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Emphysema as a complication after transanal endoscopic microsurgery (TEM) (case report and review)

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ABSTRACT *BACKGROUND: transanal endoscopic microsurgery (TEM) is a safe method of local excision of benign tumor and early cancer. Emphysema is rare complication after transanal procedures, occurring only in 1.5%. There is no accepted approach for these patients.*

AIM: definition and treatment options of ectopic air after TEM.

MATERIALS AND METHODS: the search was performed using PubMed and e-Library database with the following keywords: «transanal», «emphysema», «microsurgery», «pneumoperitoneum». Data about patients, symptoms, complications, treatment and results were extracted and systematized.

RESULTS: the clinical emphysema rate after TEM was 0,02%. The most frequent symptoms is crepitation in lower abdomen and fever. Increase in C-reactive protein level and leukocytosis — important markers. The method of choice for diagnosis is computed tomography. Management of emphysema symptoms is possible with conservative methods.

CONCLUSION: the accumulation of experience in the treatment of emphysema after TEM will allow a unified approach of managing these patients.

KEYWORDS: transanal microsurgery, emphysema, rectal cancer

CONFLICT OF INTEREST: the authors declare no conflict of interest

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INTRODUCTION

Transanal endomicrosurgery (TEM) is a safe and effective method of local excision of benign tumors and early rectal cancer [2]. The overall complication rate after TEM does not exceed 4% [1]. The most common complications after TEM are postoperative bleeding (1.1%), leakage (1.5%), perirectal infection (0.1%), abscesses (0.6%) and fistulas (0.1%) [1]. Emphysema of cellular spaces is a rare complication of transanal procedures, occurring only in 1.5% of cases [5]. Due to the rarity of this complication after TEM, there is no generally accepted approach. At the same time, treatment can be either conservative (antibiotics), or surgical (stoma) [7]. Given the small number of publications devoted

to this problem, it seems appropriate to present our own experience in the treatment of this kind of complications with a systematic review of the available data in the periodic specialized literature. We have presented 2 cases of emphysema of cellular spaces after TEM in patients of our center who proceeded with different clinical picture and treatment approaches.

AIM

To work out the diagnostic algorithm and treatment options for patients with emphysema of cellular spaces after TEM.

MATERIALS AND METHODS

PubMed and e-Library databases were used to search for articles. The search was performed by keywords: “transanal”, “emphysema”, “microsurgery”, “pneumo peritoneum”. The articles included in the review included a description of surgical emphysema that occurred after TEM removal of a rectal tumor characterized by the presence of air in the subcutaneous tissue, abdominal cavity, retroperitoneal space, as well as mediastinum and any other ectopic site found according to instrumental diagnostics. Nine articles published between 2001 and 2017 were analyzed. The selected papers are descriptions of clinical cases and prospective studies. Data on 19 patients were obtained. In the selected articles, the data on the site, size and nature of neoplasms, the surgery details, the course of the postoperative period, diagnosis and treatment were selected. The data obtained were presented in the form of a table and combined with the data from two of our clinical cases.

CLINICAL CASE 1

Patient M., 69 years old, complained about the discharge of blood and mucus from the anus. According to anamnesis, confirmed by instrumental diagnostics (ultrasound of the rectum, pelvic MRI, colonoscopy), a tumor up to 5 cm in diameter along the anterior-lateral wall at a distance of 8 cm from the edge of the anus without signs of malignancy was detected.

Under spinal anesthesia, in the position of the patient on her back with the help of TEM, a full-thickness resection of a section of the rectal wall with a tumor was performed, the wound lesion was sutured.

The operative time was 90 minutes. According to the results of the pathomorphology, the tumor was represented by a tubular villous adenoma with low-grade epithelial dysplasia with clear resection margins (R0). On the next day after the surgery, the patient had a fever up to 38.6 °C; crepitation in the neck and head was

detected. Computed tomography showed in the rectum in the suture area, a lesion of up to 11 mm with emphysema of the subcutaneous tissue of the anterior abdominal wall, extending to the right armpit, in the mediastinum, suspicion of the presence of free gas in the abdominal cavity and pleural cavity on the right.

Blood tests revealed leukocytosis up to 17×10^9 g/l, an increase in C-reactive protein up to 196 mg/l. It was decided to perform an emergency re-operation. During laparoscopic revision, multiple small gas bubbles were observed in the preperitoneal tissue of the anterior abdominal wall, in the mesentery of the large and small intestine, there were no signs of peritonitis and perforation of the intestinal wall. A loop sigmoidostomy was performed, cefazolin 1 g was prescribed for 6 days. On the 7th day, the patient underwent CT of the chest, abdominal cavity and pelvis, positive changes were noted. The

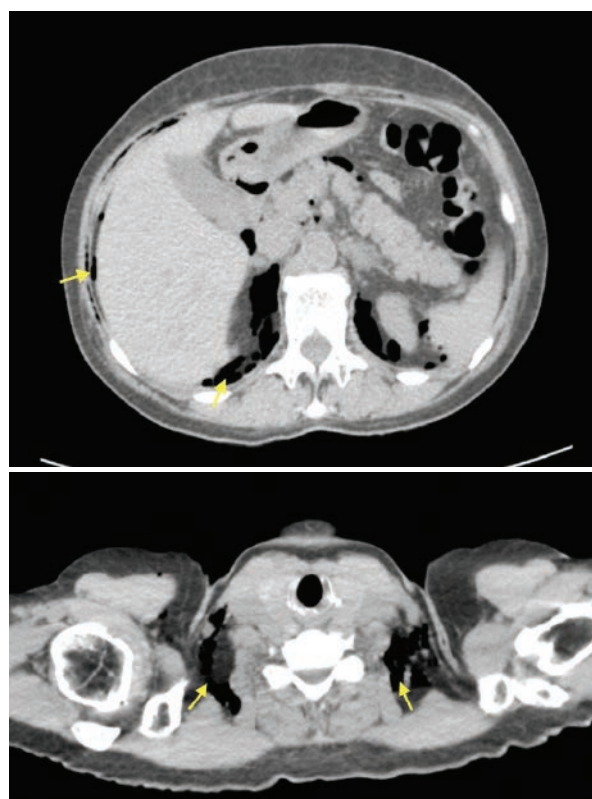


Figure 1. CT of patient M. Emphysema is localized in the subcutaneous tissue of the anterior abdominal wall, spreading to the right armpit, mediastinum, cellular spaces of the neck

further postoperative period was without complications. The patient was discharged on the 14th day. Three months after TEM, no defects were found in the area of the postoperative scar during CT of the rectum with contrast, closure of the sigmoidoma was done.

CLINICAL CASE 2

Patient O., 64 years old, was admitted to the unit with two neoplasms: on the posterior-right semicircle at a distance of 8 cm from the edge of the anus to 3 cm in diameter and on the posterior-left semicircle 5 cm from the edge of the anus to 6 cm in diameter. Under combined anesthesia, in the patient's position on the right side with the help of TEM, a full-wall resection of the intestinal wall with a tumor of 8 cm was performed. The defect of the intestinal wall was sutured (V-lock). Similarly, in the patient's position on the left side, a full-wall resection of the intestinal wall with a 5-cm tumor was performed with suturing of the defect. The operative time was 90 minutes. During pathomorphology, an 8-cm tumor was represented by a high-grade villous adenoma, a 5-cm tumor was a low-grade villous adenoma, the resection margins were intact — R0. On the next day after the surgery, the patient's temperature increased to 38.4 °C, crepitation in the lower abdomen was detected. During a digital rectal examination in the projection of the suture along the right semicircle, fluid collection was found, and therefore the suture was cut off. CT scans of the chest, abdominal cavity, and pelvis with contrast of the rectum revealed the specified lesion of the rectal wall, signs of emphysema located mainly in the retroperitoneal space, cellular spaces of the abdominal cavity and pelvic cavity, subcutaneously, in the chest and mediastinum.

In blood tests, leukocytosis was up to 18×10^9 g/L, C-reactive protein was 150 mg/L. The patient was prescribed meropenem 1 g IV drip 3 times a day for 4 days. In the postoperative period, the patient also had reflex urinary retention, and electrical stimulation of the

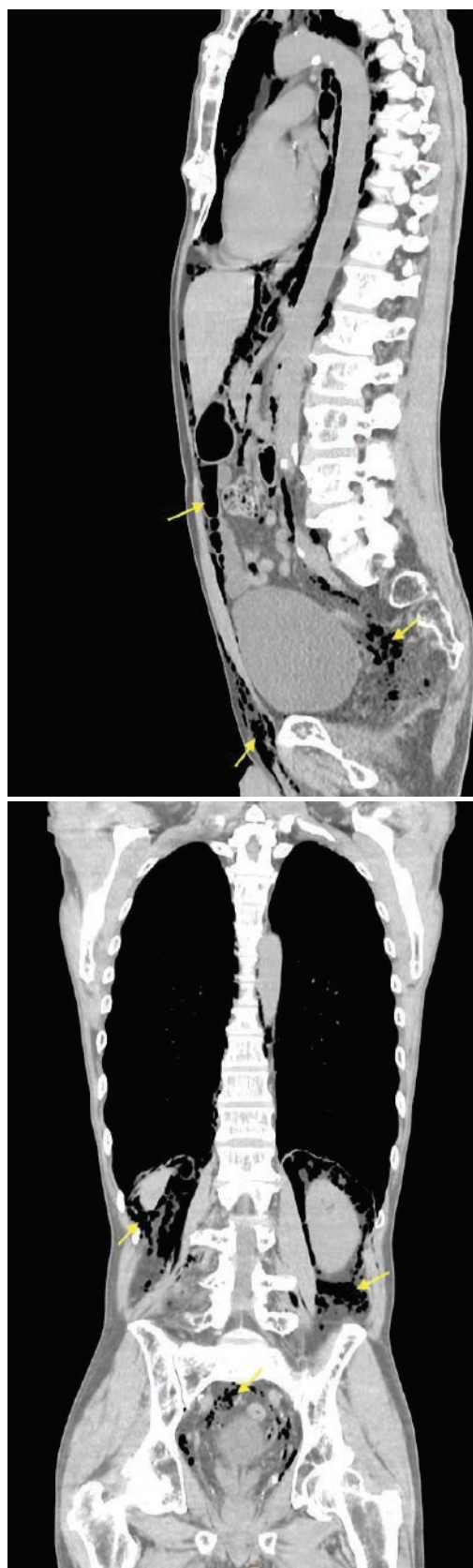


Figure 2. Computed tomogram of patient O. The arrows indicate the accumulation of air in the fiber of the anterior abdominal wall, pelvis, retroperitoneal space

Table 1. *Characteristics of neoplasms*

Author	Number of cases	Age	Gender	Localization of the lower pole of the tumor (cm)	Tumorsize (cm)	Semicircle	Histological conclusion	Suturing of a defect in the intestinal wall
Simkens, 2014	1	60	F	9	5	Anterior	Adenocarcinoma T1	Yes
Chandra, 2014	1	80	M	8	5	Posterior	Adenoma	no data
Franken, 2012	2	66	M	5	5.5	no data	Adenoma	no data
		65	M	3	3.5	Anterior	Adenocarcinoma T2	no data
Bignell, 2009	4	no data	no data	no data	no data	no data	Adenoma	Yes
Cantos, 2009	1	71	M	4	no data	Lateral	Adenoma	Yes
Kerr, 2001	1	81	M	no data	no data	no data	Adenoma	no data
Lee, 2017	3	no data	no data	no data	no data	no data	Adenoma	no data
		no data	no data	no data	no data	no data	Adenoma	no data
		no data	no data	no data	no data	no data	Adenoma	no data
Martins, 2017	1	38	M	4	no data	Posterior	Adenoma Tis	Yes
Restivo, 2016	5	no data	no data	no data	no data	no data	Adenoma	Yes
Khomyakov, 2022	1	69	F	8	5	Anterior-lateral	Adenoma	Yes
Khomyakov, 2022	1	64	M	8	3	Posterior-destra	Adenoma	Yes
				5	6	posterior-sinistra	Adenoma	Yes

bladder with 0.05% neostigminamethyl sulfate solution was prescribed for its relief. Against the background of the treatment, the patient showed positive dynamics on the 3rd day: normal temperature and a decrease in the level of C-reactive protein to 47 mg/l. The patient was discharged on the 9th day.

DISCUSSION

Emphysema of cellular spaces is a rare condition after TEM, the probability of occurrence of which is determined only by the number of surgeries performed [8]. It is important to emphasize that out of 1,029 surgeries performed in the Center, this kind of complications occurred in only 2

patients, which was 0.02%. We associate the occurrence of this condition with the creation of a carboxyrectum — insufflation of carbon dioxide into the rectum under pressure to provide an overview during the TEM process. Ectopia of air from the rectum is possible through a lesion in the intestinal wall, or in its absence by diffusion through loose connective tissue due to increased pressure in the rectum [13]. Carbon dioxide can migrate into the subcutaneous tissue of the anterior abdominal wall, into the retroperitoneal cellular space, then through the diaphragmatic opening into the mediastinum, cellular spaces of the neck and even the head [6]. In a clinical case described by Liang, H. in 2012, local excision of a rectal tumor was

Table 2. Features of the course of the postoperative period

	Time of appearance	Localization of emphysema	Diagnostics	C-RP (mg/L)	Leucocyti (10 ⁹ g/l)	A/B therapy	Hospital stay (days)	Duration of the procedure (min.)	Patient's position	Stoma	Insufflation ((mm Hg))
Simkens, 2014	On the surgery day	Face, neck, chest, retroperitoneal space	CT	160	11.0	<i>Metronidazole</i> 500, <i>Cefuroxime</i> 1500 — 3 times a day for 3 days	10	115	On the abdomen	No	12
Chandra, 2014	During TEM	Anterior and lateral walls of the abdomen, scrotum, chest, neck	CT	no data	no data	<i>Metronidazole</i>	11	no data	On the back	No	12–18
Franken, 2012	On the 2 nd day	Chest, retroperitoneal space	RG Laparoscopy	148	18	<i>Ceftriaxone</i> 2g 1 time a day, <i>Metronidazole</i> 500 mg 3 times a day	5	no data	no data	No	15
		Retroperitoneal space	RG	261	20,5	<i>Ceftriaxone</i> 2g 1 time a day, <i>Metronidazole</i> 500 mg 3 times a day	4	no data	no data	No	
Bignell, 2009	no data	Retroperitoneal space, chest, neck	CT	no data	no data	no data	no data	no data	no data	No	12–18
Cantos, 2009	On the 1 st day	Retroperitoneal space	CT	no data	no data	no data	10	no data	no data	No	no data
Kerr, 2001	no data	Subcutaneous tissue of the chest, lower back, groin, left thigh	RG	no data	no data	Yes		no data	On the back	No	no data
Lee, 2017	no data	Subcutaneous tissue, scrotum	no data	no data	no data	no data	no data	no data	no data	No	no data
Martins, 2017	no data	Retroperitoneal space	CT	250	10,2	<i>Piperacillin + Tazobactam</i>	11	no data	no data	Yes	no data
Restivo, 2016	no data	Retroperitoneal space	no data	no data	no data	Yes		no data	no data	3 — No 2 — Yes	no data
Хомяков, 2022 Khomyakov, 2022	On the 2 nd day	Retroperitoneal space, retroperitoneal space, mediastinum, neck and head fiber	CT	196	17	<i>Meropenem</i> 1 g i/v drip 3 times a day for 6 days	14	90	On the back	Yes	12
Хомяков, 2022 Khomyakov, 2022	On the 2 nd day	Retroperitoneal space, pelvis, subcutaneously, chest, mediastinum	CT	190	18,9	<i>Meropenem</i> 1 g i/v drip 3 times a day for 4 days	9	90	On the right side	No	12
									On the left side		

complicated by emphysema at the base of the skull [14]. Taking into account the connection of cellular spaces along the abdomen, chest and neck, the air penetrating through the lesion in the pelvic region can be localized in any cellular space. At the same time, there is evidence that insufflation of carbon dioxide into the rectum should be the prevention of clinically significant emphysema, since carbon dioxide, unlike atmospheric air, is absorbed faster by tissues [15,16]. As part of a systematic literature

review, we identified 9 articles, 6 of which are descriptions of clinical cases, 3 are prospective studies, a total of 19 patients are described in the selected articles. With the inclusion of the 2 clinical cases described by us, 21 patients were examined (Table 1).

The average age of the patients included in the analysis was 66.0 ± 6.8 years. In 20 cases, neoplasms were represented by benign adenomas, there were also two adenocarcinomas, one of which was classified as T2. Location of the

lower pole of the tumor from the edge of the anus averaged 6.0 ± 2.2 cm, the size of the neoplasm was 4.7 ± 1.1 cm. 14 patients underwent suturing of a lesion in the intestinal wall. The pressure in the rectum during the surgery varied from 12 to 18 mmHg. In the postoperative period, the main symptoms of the complication were fever, abdominal pain, weakness, determination of crepitation during palpation of the abdomen (Table 2). In most cases, emphysema of cellular spaces was localized in the retroperitoneal space, the anterior abdominal wall. In 7 patients, air was detected in the mediastinum, in 5 — in the neck tissue. The temperature after surgery in the studied patients reached febrile figures of 38.6°C . The average level of C-reactive protein was 200.8 ± 43.9 mg/L, leukocytosis was 16.9 ± 1.4 mg/L.

Among the analyzed group of patients, 3 cases of intraoperative hypercapnia and respiratory insufficiency were observed, followed by observation of patients in the intensive care unit, 1 case of sepsis, 1 patient had reflex urinary retention, 1 patient had presacral abscess. The most common complaints and clinical signs of emphysema appeared a day after surgery. To verify the diagnosis, three patients underwent radiography (RG), 10 — computed tomography (CT), 1 patient underwent sigmoidoscopy, 1 — diagnostic laparoscopy. The stoma was formed in 4 patients. Clinical manifestations of emphysema on the background of ongoing treatment disappeared on average on the 6th day (± 3.8). The average period of hospitalization was 9 days (± 3.6).

The results obtained by us largely correspond to the systematic literature review by Balla, A. et al. in 2018 [6], which indicates the reproducibility of the data obtained.

The intersection of literary sources indicates the completeness of the search and the full coverage of the analyzed literature. In addition, the results of this review are limited to the inclusion of cases of emphysema that occurred after transanal excision of the tumor,

the use of alternative platforms and endoscopic interventions, which compromises the results of this work. At the same time, the mechanism of air ectopia during procedures during which gas insufflation is not performed is unclear and these cases of emphysema should be studied separately. The main limitation of our study is a small sample of patients. Therefore, it is not possible to identify statistical correlations between gender, age, height, localization and histological structure of the neoplasm, duration of the procedure, the patient's position on the operating table, pressure during insufflation and the analyzed complication.

CONCLUSION

The accumulation of experience in the treatment of emphysema of cellular spaces after TEM will allow us to form a unified approach to the tactics of managing these patients. However, it can already be concluded that this complication is quite rare and occurs according to our data only in 0.02% of cases. The main symptoms of this undesirable event are crepitation in the lower abdomen and temperature.

CRP and leukocytosis are reliable markers of the intensity of inflammation. Computed tomography is the method of choice for diagnosing this complication. In most cases, it is possible to achieve relief of emphysema symptoms by conservative methods, and the issue of stoma formation should be resolved individually.

AUTHORS CONTRIBUTION

Concept and design of the study: *Evgeniy A. Khomyakov, Mikhail V. Kapitanov*

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