© Med Sci Monit, 2010; 16(3): CR116-123
PMID: 20190681

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Clinical Research

Received: 2009.10.19
Accepted: 2009.11.24
Published: 2010.03.01

Local infection after percutaneous endoscopic gastrostomy in ENT tumor patients: Evaluation of the influence of the abdominal thickness and other parameters

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Data Interpretation
E Manuscript Preparation
F Literature Search
G Funds Collection

Konstantinos Mantsopoulos[1ABCDEF], Johannes Zenk[1ABDEG], Peter C. Konturek[2EF], Heinrich Iro[1AEG]

[1] Department of Otolaryngology-Head and Neck Surgery, University of Erlangen, Erlangen, Germany
[2] Department of Gastroenterology, University of Erlangen, Erlangen, Germany

Source of support: Departmental sources

Summary

Background: The percutaneous endoscopic gastrostomy is the method of choice in patients with advanced tumours of the upper aerodigestive tract, after surgery or before radiochemotherapy, for the establishment of a sufficient nutrition therapy. The aim of this observation study was to investigate, to what extent the abdominal thickness and other factors have an influence on the rate of peristomal infection after a percutaneous endoscopic gastrostomy.

Material/Methods: Percutaneous endoscopic gastrostomy was performed on 135 patients in 2008–2009. 101 patients were fully evaluated and included in the study. The different layers of the abdominal wall were measured with B-scan ultrasound (7.5 MHz). Furthermore, potential patient-related risk factors (gender, age, nutritional status (Body Mass Index, Nutritional Risk Score, total serum protein, the tumor stage and presence of Diabetes mellitus) and their effect on the occurrence of a wound infection were evaluated.

Results: A peristomal infection was documented in 21.8% of the patients (22/101). Serious complications were not observed. There were no statistically significant predictors for the occurrence of a peristomal infection detected.

Conclusions: The hypothesis that the abdominal wall thickness has an influence on the rate of the peristomal infection is not confirmed. This is of clinical relevance in patients, who are still in a relatively good general and nutritional condition before radiochemotherapy. The intraoperative ultrasonography can be used to guide catheter insertion while providing a safe adjunct to confirm proper tube placement and minimizing the risk of inadvertently entering adjacent intraabdominal organs.

key words: **percutaneous endoscopic gastrostomy • head and neck cancer • dysphagia**

Full-text PDF: http://www.medscimonit.com/abstract/index/idArt/878460

Word count: 2500
Tables: 5
Figures: 10
References: 34

Author's address: Konstantinos Mantsopoulos, Department of Otolaryngology-Head and Neck Surgery, Unsiversity of Erlangen, Waldstrasse 1, 91054 Erlangen, Germany, e-mail: konstantinos.mantsopoulos@uk-erlangen.de

Background

Since the introduction of the method in the early 1980s [1], several modifications have been made and percutaneous endoscopic gastrostomy has become the most popular method for providing long-term enteral nutritional support. Early and consistent enteral nutrition via percutaneous endoscopic gastrostomy (PEG) helps to stabilize the state of nutrition of patients with head and neck cancer, and is recommended, especially for patients already suffering from malnutrition before starting an aggressive multimodal tumor therapy (oncological surgery, reconstructive surgery, radiochemotherapy). Even with other medical and neurological disorders is the percutaneous endoscopic gastrostomy nowadays the method of choice in maintaining a sufficient nutritional status (Table 1).

The percutaneous endoscopic gastrostomy is contraindicated in severe coagulation disorders, lack of intraoperative diaphanoscopy, ileus, peritonitis, ascites, peritonitis carcinomatosa, severe psychosis, anorexia nervosa and by patients with a significantly reduced life expectancy.

Prospective studies have proved the effectiveness and safety of the procedure. The complications of percutaneous endoscopic gastrostomy may be slightly (wound infection, wound leakage, bleeding around the PEG tube, skin or gastric ulceration, Pneumoperitoneum, temporary ileus, gastric obstruction) or severe (necrotic fasciitis, perforation of the oesophagus, gastric perforation, colocutaneus fistula, "buried bumper" syndrome, accidental PEG removal) [2]. The complication rate after percutaneous endoscopic gastrostomy, as shown by various study results, depends on both the definition of complications as well as the examined patient group. In the series of Taylor et al. the rate of "minor" complications (wound infection, wound leakage and PEG-dislocation) was 70% [3].In the study of Larson et al., 13% of patients had minor and 3% severe complications [4]. In the study of Lee et al., 22 (16.4%) of 134 patients developed complications. In this patient series, the wound infection represents the most frequent complication (19 patients, 14.2%) [5]. In a study by Ahmad et al. 18% of the patients developed a wound infection (without perioperative antibiotic administration) [6].

The background to our study was the clinical observation that the rate of local complications after percutaneous endoscopic gastrostomy is higher in obese patients or in patients with higher abdominal wall thickness. Clinical and epidemiological data show that the postoperative infection rates are significantly higher in obese patients [7–9]. It is known that the adipose tissue is relatively poorly supplied with blood vessels and therefore poorly accessed by the immune system. Hypothetically could be assumed that in patients with thicker abdominal wall (and therefore a longer PEG channel) more pressure is exerted on the tissue between the outer and inner bumper. As a result, the blood circulation of the subcutaneous layer would deteriorate further due to vascular compression and thus the risk of wound infection would increase. However, it is also possible that wound healing is also impaired in patients with lower body mass index or lower abdominal thickness because of malnutrition. Thus, another hypothesis could be that patients with thin abdominal wall have also an impaired wound healing – provided that the Body Mass Index correlates with the sonografic measured abdominal wall thickness. So far, the influence of the (sonographic measured) thickness of the abdominal wall on wound infection after PEG has not yet been systematically reviewed in the literature. Furthermore, potential patient-related risk factors (gender, age, nutritional status (Body Mass Index, Nutritional Risk Score, total protein in serum), the tumor stage and presence of Diabetes mellitus) and their effect on the occurrence of a peristomal wound infection were evaluated.

Material and Methods

In the period from 01.03.2008 to 02.03.2009 a percutaneous endoscopic gastrostomy was performed in 135 patients in

Table 1. Indications for percutaneous endoscopic gastrostomy [2].

Oncology	Stenotic ENT tumors, tumors of the upper gastrointestinal tract Radiation/ Chemotherapy with expected weight decrease Inadequate oral food intake
Neurology	Potentially reversible und irreversible swallowing disorders Brain tumors, apallic syndrome, bulbar paralysis Multiple sclerosis, amyotrophic lateral sclerosis
Otolaryngology, Head and Neck Surgery	Tumors with swallowing disorders and weight loss Facial und Head trauma Reconstructive surgery
Gastroenterology	Tumors of the upper gastrointestinal tract Short bowel syndrome Morbus Crohn Serious resorption disorders Decompression by gastrointestinal obstruction
Internal Medicine	„Wasting" by AIDS Prolonged coma by non infaust prognosis Palliative gastric decompression by chronic gastrointestinal stenosis

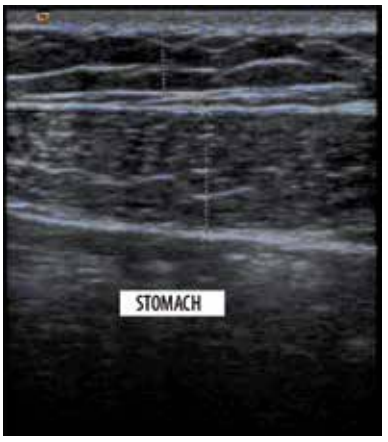

Figure 1. Measurement of the abdominal wall thickness with sonography: The thickness of the total abdominal wall, the subcutaneous and the muscle layer can easily be measured with the 5.0 MHz ultrasound probe (here: subcutaneous layer =0.69 cm and muscle layer =1.34 cm).

our clinic. Included in the observational study were patients suffering from dysphagia because of a tumor in the head and neck area, or previous to radiochemotherapy. Patients were excluded from the study if one or more of the following criteria were present: sonografic measurement of the thickness of the abdominal wall due to scarring and previous surgery not possible, perioperative administration of antibiotics, corticosteroid or non-steroidal anti-inflammatory drugs (NSAIDs). Routine antibiotic prophylaxis is currently not applied in uncomplicated PEG procedures in our department.

In order to estimate the nutritional status, the "Nutritional Risk Screening" (NRS-2002) [10] and the "Body Mass Index (BMI = weight (kg)/height $(m)^2$) were recorded in the preoperative phase in all patients of our study. Another nutritional status parameter was the total protein in blood serum (normal range: 60–80 g/L).

B-scan ultrasonography

Before the oesophagogastroscopy, the first measurement of the abdominal wall thickness, the subcutaneous layer and muscle layer was made at the injection site with B-scan ultrasonography. As shown on Figure 1, it can be easily distinguished between the subcutaneous tissue and muscle layer of the abdominal wall with B-scan ultrasonography (Figure 1). In the typical injection site, the muscle layer of the abdominal wall consists of the anterior wall of the rectus sheath (aponeurosis of M. obliquus externus abdominis and the anterior portion of the aponeurosis of M. obliquus internus abdominis), the M. rectus abdominis, the posterior wall of the rectus sheath (posterior portion of the aponeurosis of M. obliquus internus abdominis and aponeurosis of the M. transversus abdominis) and the Fascia transversalis. After positive diaphanoscopy the second measurement of the above parameters was performed using B-scan ultrasonography. The oesophagogastroscopy was performed in the pull-through technique by the same surgeon. In all patients of the study the same tube size (Freka® PEG Set gastral CH 9 Fresenius Kabi Deutschland GmbH) was used.

Table 2. Classification of the patients according to the categorical variables of the study.

Variable	Value	Number of patients	%
Gender	Male	87	86.1
	Female	14	13.9
Age	≤60	57	56.4
	>60	44	43.6
Body Mass Index	Underweighted/normal weighed (≤24.99)	51	50.5
	Overweighed (>25)	50	49.5
Age-adjusted NRS	≤3	34	33.7
	>3	67	66.3
Tumor stadium (UICC)	Primary stadium (I, II)	18	17.8
	Advanced stadium (> II)	83	82.2
Diabetes mellitus	Yes	17	16.8
	No	84	83.2

The sonography of the abdominal wall was performed by the same investigator using the same ultrasound device (SonoSite TITAN®, 7.5 MHz).

Additional parameters

Moreover, the following parameters were recorded for all patients of our study: gender, age, tumor stadium and the presence of diabetes mellitus. In the postoperative phase, the Jain-score for all patients was documented [10].

The tumor staging was performed according to the UICC Classification (International Union Against Cancer, 6th edition, 2002), collecting the information from the clinical examination, imaging (ultrasonography, head and neck computer tomography) and endoscopy in all patients of the study.

Statistical analysis

The statistical analysis of our data and the construction of the corresponding diagrams were made with the statistical program SPSS v. 16.0 for Windows. The significance level was set at 5%. The patients were classified in two groups according to the presence of peristomal infection. The comparison of the means for the total abdominal wall thickness, muscle layer and subcutaneous layer thickness before and after the insufflation of the stomach and the total protein between patients with and without peristomal infection was performed using the T-test for independent samples. Furthermore, the patients were classified in 2 groups according to the values of the categorical independent variables of the study (gender, age, body mass index, age-adjusted Nutritional Risk Score, tumor stadium, presence of diabetes mellitus) (Table 2). The evaluation of the prognostic value of each of the categorical independent variables of

Table 3. Comparison of the means for the total abdominal wall thickness, the subcutaneous layer thickness and the muscle layer thickness before oesophagogastroscopy and after stomach insufflation for the patient groups with and without peristomal wound infection (T-Test for independent samples).

Continuous variables	T	Sig. (2-sided)
Total abdominal wall thickness before oesophagogastroscopy	–.287	.776
Subcutaneous layer thickness before oesophagogastroscopy	–.503	.616
Muscle layer thickness before oesophagogastroscopy	–1.297	.207
Total abdominal wall thickness after stomach insufflation	–.390	.698
Subcutaneous layer thickness after stomach insufflation	–.398	.691
Muscle layer thickness after stomach insufflation	–.825	.411
Total serum protein	1.011	.315

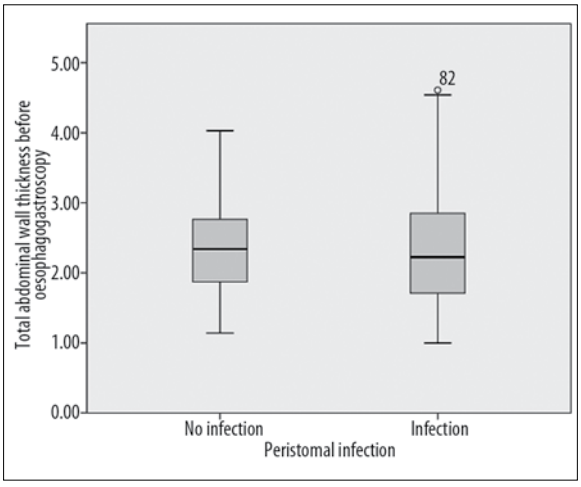

Figure 2. Graphic display of the comparison of the means of the total abdominal wall thickness before oesophagogastroscopy for the patient groups with (n=22, 21.8%) and without (n=79, 78.2%) peristomal infection (T=–0.287, p=0.776).

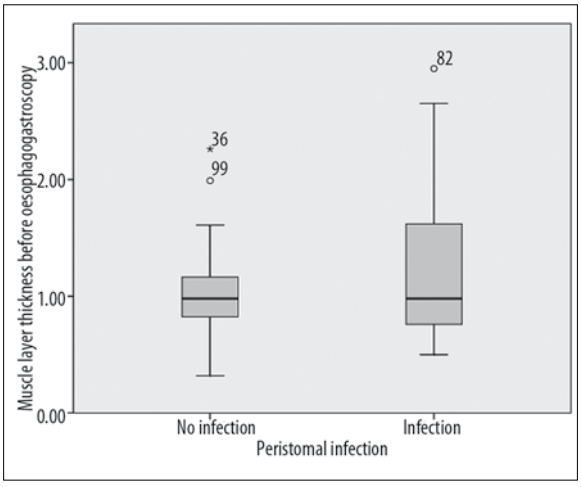

Figure 4. Graphic display of the comparison of the means of the muscle layer thickness before oesophagogastroscopy for the patient groups with (n=22, 21.8%) and without (n=79, 78.2%) peristomal infection (T=–1.297, p=.207).

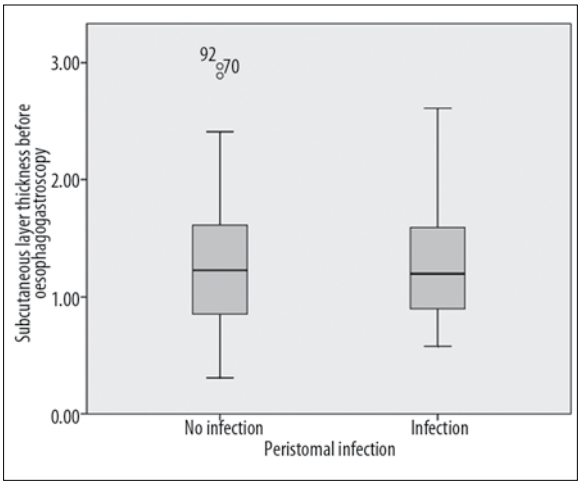

Figure 3. Graphic display of the comparison of the means of the subcutaneous layer thickness before oesophagogastroscopy for the patient groups with (n=22, 21.8%) and without (n=79, 78.2%) peristomal infection (T=–0.503, p=0.616).

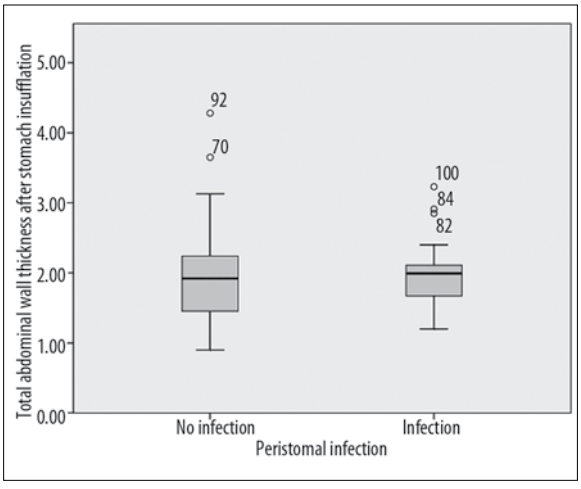

Figure 5. Graphic display of the comparison of the means of the total abdominal wall thickness after stomach insufflation for the patient groups with (n=22, 21.8%) and without (n=79, 78.2%) peristomal infection (T=–0.39, p=0.698).

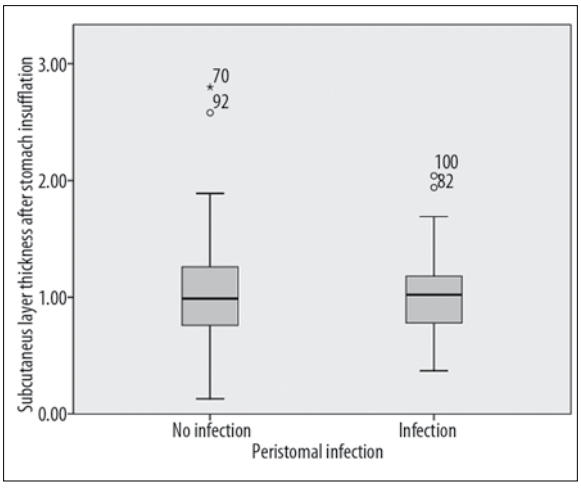

Figure 6. Graphic display of the comparison of the means of the subcutaneous layer thickness after stomach insufflation for the patient groups with (n=22, 21.8%) and without (n=79, 78.2%) peristomal infection (T=–0.398, p=0.691).

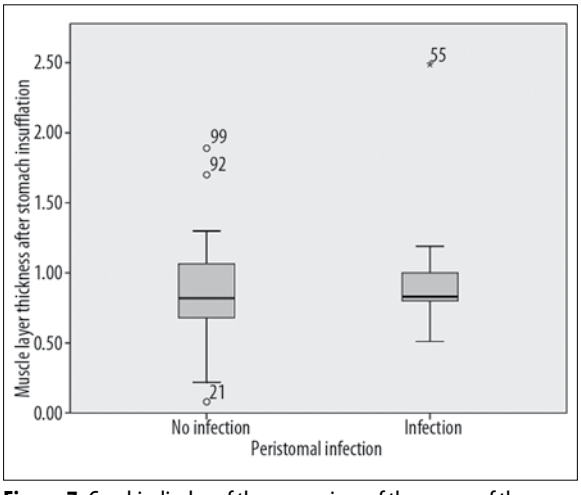

Figure 7. Graphic display of the comparison of the means of the muscle layer thickness after stomach insufflation for the patient groups with (n=22, 21.8%) and without (n=79, 78.2%) peristomal infection (T=–0.825, p=0.411).

the study ("univariate data analysis") has been performed using the Chi-square test (χ^2). The selection of the statistical models was based on the dichotomous nature of the dependent variable of the study ("presence of peristomal infection").

Results

Between March 2008 and March 2009, percutaneous endoscopic gastrostomy was performed on 135 patients in the Department of Otorhinolaryngology, Head and Neck Surgery, University of Erlangen. 101 patients were included in the study and fully evaluated (87 male, 14 female; mean age 61.3 years). The PEG tube was inserted by the Ponsky-Gauderer (pull-through) technique. The placement of the gastrostomy tube was successful in all cases. Demographic and clinical factors were analysed to detect variables associated with the development of wound infection after PEG

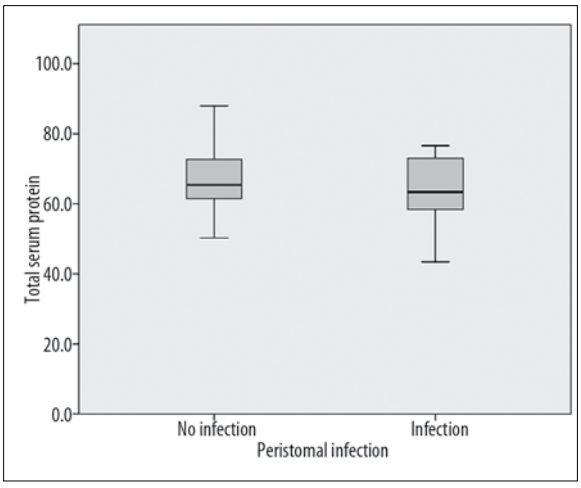

Figure 8. Graphic display of the comparison of the means of the total serum protein for the patient groups with (n=22, 21.8%) and without (n=79, 78.2%) peristomal infection (T=1.011, p=0.315).

Table 4. Univariate Analysis: Correlation of the categorical variables of the study with the probability of a peristomal infection (x^2).

Categorical variables	Continuity correction	P value
Gender	.147	.701
Age	.868	.352
Body Mass Index	0.000	1.000
Age-adjusted NRS	.543	.337
Tumor stadium (UICC)	.325	.127
Diabetes mellitus	.248	.072

procedures. 6 patients were underweight (5.9%), 45 had normal weight (44.6%) and 50 were overweight (49.5%). 7 patients were stage I (6.9%), 11 patients stage II (10.9%), 15 stage III (14.9%), 49 stage IVA (48.5%), 18 stage IVB (17.8%) and 1 patient stage IVC (1%). 22 patients (21.8%) developed a peristomal wound infection.

The T-Test showed no statistically significant difference between patients with and without peristomal infection with respect to the mean values of the total abdominal wall thickness, muscle layer and the subcutaneous layer thickness before and after the insufflation of the stomach and the total serum protein (Table 3, Figures 2–8). The univariate analysis gave no evidence for a statistically significant relationship between the categorical variables of the study (gender, age, body mass index, age-adjusted Nutritional Risk Score, tumor stage, presence of diabetes mellitus) and the occurrence of peristomal infection (Table 4). The statistical analysis of our data showed a moderate to strong (r>0.3) positive statistically significant correlation of the investigated anthropometric parameters of our study with the Body Mass Index (Table 5, Figures 9,10).

Table 5. Correlation of the total abdominal wall thickness before oesophagogastroscopy and after stomach insufflation with the Body Mass Index (bivariate Correlation nach Pearson).

Variables	Correlation (r) with BMI (Pearson)	Significance
Total abdominal wall thickness before oesophagogastroscopy	.466	.000
Total abdominal wall thickness after stomach insufflation	.526	.000

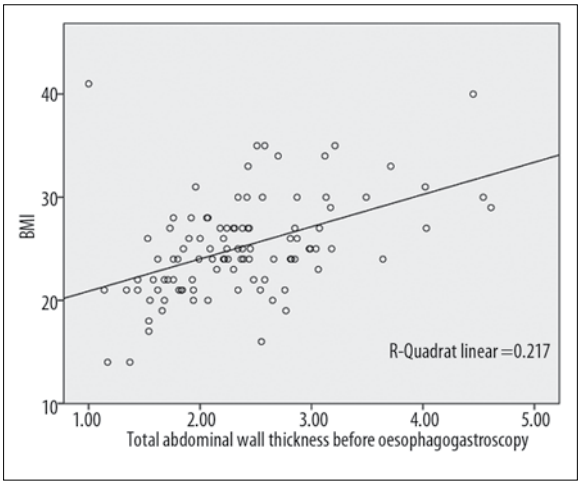

Figure 9. Graphic display of the correlation of the total abdominal wall thickness before oesophagogastroscopy with the Body Mass Index (r=0.466, p=0.000).

Discussion

Since its first description by Gauderer and Ponsky in 1980 [1], percutaneous endoscopic gastrostomy has become a convenient means for long-term enteral nutrition. A large proportion of patients with advanced head and neck cancer are at the time of initial diagnosis already in a poor nutritional status because of the prolonged dysphagia. In this way, the morbidity of the underlying tumor disease can be positively influenced [12,13]. Additionally, drugs such as antibiotics and analgesics could be administered via PEG, leading to an improvement of the quality of life in this patient group.

While the technique of the method largely matured, the need for perioperative systemic antibiotic prophylaxis in percutaneous endoscopic gastrostomy in the literature is still controversial. The recommendations for antibiotic prophylaxis on the type of antibiotic or the duration of the perioperative treatment are still under review. In the study by Lee et al. the perioperative antibiotic prophylaxis could not be statistically significantly associated with the rate of peristomal infection [5]. Jonas et al. considered a perioperative administration of antibiotics for not necessary [14]. On the contrary, Ahmad et al. [6] and Preclik et al. [15] recommend a routine antibiotic prophylaxis by percutaneous endoscopic

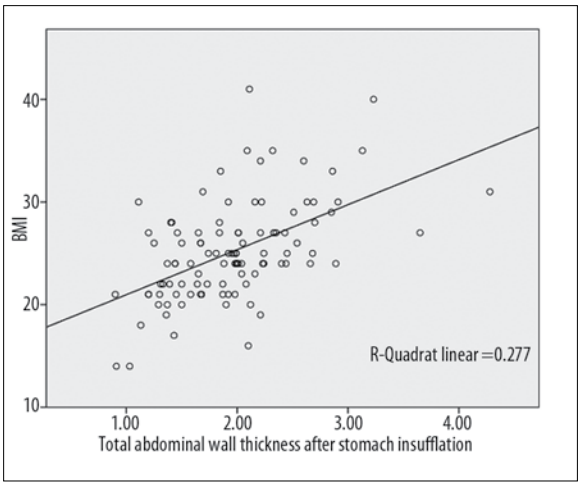

Figure 10. Graphic display of the correlation of the total abdominal wall thickness after stomach insufflation with the Body Mass Index (r=0.526, p=0.000).

gastrostomy. In a metaanalysis of 10 relevant studies, Lipp and Lusardi concluded that the administration of systemic prophylactic antibiotics by PEG reduces the rate of local infection [16]. In our sample, antibiotic prophylaxis was not administered. The significantly lower infection rate in patients treated with antibiotics in similar studies in comparison with our results leads to the hypothesis that perioperative antibiotic prophylaxis would be reasonable for most multimorbid patients.

The cancer patients are exposed to a high risk of peristomal infection due to age, reduced nutritional status due to the tumor und immunosuppression because of the underlying disease (malignancy, diabetes mellitus) [5]. In the study by Lee et al., 29% of the patients with diabetes mellitus developed an infection after PEG (p=0.015) [5]. Abnormalities in granulocyte adherence, chemotaxis, phagocytosis, and microbicidal function in patients with poorly controlled diabetes mellitus have been demonstrated [17]. In addition, diabetes mellitus can cause significant changes in stomach function, which may exert an effect on the development of wound infection after PEG [18].

A peristomal wound infection was identified in 22 of 101 patients of our study (21.8%). The literature data on the incidence of peristomal infection varies from 2 to 60% [4,19–23]. The rate of wound infection may differ significantly depending on the definition of the term "peristomal wound infection" used in studies, the study type or the presence of an antibiotic prophylaxis. The head and neck cancer patients sometimes suffer from obstruction of the upper aerodigestive tract, resulting in a significant oral and hypopharyngeal bacterial overgrowth. When the pull technique is used, these organisms can adhere to the tube and are transported to the PEG surgical site. This may explain the high rate of PEG-site infections in head and neck cancer patients who undergo the pull-through technique [24].

Severe complications were not documented in our series. This could be explained by the fact that in case of lack or inadequate intraoperative diaphanoscopy the procedure was in our clinic abandoned. Moreover, ultrasound imaging

at the time of endoscopy allowed a rapid localization of an appropriate area for PEG placement, thereby minimizing the risk of inadvertently entering adjacent abdominal organs. It is easily understood that the intraoperative sonography can be used to guide catheter insertion while providing a safe and quick adjunct to confirm proper G-tube placement [25–29].

The statistical analysis of our data did not show a statistically significant relationship between gender, age, nutritional status (Body Mass Index, Nutritional Risk Score), tumor stage, presence of diabetes mellitus and the occurrence of a wound peristomalen evidence. Also, no statistically significant difference was found in the mean values of the total abdominal wall thickness, muscle layer and the subcutaneous layer thickness before and after the insufflation of the stomach and the total serum protein between the groups of patients with and without local infection. However, this could be possibly attributed to the size of our study sample (n=101). On the contrary, the analysis showed a moderate to strong (r>0.3) positive statistically significant correlation of the investigated anthropometric parameters (total abdominal wall thickness before oesophagogastroscopy and after positive diaphanoscopy) with Body Mass Index. In their study, Milad and Terkildsen found a statistically significant correlation between Body Mass Index and abdominal wall thickness [30]. Our results agree with the existing literature and thus the total abdominal wall thickness could be possibly helpful to estimate the Body Mass Index and thus the nutritional status of a patient.

According to the literature, the rate of local infection after PEG tube placement depends among others on the clinical institution performing the procedure, the experience of the endoscopist and the size of PEG tubes used [23]. The role of the personal factor (competence of the physician performing the bedside ultrasound examination, efficiency of the surgeon) was counterbalanced in our study by the fact that the same examiner performed the bedside ultrasound examination and the gastrostomy. Equally important in this sense was the use of the same type and size of PEG tubes in all patients of our study with the pull through technique.

To avoid the development of local infectious complications after PEG, except the perioperative systemic antibiotic prophylaxis, some other methods have been also described (reducing oropharyngeal contamination by gargling with an antibiotic solution [31], performing an adequate skin incision and avoiding an excessive traction on the internal bumper [32], applying a povidone-iodine ointment to the stoma [33]).

Conclusions

Our hypotheses were not confirmed by the results of the statistical analysis of our study. This is of clinical relevance, as the percutaneous endoscopic gastrostomy does not seem to be connected with an increased risk of local infection in ENT tumor patients, which are, prior to undertaking tumor surgery or receiving primary chemotherapy, often in a relatively good nutritional status. Interesting was the fact that 95 patients of our series (94.1%) had normal weight or overweight. According to our study results, even in undernourished patients with a low BMI or very thin abdominal wall, the risk of local wound infection does not seem to increase. The technique is thus in experienced hands a generally safe, relatively risk-free and less uncomfortable procedure for the patient. Sonographic guidance enables completion of PEG oft despite inadequate findings on diaphanoscopy and is a useful tool intraoperatively to avoid injury of intraabdominal organs (ultrasound-guided percutaneous endoscopic gastrostomy).

References:

1. Gauderer MWL, Ponsky JL, Izant RJ: Gastrostomy without Laparotomy. J Pediatr Surg, 1980; (15): 872–75
2. DeLegge MH: Prevention and management of complications from percutaneous endoscopic gastrostomy. *http://www.uptodate.com/home/content/topic.do?topicKey=gi_dis/16476*
3. Taylor CA, Larson DE, Ballard DJ et al: Predictors of outcome after percutaneous gastrostomy: A community-based study. Mayo Clin Proc, 1992; 67: 1042
4. Larson DE, Burton DE, Schroeder KW: Percutaneous endoscopic gastrostomy: Indications, success, complications and mortality in 314 patients. Gastroenterology, 1987; 93: 48–52
5. Lee JH, Kim JJ, Kim YH et al: Increased risk of peristomal wound infection after percutaneous endoscopic gastrostomy in patients with diabetes mellitus. Dig Liver Dis, 2002; 34(12): 857–61
6. Ahmad I, Mouncher A, Abdoolah A et al: Antibiotic prophylaxis for percutaneous endoscopic gastrostomy – a prospective randomised, double-blind trial. Aliment Pharmacol Ther, 2003; 18: 209–15
7. Anaya DA, Dellinger EP: The obese surgical patient: a susceptible host for infection. Surg Infect (Larchm). 2006; 7(5): 473–80
8. Bamgbade OA, Rutter TW, Nafiu OO, Dorje P: Postoperative complications in obese and nonobese patients. World J Surg, 2007; 31(3): 556–60
9. Falagas ME, Kompoti M: Obesity and Infection. Lancet Infect Dis, 2006; 6(7): 438–46
10. Kondrup J, Rasmussen HH, Hamberg O, Stanga Z: Ad hoc ESPEN working Group. Nutritional risc screening (NRS 2002): a new method based on an analysis of controlled clinical trials. Clinical Nutrition, 2003; 22(3): 321–26
11. Jain NK, Larson DE, Schroeder KW et al: Antibiotic prophylaxis for percutaneous endoscopic gastrostomy: A prospective, randomised, double-blind clinical trial. Ann Intern Med, 1987; 107(6): 824–28
12. Arends J: Mangelernahrung bei Tumorpatienten. Ursachen, Diagnostik und Kodierung. Der Onkologe, 2008; 14: 9–14
13. DeWys DE, Begg C, Lavin PT et al: Prognostic effect of weight loss prior to chemotherapy in cancer patients. Am J Med, 2009; 69: 491–97
14. Jonas SK, Neimark S, Panwalker AP: Effect of antibiotic prophylaxis in percutaneous endoscopic gastrostomy. Am J Gastroenterol, 1985; 80(6): 438–41
15. Preclik J, Gruene S, Leser HG et al: Prospective, randomised, double blind trial of prophylaxis with single dose of co-amoxiclav before percutaneous endoscopic gastrostomy. BMJ, 1999; 319: 881–84
16. Lipp A, Lusardi G: Systemic antimicrobial prophylaxis for percutaneous endoscopic gastrostomy (review). The Cochrane Library, 2008; (4)
17. Jee JH, Rhee PL, Choe WH et al: Desinfection efficacy of glutaraldehyde and an automated endoscope reprocessor: an in use evaluation. Korean J Gastrointest Endosc, 2001; 22: 393–98
18. Stacher G: Diabetes and the stomach. Digest Liver Dis, 2000; 32(Suppl.3): 253–54
19. Schapiro GD, Edmundowicz SA: Complications of percutaneous gastrostomy. Gastrointest Endosc Clin N Am, 1996; 6: 409–22
20. Mellinger JD, Ponsky JL: Percutaneous endoscopic gastrostomy: state of the art. Endoscopy, 1998; 30: 126–32
21. Chowdhury MA, Batey R: Complications and outcome of percutaneous endoscopic gastrostomy in different patient groups. J Gastroenterol Hepatol, 1996; 11: 835–39
22. Akkersdijk WL, Berggeijk JD, van Egmond T et al: Percutaneous endoscopic gastrostomy (PEG): comparison of push and pull methods and evaluation of antibiotic prophylaxis. Endoscopy, 1995; 27: 313–16
23. Zopf Y, Konturek P, Nuernberger A et al: Local infection after placement of percutaneous endoscopic gastrostomy tubes: A prospective study evaluating risk factors. Can J Gastroenterol, 2008; 22(12): 987–91

24. Foster JM, Filocamo P, Nava H et al: The introducer technique is the optimal method for placing percutaneous endoscopic gastrostomy tubes in head and neck cancer patients. Surgical Endoscopy, 2007; 21: 897–901
25. Hoeroldt BS, Lee FK, Gleeson D et al: Ultrasound guidance in the placement of percutaneous endoscopic gastrostomy (PEG): an adjuvant technique in patients with abdominal wall varices? Dig Liver Dis, 2005; 37(9): 709–12
26. Moreno JM, Galiano MJ, Urruzuno P et al: A patient with visceromegaly: risk factor for performing percutaneous endoscopic gastrostomy. A clinical case. Nutr Hosp, 1999; 14(6): 237–39
27. Vargo JJ, Germain MM, Swenson JA, Harrison CR: Ultrasound-assisted percutaneous endoscopic gastrostomy in a patient with advanced ovarian carcinoma and recurrent intestinal obstruction. Am J Gastroenterol, 1993; 88(11): 1946–48
28. Wu ST, Leech SJ, Rosenberg M et al: Ultrasound Can Accurately Guide Gastrostomy Tube Replacement and Confirm Proper Tube Placement at the Bedside. J Emerg Med, 2008
29. Schlottmann K, Klebl F, Wiest R et al: Ultrasound-guided percutaneous endoscopic gastrostomy in patients with negative diaphanoscopy. Endoscopy, 2007; 39(8): 686–91
30. Milad MP, Terklidsen MF: The spinal needle test effectively measures abdominal wall thickness before cannula placement at laparoscopy. J Am Assoc Gynecol Laparosc, 2002; 9(4): 514–18
31. Park RH, Allison MC, Lang J et al: Randomised comparison of percutaneous endoscopic gastrostomy and nasogastric tube feeding in patients with persisting neurological dysphagia. BMJ, 1992; 304: 1406–9
32. Safadi BY, Marks JM, Ponsky JL: Percutaneous endoscopic gastrostomy. Gastrointest Endosc Clin N Am, 1998; 8: 551–68
33. Foutsch PG: Complications of percutaneous endoscopic gastrostomy and jejunostomy. Gastrointest Endosc Clin N Am, 1992; 2: 231–48
34. Loeser C: Endoskopische Anlage von Sondensystemen (PEG-/PEJ-Sonde) fur die enterale Ernahrung. Dtsch Med Wschr, 2000; 125: 805–9