Relationship of percutaneous endoscopic gastrostomy-related mortality and morbidity rates and effectiveness with advancing age

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Abstract

Background and aims : **Percutaneous endoscopic gastrostomy (PEG) is insertion of a tube to stomach through abdominal wall for provision of nutrition in patients who couldn't be fed by oral route. In the present study, it was aimed to evaluate PEG procedures performed in our facility regarding indication, complication and effectiveness and to determine whether these characteristics have a relationship with advancing age.**

Material and method : **In this descriptive study, we reviewed clinical and endoscopic records of 300 patients who underwent PEG procedure between May 2009 and December 2011. The patients were divided into 2 groups(group 1 > 75, group 2 < 75 years). All patients were retrospectively reviewed regarding demographic data, indications, biochemical parameters (Hemoglobin, total protein and albumin) at baseline and 3 months after procedure, complications and mortality.**

Results : **The most common indication for PEG was neurological (67.3%). Wound infection (6.0%) was most common early complication while tube occlusion (4.7%) was most common late complication. No significant difference was detected between groups regarding morbidity and mortality ($p < 0.05$). It was seen that there were significant improvement in all biochemical parameters ($p < 0.001$). The most significant improvement was observed in total protein values ($p < 0.05$). However, no significant difference was detected in individual parameters ($p > 0.05$).**

Conclusion : **PEG should be preferred at early period in patients who couldn't be fed by oral route for prolonged time as it is a minimally invasive, simple, inexpensive, highly effective, physiologic and safe. PEG was found to have no relationship with advancing age regarding indications, morbidity, mortality rate and effectiveness.** (Acta gastroenterol. belg., **2015**, 78, **292-298**).

Key words : percutaneous endoscopic gastrostomy, enteral feeding, effectiviteness, geriatric.

Introduction

Nutritional support is of importance to meet metabolic requirements for who have no or insufficient oral intake. Particularly it becomes increasingly important in advanced age groups (1). It is intended to protect gastrointestinal flora ; to ensure integrity of mucosal barrier function that will maintain intestinal immune function. Thus, percutaneous endoscopic gastrostomy (PEG) is important in patients with intact gastrointestinal system (GIS) activity but impaired swallowing reflex (2). Enteral feeding by PEG needs to apply in patients who require long-term nutritional support such as reduced levels of consciousness or cognition, neurologic conditions and upper gastrointestinal tract obstruction. PEG tubes are used to provide a route for enteral system with placement of a tube to stomach through abdominal wall (3).

In general, tube systems for artificial enteral nutrition can be placed by nasal insertion, guided percutaneous application, or surgical techniques. When compared to surgical gastrostomy procedures, PEG procedures is more superiority due to inexpensive, low-risk procedure which can be readily performed at endoscopy unite or bedside with sedation (4,5). PEG tube will be available for use 6-12 hours after procedure and it has life span of 6 months under normal conditions (6,7). Advances in PEG technique make it an alternative for enteral feeding by emphasizing safety and ease of this technique. However, complications can be observed during or after procedure. Major peri-procedural complications include abdominal wall bleeding, pneumoperitoneum, peristomal leakage and intraperitoneal bleeding. Peristomal pain, wound infection, abscess, necrotizing fasciitis, gastric outlet obstruction, gastro-colic fistula, gastroparesis, diarrhea, tube occlusion and aspiration can be observed after procedure (8). In fact, assessment of PEG effectiveness is to assess its contribution to nutrition. However, several biomarkers with varying sensitivities are used to assess nutritional status (9).

In the present study, it was aimed to evaluate PEG procedures performed in our facility regarding indication, complication and effectiveness and to determine whether these characteristics have a relationship with advancing age.

Material and methods

Between May, 2009 and December, 2011, gastrostomy tube with roll type bumper (20 Fr) was successfully placed through percutaneous route in 300 patients with pull technique by Gastroenterology Department of Inonu University, Medicine School. Medical and endoscopic records were retrospectively reviewed for patients underwent PEG procedure in Medical, Neurology, Neurosurgery Intensive Care Unites (ICUs) and Reanimation Unite. The records of the patients who underwent PEG

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procedure were reviewed to obtain data regarding demographic characteristics (age, gender), indication, hemoglobin, total protein and albumin values obtained at baseline and 3 months after procedure, peri-portal leakage, tube occlusion, peri-portal infection and mortality. Then, the patients were divided into 2 groups as follows : those older (group 1) and those younger (group 2) than 75 years.

PEG indication was defined as life expectation longer than 4 weeks and need for nutritional support within this period. PEG was performed in endoscopy unit or at bedside if transport is impossible. PEG wasn't performed in patients with coagulopathy (INR > 1,2 ; These patients were given fresh frozen plasma and PEG was performed when INR decreased below 1.2). In addition, PEG wasn't performed in patients with intraoral or esophageal abnormality that may preclude gastroscopy, those with gastric ulcer, those with ascites, morbid obese patients and those with peritonitis. Procedure was performed after 6-hours fasting by sedating patients with local lidocaine and midazolam. Sedation was performed by an anesthesiologist in some patients whereas by gastroenterologist in some others. In accordance to current guidelines, all patients received single dose of cephazoline sodium (2 g ; IV) as prophylaxis 8 hours before intervention. Patients were monitored for oxygen saturation and vital signs during procedure. Supplemental oxygen was delivered if needed. The procedure was performed by an endoscopist and endoscopy nurse. Nutrition was initiated 6 hours after procedure. Enteral solutions were started at a rate of 10 ml/hr by using an infusion pump, which then uptitrated by 10 cc with 6-hours intervals based on patient's tolerance. Target amounts were reached within a few days. One-year follow-up data were reviewed.

We defined complications related to PEG as minor (wound infection, minor bleeding, periostomal leakage, tube occlusion, tube removal), and major (necrotizing fasciitis, colocutaneous fistula, perforation, bleeding).

Statistical Analysis

Statistical analysis was performed by using IBM SPSS for Windows Version 22.0. Arithmetic mean (X±) and standard deviation (SD) were used to define quantitative data, whereas figure and percentage were used to define qualitative data. Normal distribution of quantitative data was shown by using Shapiro-Wilk test ($p > 0.05$). Hemoglobin, albumin and total protein values obtained at baseline and 3 months after PEG were compared by using paired t test. The difference in each parameter between groups was compared by using unpaired t test. Kaplan Meier survival curve was depicted in the related charts. $p < 0.05$ was considered as statistically significant.

Results

In all patients, PEG was performed with pull technique by using 20 Fr gastrostomy tube with roll type bumper. The procedure was performed successfully in all patients. The procedure was completed in approximately 15-25 minutes. Table 1 presents demographic characteristics of the patient. The youngest patient was 10 years old while oldest patient was 97 years old. Before procedure, feeding was achieved via nasogastric tube in 174 patients (58%), nasogastric tube plus parenteral route in 102 patients (34%), parenteral route alone in 18 patients and oral route in 6 patients (2%).

Table 1. — **Demographic data of the cases**

Gender (F/M)	138/162
Age (min-max)	63.07 ± 18,3 (10-97)
Group 1 (F/M)	100 (45/55)
Group 2 (F/M)	200 (116/84)

Patients with PEG indication had various comorbidities (Table 2). Majority of the patients were recruited from ICU and reanimation department. The most frequent cause for PEG insertion was neurological disorders. It was seen that approximately 51% of these cases were related to cerebrovascular disease. It was seen that the second most frequent causes were associated with chronic disorders including cardiac and chest diseases in most cases. Malignancy-related PEG indication was the third most common cause including tongue root cancers in vast majority of cases (Table 2 and 3). There were differences in disease frequencies between groups but the difference didn't reach statistical significance (Table 3 ; $p > 0.05$).

No major complication occurred in patients during or after procedure. Minor complications were observed in 17.7% of the patients (Table 4). It was seen that the most common early complication was wound infection (6.0%) while the most common late complication was tube occlusion (4.7%). Occluded tubes were removed and percutaneous replacement tubes were inserted at the same site. No significant difference was observed in minor complications between groups (Table 5 ; $p > 0.05$).

Deaths occurred during follow-up as earliest being on day 1 and latest being on month 9 (Fig. 1 and 2). It was observed that deaths were related to primary and comorbid diseases rather than being related to PEG procedure. No PEG-related mortality was observed in the study sample. Of the patients, 66.4% were survivors at the end of study. There were 101 deaths in the 9-months retrospective review. sixty-eight death (67.3%) occurred within first month while 91% of all deaths occurred within first 3 months. Of all deaths, 41.6% (42 cases) occurred in group 1 while 58.4% occurred in group 2. Most deaths occurred due to neurological disorders (59%) ; followed by chronic diseases and malignancy (Fig 1, 2). No significant difference was observed in deaths between groups.

Table 2. — **Cause of hospitalizations (n = 300)**

PEG indications	Number of patients (%)
Cerebrovascular diseases	153 (51)
Ischemic cerebrovascular diseases	92 (30.6)
Hypoxic ischemic encephalopathy	43 (14.5)
Cerebral hemorrhage	16 (5.3)
Cerebral trauma	2 (0.7)
Malignancy	23 (7.7)
Breast cancer	3 (1.0)
Larynx cancer	1 (0.3)
Esophagus cancer	2 (0.7)
Tongue root cancer	5 (1.7)
Lung cancer	3 (1.0)
Prostate cancer	1 (0.3)
Squamous cell cancer of neck	2 (0.7)
Palatal cancer	1 (0.3)
Colon cancer	1 (0.3)
Melanoma	1 (0.3)
Multiple myeloma	1 (0.3)
Nasopharynx cancer	1 (0.3)
Chronic diseases of central nervous system	49 (16.3)
Dementia	11 (3.7)
Amyotrophic lateral sclerosis	12 (4.0)
Hungtinton chorea	1 (0.3)
Epilepsy	1 (0.3)
Intracranial aneurysm	6 (2.0)
SSPE	5 (1.7)
Multiple sclerosis	3 (1.0)
Acute disseminated encephalomyelitis	1 (0.3)
Hydrocephaly	2 (0.7)
Parkinson's disease	5 (1.7)
Cerebral palsy	1 (0.3)
Spinal stenosis	1 (0.3)
Chronic disorders	3 (1.0)
Chronic renal failure	2 (0.7)
Liver transplantation	1 (0.3)
Chronic liver disease	1 (0.3)
Chronic obstructive pulmonary disease	1 (0.3)
Osteomyelitis	1 (0.3)
Others	
Cardiac arrest	59 (19.7)
Respiratory failure	28 (9.4)
Acute renal failure	20 (6.7)
Pulmonary embolism	1 (0.3)
Septicemia	1 (0.3)
Motor vehicle accident	16 (5.3)
Intoxication	6 (2.0)
Electric shock	1 (0.3)
Drowning	3 (1.0)
Firearm injury	1 (0.3)
Stab injury	3 (1.0)
	2 (0.7)

There were significant differences in biochemical parameters obtained before and 3 months after PEG procedure ($p < 0.0001$; Table 6). However, no significant difference was observed between groups when individual parameters were compared ($p > 0.05$).

Discussion

Provision of nutritional support is important in critically ill patients as it decreases morbidity and mortality rates in particular. It becomes increasingly important by advancing age and it is recommended to provide nutritional support at early course of disease (10). Nutrition should be provided by enteral route if gastrointestinal system is intact (11). PEG is a widely preferred method for hospitalized patients who couldn't be fed by oral route for prolonged time and require nutritional support for a period longer than 4-6 weeks (12).

PEG is commonly performed for various indications. Swallowing difficulties secondary to cerebrovascular disease (CVD) or chronic motor neuron disorders comprise first-line indications for nutrition via PEG. Pull PEG is indicated for neurological diseases but not upper GI tract or throat malignancy. Push PEG is recommended in this setting to avoid cancer cell seeding in the site of the PEG. Although previous studies have been published, this risk has limited clinical significance because of its rarity (13,14). PEG was administered to patients with upper GI tract and throat malignancy in our study with success and no complications (Table 7).

In a study on 674 patients between 1999 and 2002, swallowing difficulty due to CVD (54%) was most common PEG indication (14). In a study by Verhoef *et al*., frequency of PEG indication due to neurological disease was found to be 66% (15). In our study, neurological diseases were the leading PEG indication by 67.3%. No significant difference was detected between groups because approximately half of the patients in group 2 were older than 65 years of age. In western communities, geriatric age threshold is accepted as 65 years or higher (10). Thus, it wasn't surprising that there was no significant difference between geriatric age groups. In a study in 1991, 10% of PEG indications were reported as neoplasm (16). In our study, overall rate of neoplasm was 7.7%. It was found as 9.0% in group 1 whereas 7.5% in group 2, indicating no significant difference between groups. This was attributed to closer mean age of groups. Again, when comorbid chronic diseases were compared between groups, it was found that incidences of comorbid diseases were higher in group 1.

In a study by Mohandas *et al*., PEG was performed in 54 patients at a period of 10 months. Authors reported that PEG was successfully inserted in 50 patients (93.0%) (17). Minor complications occurred in 11 of these patients. Reasons for PEG failure was reported as

Table 3. — **Distribution of diseases across groups**

Groups	CVO	CNS	Chronic	Malignancy	Others	Total
Group 1	51	11	24	9	5	100
Group 2	102	37	35	15	11	200
Total	153	48	59	24	16	300

CVO, cerebrovascular occlusion; CNS, central nervous systems diseases.

Table 4. — **PEG-related minor complications in study sample**

Complication	Early (within first month)	Late (After first month)	Total	Percent (%)
Periostomal leakage	4	10	14	4.7
Wound infection	18	–	18	6.0
Tube removal	4	2	6	2.0
Tube occlusion	–	14	14	4.7
Bleeding	1	–	1	0.3
Total	27	26	53	17.7

Table 5. — **Complication frequency after PEG procedure in groups**

Groups	Minor complications					
	Wound infection (%)	Leakage (%)	Occlusion (%)	Removal (%)	Bleeding (%)	None (%)
Group 1 (n = 100)	5 (5.0)	7 (7.0)	4 (4.0)	1 (1.0)	1 (1.0)	82 (82)
Group 2 (n = 200)	13 (6.5)	7 (3.5)	10 (5.0)	5 (2.5)	–	165 (82.5)
Total	18 (6.0)	14 (4.7)	14 (4.7)	6 (2.0)	1 (3.0)	247 (82.3)

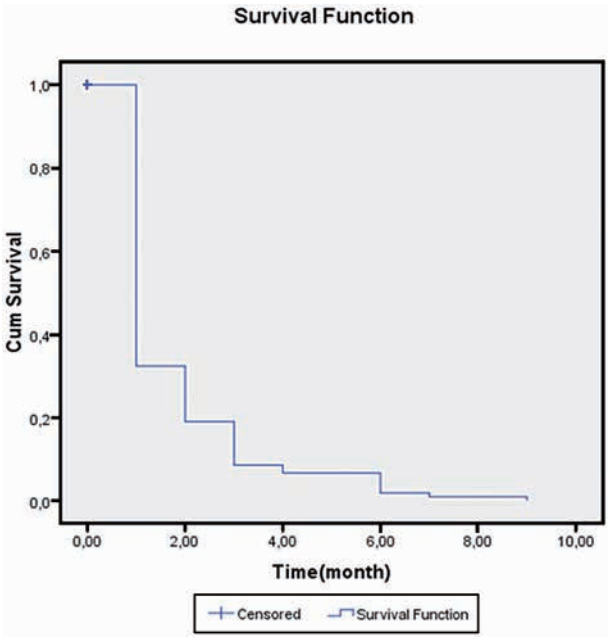

Fig. 1

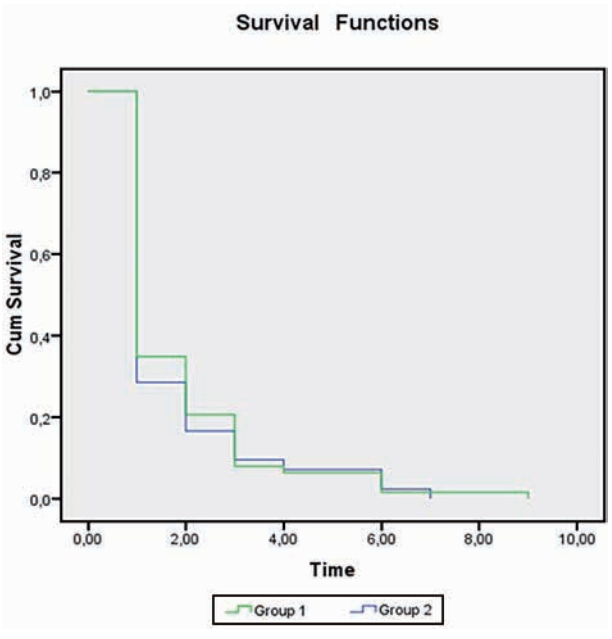

Fig. 2

tumor invasion at PEG site in 4 patients (17). In our study, PEG was successfully performed in all patients included. No major complication was observed during or after procedure. In previous studies, no failure was observed in PEG procedure ; however, minor complications were observed (18). Most complications were reported as minor (19). In a previous study, it was reported that minor complication rate was 13% while major complication was 3% (20). In the literature, post-PEG complication rate varies from 8% to 30% based on variations in the definition of complication. Major complications requiring intervention account for approximately 1-4% of all cases. However, surgery is needed less than 0.5% of these cases (21). In a series including 117 cases, local infection rate after PEG insertion was reported to be 18.% while complication rate during insertion as 4%, replacement of PEF tube as 7.4% and bleeding as 3%(1)). In another study, periostomal leakage mostly observed within a few days after PEG insertion (22). In our study, it was mostly seen within in first month. It is thought this

Table 6. — **Comparison of hemoglobin, albumin and total protein values obtained at baseline and on the month 3 after PEG procedure in patients Group 1 and Group 2**

Variables (g/dL)	Baseline X ± SD		3 months after PEG X ± SD		P values	
	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2
Hemoglobin	10.77 ± 1.65	11.00 ± 1.62	11.42 ± 1.23	11.54 ± 1.38	0.0001	0.0001
Albumin	2.68 ± 0.69	2.69 ± 0.64	5.73 ± 0.68	3.12 ± 0.49	0.0001	0.0001
Total protein	5.73 ± 0.68	5.87 ± 0.63	6.56 ± 0.55	6.63 ± 0.63	0.0001	0.0001

X, mean ; SD, standard deviation.

Table 7. — **Outcome for patients with upper GI tract or throat malignancy**

Malignancy	Alive	Time of Death	Number of Patients (%)
Esophagus cancer	–	One patient after one day and one patient after 4 months	2 (0.7)
Tongue root cancer	4	One patient after 7 months	5 (1.7)
Palatal cancer	1	–	1 (0.3)
Nasopharynx cancer	–	Two days after	1 (0.3)

Table 8. — **Comparison of hemoglobin, albumin and total protein values obtained at baseline and on the month 3 after PEG procedure in patients older than 75 years**

Variables (g/dL)	Baseline X ± SD	3 months after PEG X ± SD	P values
Hemoglobin	10.77 ± 1.65	11.42 ± 1.23	0.0001
Albumin	2.68 ± 0.69	5.73 ± 0.68	0.0001
Total protein	5.73 ± 0.68	6.56 ± 0.55	0.0001

X, mean ; SD, standard deviation.

could be due to malnutrition patients with greater number of comorbidities. In those studies, the most common minor complication was reported to be wound infection (23,24). In our study, complications were observed in 53 patients. About half of these complications (26 patients) occurred in early period (within first month). Of these, 6% (18 patients) were wound infections. Minor complications were observed in 17.7% of the patients. In agreement with literature, low rate of PEG-related complication was observed in our study. Lower infection rates in our study support benefits of antibiotic prophylaxis. Indeed, antibiotic prophylaxis is recommended by many studies in the literature in order to reduce peristomal infection risk (25,26) and there is a meta-analysis showing that antibiotic prophylaxis markedly reduces infection rates at PEG insertion site (27). Infections were regressed by wound care and antibiotic treatment. It was seen that the most common complications was tube occlusion in late period. It is found that tube occlusion resulted from interruption in tube care and tube replacement by patient's relatives. In agreement with literature, low rate of PEG-related complication was observed without any mortality in our study. No significant difference was found in minor complications between groups.

PEG-related mortality was reported as 2.4% in a prospective study on 85 patients by Erdil *et al*. (18), whereas 0.3% in a prospective study on 674 patients by Rimon *et al*. (14). No PEG-related mortality was observed in our study. Deaths were attributed to primary and comorbid diseases. In the study by Verhoef and Grant, early and late mortality rates were reported to be 8-26% and 13-60%, respectively (28). In our study, mortality rate was found to be 33.6% (101 patients) during one-year follow-up. Of these 22.6% (68 patients) were observed within first month. It was found that the mortality rate was 42% (28% within first month) in group 1 whereas 31.5% in group 2. The earliest death occurred on the day 1. It was seen that mortality was related to primary and comorbid diseases rather than being related to PEG. Thus, mortality rate in our study was consistent to those in the literature.

Several biomarkers have been used as indicator of nutritional status. Among these, serum albumin level is used as an ancillary method in the assessment of nutrition. Although albumin isn't an ideal marker, it is widely used in clinical practice due to its availability (29). In our study, we aimed to evaluate parameters that could be used to show malnutrition and effectiveness regarding both effectiveness of PEG in nutrition and potential difference between groups. For this purposes, we attempted to select readily available, simple parameters routinely used in daily practice. In the literature, we observed that

Table 9. — **Comparison of hemoglobin, albumin and total protein values obtained at baseline and on the month 3 after PEG procedure in patients younger than 75 years**

Variables (g/dL)	Baseline X ± SD	3 months after PEG X ± SD	P values
Hemoglobin	11.00 ± 1.62	11.54 ± 1.38	0.0001
Albumin	2.69 ± 0.64	3.12 ± 0.49	0.0001
Total protein	5.87 ± 0.63	6.63 ± 0.63	0.0001

X, mean ; SD, standard deviation.

routinely used parameters haven't been compared although serum proteins evaluated have varying specificity and sensitivity. In addition, parameters which are considered to be not cost-effective for routine use also have low specificity and sensitivity (30). When parameters evaluated at baseline and 3 months after PEG insertion were compared, a significant positive change was observed ($p < 0.001$). However, no significant difference was observed between groups. Based on this result, it was observed that total protein is more valuable in the assessment of nutrition by PEG and that albumin is more sensitive than hemoglobin although there was no significant difference between albumin and hemoglobin. This is attributed to greater extent of change due to interaction of albumin and hemoglobin with other factors (31,32). Since total protein is more global, interaction isn't as much as those observed in other proteins (33). In many randomized and prospective cohort studies, it was shown that serum proteins are poorly correlated with nutritional status. There is no clear correlation between low or high intake and decreased or increased albumin. As a negative acute phase reactant, concentrations of these proteins are affected by acute phase response. Levels of these proteins are also affected by several other factors (29,30). In the literature, there are limited numbers of studies on hemoglobin as a nutritional indicator. Serum levels of hemoglobin and magnesium and phosphor are used as additional biochemical indicators for monitoring nutritional status in critically ill patients. However, only transferrine was studied in the assessment of nutrition. In a previous study on transferrine, it was shown that hemoglobin could be a nutritional indicator (34). However, contradictory results were also shown (35,36).

We couldn't assess statistical relationship between parameters used and time of death as we measured these parameters at baseline and 3 months after PEG insertion. However, 30.6% of the deaths occurred within first 3 months. Although deaths which occurred after 3 months comprised a minor proportion of all deaths, it was seen that parameters were lower than those in survived. This finding is consistent to previous studies (37). Lower baseline parameters in non-survivors confirm the relationship between decrease in these parameters and high morbidity and mortality (38). We think that the deaths are related to primary diseases where malnutrition increases mortality. Primarily, we showed that enteral nutrition by PEG effectively improved parameters used as malnutrition indicators. However, it was seen that there was no difference between groups in our study. This doesn't only indicate that these parameters can be used in the assessment of enteral feeding via PEG but also indicates that enteral feeding via PEG tube is an effective nutritional option.

Conclusion

In conclusion, PEG should be preferred in patients who couldn't be fed by oral route for prolonged time period as it is a simple, inexpensive, highly effective and physiologically safe procedure yielding lower complications rate and shorter length of hospital stay. In our study, it was seen that age had no significant influence on PEG effectiveness. There was no significant relationship between age and effectiveness or complication rate in our study ; however, further studies are needed to draw definitive conclusion in this issue. Nutritional support should be implemented in early course of disease before onset of malnutrition in patients who couldn't be fed by oral route for prolonged periods. Another advantage is to deliver oral agents together with nutrition by this route.

References

1. SCHURINK C.A., TUYNMAN H., SCHOLTEN P. *et al*. Percutaneous endoscopic gastrostomy : complications and suggestions to avoid them. *European journal of gastroenterology & hepatology*, 2001, **13** (7) : 819-823.
2. PEARCE C., DUNCAN H. Enteral feeding. Nasogastric, nasojejunal, percutaneous endoscopic gastrostomy, or jejunostomy : its indications and limitations. *Postgraduate medical journal*, 2002, **78** (918) : 198-204.
3. KURIEN M., MC ALINDON M.E., WESTABY D. *et al*. Percutaneous endoscopic gastrostomy (PEG) feeding. *BMJ*, 2010, 340.
4. HOWARD L., AMENT M., FLEMING C.R. *et al*. Current use and clinical outcome of home parenteral and enteral nutrition therapies in the United States. *Gastroenterology*, 1995, **109** (2) : 355-365.
5. LOSER C., ASCHL G., HEBUTERNE X. *et al*. ESPEN guidelines on artificial enteral nutrition–percutaneous endoscopic gastrostomy (PEG). *Clin. Nutr*., 2005, **24** (5) : 848-861.
6. PENNINGTON C., SHAFFER J. Artificial nutritional support for improved patient care. *Alimentary pharmacology & therapeutics*, 1995, **9** (5) : 471-481.
7. RABENECK L., WRAY N.P., PETERSEN N.J. Long-term outcomes of patients receiving percutaneous endoscopic gastrostomy tubes. *Journal of general internal medicine*, 1996, **11** (5) : 287-293.
8. TOKUNAGA T., KUBO T., RYAN S. *et al*. Long-term outcome after placement of a percutaneous endoscopic gastrostomy tube. *Geriatrics & gerontology international*, 2008, **8** (1) : 19-23.
9. MUELLER C. True or false : Serum hepatic proteins concentration measure nutritional status. *Support Line*, 2004, **26** (1) : 8-16.

10. VOLKERT D., BERNER Y., BERRY E. *et al*. ESPEN guidelines on enteral nutrition : geriatrics. *Clinical Nutrition*, 2006, **25** (2) : 330-360.
11. KUDSK K.A., CROCE M.A., FABIAN TC. *et al*. Enteral versus parenteral feeding. Effects on septic morbidity after blunt and penetrating abdominal trauma. *Annals of surgery*, 1992, **215** (5) : 503.
12. MC CARTER T.L., CONDON S.C., AGUILAR R.C. *et al*. Randomized prospective trial of early versus delayed feeding after percutaneous endoscopic gastrostomy placement. *The American journal of gastroenterology*, 1998, **93** (3) : 419-421.
13. ELLRICHMANN M., SERGEEV P., BETHGE J. *et al*. Prospective evaluation of malignant cell seeding after percutaneous endoscopic gastrostomy in patients with oropharyngeal/esophageal cancers. *Endoscopy*, 2013, **45** (7) : 526-531.
14. RIMON E., KAGANSKY N., LEVY S. Percutaneous endoscopic gastrostomy, evidence of different prognosis in various patient subgroups. *Age and ageing*, 2005, **34** (4) : 353-357.
15. VERHOEF M.J., VAN ROSENDAAL G.M. Patient outcomes related to percutaneous endoscopic gastrostomy placement. *Journal of clinical gastroenterology*, 2001, **32** (1) : 49-53.
16. MOHANDAS K., DAVE U., SWAROOP V.S. *et al*. Percutaneous endoscopic gastrostomy for long term enteral nutrition. *National Medical Journal of India*, 1992, **5** (2).
17. MC CLAVE S.A., LUKAN J.K., STEFATER J.A. *et al*. Poor validity of residual volumes as a marker for risk of aspiration in critically ill patients. *Critical care medicine*, 2005, **33** (2) : 324-330.
18. ERDIL A., SAKA M., ATES Y. *et al*. Enteral nutrition via percutaneous endoscopic gastrostomy and nutritional status of patients : Five-year prospective study. *Journal of gastroenterology and hepatology*, 2005, **20** (7) : 1002-1007.
19. BLOMBERG J., LAGERGREN J., MARTIN L. *et al*. Complications after percutaneous endoscopic gastrostomy in a prospective study. *Scandinavian journal of gastroenterology*, 2012, **47** (6) : 737-42.
20. LARSON D.E., BURTON D.D., SCHROEDER K.W. *et al*. Percutaneous endoscopic gastrostomy. *Gastroenterology*, 1987, **93** (1) : 48-52.
21. KOZAREK R.A., PAYNE M., BARKIN J. *et al*. Prospective multicenter evaluation of an initially placed button gastrostomy. *Gastrointestinal endoscopy*, 1995, **41** (2) : 105-108.
22. FINOCCHIARO C., GALLETTI R., ROVERA G. *et al*. Percutaneous endoscopic gastrostomy : a long-term follow-up. *Nutrition*. 1997, **13** (6) : 520-523.
23. KHATTAK I., KIMBER C., KIELY E. *et al*. Percutaneous endoscopic gastrostomy in paediatric practice : complications and outcome. *Journal of pediatric surgery*, 1998, **33** (1) : 67-72.
24. SCHRAG S.P., SHARMA R., JAIK N.P. *et al*. Complications related to percutaneous endoscopic gastrostomy (PEG) tubes. A comprehensive clinical review. *Journal of Gastrointestinal and Liver Diseases*, 2007, **16** (4) : 407.
25. JAFRI N., MAHID S., MINOR K. *et al*. Meta-analysis : antibiotic prophylaxis to prevent peristomal infection following percutaneous endoscopic gastrostomy. *Alimentary pharmacology & therapeutics*, 2007, **25** (6) : 647-656.
26. LIPP A, LUSARDI G. Systemic antimicrobial prophylaxis for percutaneous endoscopic gastrostomy. *The Cochrane Library*, 2013.
27. SHARMA V.K, HOWDEN C.W. Meta-analysis of randomized, controlled trials of antibiotic prophylaxis before percutaneous endoscopic gastrostomy. *The American journal of gastroenterology*, 2000, **95** (11) : 3133-3136.
28. GRANT M.D., RUDBERG M.A., BRODY J.A. Gastrostomy placement and mortality among hospitalized Medicare beneficiaries. *JAMA*, 1998, **279** (24) : 1973-1976.
29. CR. P. Serum proteins as markers of nutrition : What are we treating ? *Practical Gastroenterol*, 2006, **46** : 46-64
30. FUHRMAN M.P., CHARNEY P., MUELLER C.M. Hepatic proteins and nutrition assessment. *Journal of the American Dietetic Association*, 2004, **104** (8) : 1258-1264.
31. RAGUSO C.A., DUPERTUIS Y.M., PICHARD C. The role of visceral proteins in the nutritional assessment of intensive care unit patients. *Current Opinion in Clinical Nutrition & Metabolic Care*, 2003, **6** (2) : 211-216.
32. SERES D.S. Surrogate nutrition markers, malnutrition, and adequacy of nutrition support. *Nutrition in Clinical Practice*, 2005, **20** (3) : 308-313.
33. MARSHALL W.J., MITCHELL P.E. Total parenteral nutrition and the clinical chemistry laboratory. Annals of Clinical Biochemistry : *An international journal of biochemistry in medicine*, 1987, 24 (4) : 327-36.
34. HIGGINS P.A., DALY B.J., LIPSON A.R. *et al*. Assessing nutritional status in chronically critically ill adult patients. *American Journal of Critical Care*, 2006, **15** (2) : 166-176.
35. FLETCHER J., LITTLE J., GUEST P. A comparison of serum transferrin and serum prealbumin as nutritional parameters. *Journal of Parenteral and Enteral Nutrition*, 1987, **11** (2) : 144-148.
36. ROZA A.M., TUITT D., SHIZGAL H.M. Transferrin — a poor measure of nutritional status. *Journal of Parenteral and Enteral Nutrition*, 1984, **8** (5) : 523-528.
37. SELTZER M.H., BASTIDAS J.A., COOPER D.M. *et al*. Instant nutritional assessment. *Journal of Parenteral and Enteral Nutrition*, 1979, **3** (3) : 157-159.
38. FORSE R.A., SHIZGAL H.M. Serum albumin and nutritional status. *Journal of Parenteral and Enteral Nutrition*, 1980, **4** (5) : 450-454.