Table 2). All patients in the RLP group needed surgery for the second time. The second operation status of these patients was evaluated with different operations, different laboratory results, and different films. This second operative condition was included in the Laparotomy group. The findings of both groups were analyzed statistically.

Statistical analysis

Quantitative data were summarized by median (Interquartile range) and Mann Whitney U test was used for comparisons. Qualitative data were expressed as count (percent) and comparisons were made by Fisher's exact test. In all analysis level of significance was considered as 0,05.

RESULTS

After laparotomy, there were 101 patients who were followed up with APR film every day because of complaints of vomiting from postoperative first day, considering postoperative problem. The ages of these patients ranged from 1 day to 16 years. Of these patients, 64 were males and 37 were females. The demographic information of the patients in the LG is shown in table 1. Free air in the APR in 9 out of 101 patients continued to be seen even after the 5th day. These 9 patients were re-operated considering

the clinical, radiological and laboratory findings.

From these patients, 6 were boys, 3 were girls. The demographic information of the patients in the RLG is shown in table 2. Free air in the APR film of patients in the LG continued to be seen for the longest 3 days. From the longest 4th day, the free air in the APR was invisible. The free air in the APR film of the RLG continued to be seen even on the 7th day. In the APR film in the LG, no patients who lost free air were reoperated. Appendicitis is the most common disease in the LG. The most common disease in the RLG was Hirschsprung's disease.

There was no significant difference in terms of age and gender when groups were compared (p>0,005) (Table 3). The number of male patients in the LG (n=101) was 64. Of all male patients, 91.4% were in the LG. The number of male patients in the RLG (n=9) was 6. Of all male patients, 8.6% were in the relaparotomy group.

The number of female patients in the LG was 37. Of all female patients, 92.5% were in the LG. The number of female patients in the RLG is 3. Of all female patients, 7.5% were in the RLG. The median age of the laparotomy group was 108 (Inter quartile range (IQR)= 111). The median age (month) of the RLG was 12 (IQR= 108).

When the LG and RLG were examined statistically in terms of preoperative WBC count, there was no significant difference (p>0,005). The median WBC count in the LG (n = 101) was 15.5 (IQR = 7.85). The median WBC count in the RLG (n = 9) was 17.6 (IQR = 7.10).

The difference was significant when groups were statistically analyzed in terms of the number of days in which postoperative abdominal free air continued to be observed in APR (p<0,.001) (Table 4). The median number of days in the LG (n = 101) continued to show free air in the postoperative APR was 2 days (IQR = 1). The median number of days in which RLG (n = 9) continued to show free air in the postoperative APR was 6 days (IQR = 2). In other words, continuing to see free air for more than 3 days in a patient's postoperative APR film indicates that the patient needs surgery again.

Table 1. Patients with free abdominal X-ray and free air monitoring due to vomiting after the first operation

The diagnosis of the patients	The number of patients	Male	Female	The average number of days the free air disappeared	Postoperative vomiting	Mean Leucocytosis	Average age (Mounth)
Appendicitis	57	35	22	2,03 ± 0,5	Positive	16.5± 4.5	118.7±40.6
Duodenal perforation	2	2		2	Positive	23.7± 6.1	126±8.4
Invagination	4	4		2	Positive	17.45±12.2	27±14.2
Neuroblastoma	1		1	1	Positive	11	24
Duodenal stenosis	1	1		1	Positive	6.7	24
Hirschsprung	4	3	1	2	Positive	14.1±6.1	6±6.9
Necrotizing enterocolitis	2	2		3	Positive	16.3±6.9	1
Duodenal atresia	2	2		1	Positive	12.5±3.8	1D*
Diaphragm hernia	2	1		2	Positive	24±5.5	1D
Pyloric stenosis	2	2		1	Positive	9.6±0.28	1
Over cyst	1		1	2	Positive	19,1	132
Umblical hernia	3	1	2	1	Positive	8.5±2.4	45.6±46.2
Anal atresia	5	3	2	1.2± 0.4	Positive	12.5±3.1	6.2±3.4
Stomach fixation anomaly	1		1	1	Positive	8.1	15
Mid-gut volvulus	1		1	1	Positive	22.3	12
Over torsion	2		2	1.5± 0.7	Positive	16.4±1.2	102±76.3
Brid ileus	4	4		2.25±1.25	Positive	17.3± 2.8	141±39.6
Acute abdomen	4	2	2	1.5± 0.5	Positive	14.8±6.8	69±55.7
Sigmoid volvulus	1	1		4	Positive	10.6	144
maltoration	2		1	1	Positive	10.2±0.63	36.1±33.9

*D:Day

Table 2. Characteristics of re-operated patients with free air continued

Patient's number	Age*	Gender	Previous diagnosis	Intra operative findings	Ongoing free-air day	Leucosytosis	Abdominal sign	Type of surgery
1	6 D	m	Hirschsprung	Leak from biopsy site	5	13.9	abdominal distention	Primer repair
2	7 D	m	Hirschsprung	Intestinal perforation	6	15.5	abdominal distention	Primer repair
3	6 Y	m	Appendicitis	Leak from appendec-tomy site	7	23.5	abdominal distention and tenderness	Colostomy
4	6 M	m	Anal atresia	Anastomotic leakage	7	17.10	abdominal distention and tenderness	Primer repair
5	15 M	f	Achalasia	Esophageal perforation	5	14.1	abdominal distention and tachypnea	Primer repair
6	15 Y	f	Crohn's disease	Leak from appendectomy site	7	21.4	abdominal distention and tenderness	Resection-anostomosis
7	7 D	m	Hirschsprung	Leak from biopsy site	5	17.6	abdominal distention	Primer repair
8	12 Y	m	Appendicitis	Spontaneous perfora-tion	6	22.4	abdominal distention and tenderness	Primer repair
9	1 Y	f	Colon perforation due to enterocolitis	Negatif perforation, normal findings	6	19.1	abdominal distention	Laparotomy

*D:Day, M:Mounth, Y:Year

Table 3. Statistical analysis of age and gender of patients with laparotomy group and Re-laparotomy group, with free air on abdominal plain graph

		Laparotomy Group(n=101)	Relaparotomy Group (n=9)	p value
Age (month)	Male	Median (IQR)	Median (IQR)	0.065
Sex	Female	108 (111)	12 (108)	1.000
		64 (91.4%)	6 (8.6%)	
		37 (92.5%)	3 (7.5%)	

Table 4. Statistical analysis of the number of days lost free air and number of WBCs in patients who underwent laparotomy and re-laparotomy

	Laparotomy Group (n=101) Median (IQR)	Relaparotomy Group (n=9) Median (IQR)	p value
The day when the free air disappeared	2 (1)	6 (2)	<0.001
WBC	15.5 (7.85)	17.6 (7.10)	0.105

DISCUSSION

The incidence of postoperative nausea is 20-30% of patients (7). Of these patients, 80% consist of high-risk patients (7). The causes of postoperative vomiting consist of factors related to anesthesia, genetic factors and surgical complications (8). Surgical complications causing postoperative vomiting may be due to an emergency surgical intervention such as anastomotic leakage or intestinal perforation (9). When evaluating a patient with postoperative recurrent vomiting, an APR film is often reviewed along with other findings (9). Free air is usually seen on APR film on the first postoperative day and this is normal (9). The most important question about the abdominal free air seen in the postoperative APR film is the question, "When does this point to a dangerous situation?".

In limited studies conducted in this respect, while evaluating an existing postoperative problem, it has been pointed out that clinical, laboratory and radiological findings should be evaluated together (10-14). In this situation, the concept of time gains importance. There is no study in the literature concerning the importance and the duration of abdominal free air in APR in terms of early intervention time.

In a study conducted by Milone et al, 648 patients prospectively examined the time at which the free air was invisible in the postoperative APR (14). They found that 95% of patients lost 2-3 days (14). Sensitivity, specificity, positive predictive value and negative predictive value were found to be 70, 93, 33 and 98, respectively. Among 648 patients, 22 patients underwent urgent surgical intervention due to bowel perforation (14).

Tang et al., Lee et al., And Draper et al. Claim that 70% of free air disappeared on postoperative 3rd day (12,16,17).

Shatari et al., Stanley et al., and Schauer et al., claim that free air disappeared within 2 days after surgery in their study (11,18,19).

In a prospective study by Ein et al. in pediatric patients, they claimed that the free-air disappearance time was 3 days (2). They claimed that the length of the incision made during the operation, age, presence of drains, wound infection, affected this period (2).

In our study, we found that the age of the patients and the type of surgeon did not affect this period. None of the 101 patients had drains and no wound infection. None of the patients we evaluated in our study had undergone laparoscopy.

Some studies focused on how to detect more precisely, not the duration of postoperative free air. Earls et al. prospectively investigated postoperative free-air detection in adults, between computed tomography (CT) and lateral decubitus radiography, which were more sensitive (13). CT is more sensitive, suggesting that radiography is less sensitive to showing free air in obese patients (13). In a study by Seltzer et al, they claimed that even a small collection of intra-abdominal gas can be demonstrated with CT (20).

Because we do not find it to be ethically appropriate, we usually use APR to monitor patients so that they do not expose the patient to X-rays unless needed. We did not use CT to detect free air because of retrospective study.

In our study, we found that abdominal free air was lost in APR in 28.7% of patients in 1 day, 60.3% in 2 days, 7.9% in 3 days and 2.9% in 4 days after surgery. We had to reoperate all of the patients with continuing to see free air in APR for longer than 4 days. We had only 1 negative exploration.

In our study, the best example of this is the 9th patient from the RLG. This patient applied with abdominal pain and vomiting on 6th day after appendectomy. As a result of the review, there was an increase in WBC in the routine blood test. Free air was also seen in the APR film (Figure 4). Under normal conditions, this patient could be treated conservatively by considering intra-abdominal infection. However, since we observed free air on the APR film on the 6th postoperative day, we performed this emergency operation and found the intraoperative present perforation (Figure 5). And we repaired properly. This provided an important therapeutic advantage in the treatment of the patient.

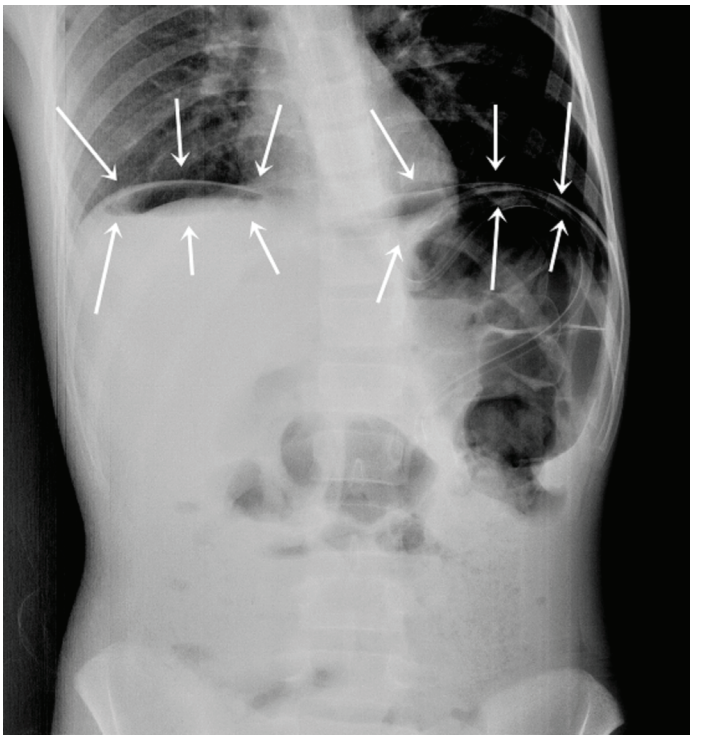

Figure 4. Abdominal plain radiograph image of a 13-year-old male patient. Free air (Arrows) continued to exist due to complications on the 6th day after appendectomy.

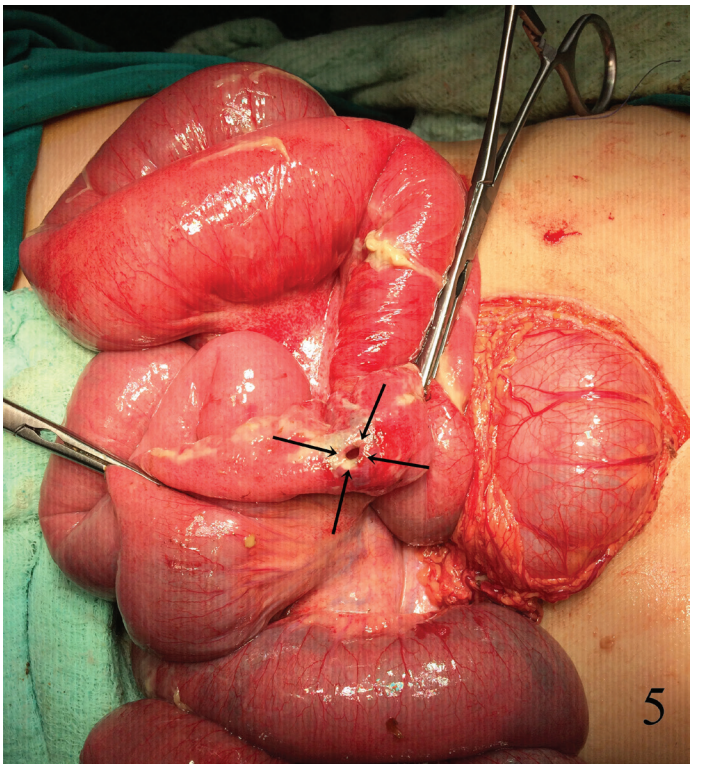

Figure 5. Intraoperative view of the same patient on the same day. Existing perforation in the ileum (arrows).

CONCLUSION

In our study, we found that free air in APR continued to be seen for 2 days after intra-abdominal surgery in children. However, the main point to note in this regard is how this information should be used. Because, if there

is no postoperative bleeding problem in a patient, it is claimed that conservative approach is appropriate for other problems (21). We claim that surgical intervention should be considered as a primary consideration if free air is present in the APR after 3rd postoperative day.

Competing interests: The authors declare that they have no competing interest.
Financial Disclosure: There are no financial supports
Ethical approval: The study began after the ethics committee's decision was approved by the ethics committee of scientific research and publications of Inonu University.

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