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Name of Journal: *World Journal of Gastrointestinal Surgery*

Manuscript NO: 82503

Manuscript Type: SYSTEMATIC REVIEWS

How far is the endoscopist to blame for a percutaneous endoscopic gastrostomy complication?

Stavrou G *et al.* PEG complications

George Stavrou, Persefoni Gionga, George Chatziantoniou, Georgios Tzikos, Alexandra Menni, Stavros Panidis, Anne Shrewsbury, Katerina Kotzampassi

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Abstract

BACKGROUND

Percutaneous endoscopic gastrostomy (PEG) is a well-established, minimally invasive, and easy to perform procedure for nutrition delivery, applied to individuals unable to swallow for various reasons. PEG has a high technical success rate of insertion-between 95% and 100% in experienced hands, but a varying complication rate, ranging from 0.4% to 22.5% of cases.

AIM

To discuss the **1** existing evidence of major procedural complications in PEG, mainly focusing on those that could probably have been avoided had the endoscopist been more experienced or less self-confident in relation to the basic safety rules for PEG performance.

METHODS

After a thorough research of the international literature of a period of more than 30 years of published “case reports” concerning such complications, we critically analyzed only those complications which were considered.

RESULTS

after assessment by two experts in PEG performance working separately-to be directly related to a form of malpractice by the endoscopist: gastrostomy tubes passed through the colon or through the left lateral liver lobe, bleeding after puncture injury of large vessels of the stomach or the peritoneum, peritonitis after viscera damage and injuries of the esophagus, spleen and pancreas.

CONCLUSION

For a safe PEG insertion the overfilling of ⁴the stomach and small bowel with air ⁴should be avoided, ⁴the clinician should check thoroughly for the proper trans-illumination of the light source of the endoscope through the abdominal wall and ensure endoscopically ¹visible imprint of finger palpation on the skin at the center of the site of maximum illumination, and finally, the physician should be more alert with obese patients and those with previous abdominal surgery.

Key Words: Percutaneous endoscopic gastrostomy; Complications; Doctor responsibility

Stavrou G, Gionga P, Chatziantoniou G, Tzikos G, Menni A, Panidis S, Shrewsbury A, Kotzampassi K. How far is the endoscopist to blame for a percutaneous endoscopic gastrostomy complication? *World J Gastrointest Surg* 2023; In press

Core Tip: For a safe percutaneous endoscopic gastrostomy insertion: Avoid ⁴overfilling the stomach and small bowel with air; Check thoroughly for ⁴the proper trans-illumination of the light source of the endoscope through the abdominal wall; Ensure endoscopically ¹visible imprint of finger palpation on the skin at the center of the site of;

Maximum illumination; Be more alert with obese patients and those with previous abdominal surgery.

INTRODUCTION

⁸ Percutaneous endoscopic gastrostomy (PEG) was introduced into clinical practice by Gauderer *et al*^[1] in 1980. Nowadays it is a widely used, minimally invasive procedure-a flexible feeding tube placed endoscopically through the mouth into the stomach and exiting *via* the abdominal wall-to administer enteral nutrition, fluids and drugs to individuals unable to swallow for various reasons^[2,3]. It is a well-established method of nutrition delivery with a high technical success rate of insertion between 95% and 100% in experienced hands^[4,5].

However, there still exists a complication rate, varying from 0.4% to 22.5% of cases^[6-9]. For teaching and communication purposes, the complications are classified as major and minor, depending on the severity of resulting illness; severe bleeding due to injury of visceral vessels or liver damage, perforation of hollow viscera, as well as cardiopulmonary events and aspiration pneumonia, although rare, are generally severe or even fatal, and thus categorized as major complications, which happen at a rate of 1.0%-2.4% with a mortality of 0.8%. ¹⁰ Minor complications include, among others, peristomal infection, peristomal leakage, tube dislodgment, pneumo-peritoneum, gastric outlet obstruction, and buried bumper syndrome. An alternative classification is based on the time elapsing after PEG performance: early and late complications, but, for no reason should a “late” complication be considered as “minor”^[3,8,10-15].

For the present commentary review we decided to focus on those complications that could have been avoided if the endoscopist had been more experienced or less self-confident and therefore less casual about the basic safety rules for PEG performance. Gastrostomy tubes passed through the colon or through the left lateral liver lobe, bleeding after puncture injury of large vessels of the stomach or the peritoneum, peritonitis after viscera damage and injuries of the esophagus, spleen and pancreas are critically discussed in relation to who should assume the responsibility.

MATERIALS AND METHODS

Data collection

¹¹ An electronic literature search of PubMed ² databases from their inception in 1980 to 2022 was performed to detect all published ² case reports or case series pertinent to a complication after PEG tube insertion. An ultimate check of databases was carried out on November 15, 2022.

² For literature search purposes, the subject heading “percutaneous endoscopic gastrostomy” ² combined with “complications”, with AND as Boolean term, were applied to retrieve data related to the objectives of this study. Inclusion criteria were that: (1) The publications be either a “case report” or “case series”; (2) The full-text of each publication be available; and (3) Human cases only. No language restriction was applied, except for Chinese.

² The titles and abstracts of all ² publications identified were first screened and assessed and those obviously irrelevant ² were discarded. If eligibility could not be ascertained from the title or abstract, the full text of the study was examined. Papers deemed suitable were then reviewed by two independent reviewers to exclude, manually, all cases related to PEG tube malfunction or peristomal wound care, peristomal infections/leakage, buried bumper syndrome and accidental dislodgement of the tube, as well as those related to sedation itself (aspiration, cardiac arrest and similar). ² The references in the remaining papers were then scrutinized for additional cases, in a further effort to ensure that relevant publications were not missed.

Grouping complication cases

Two qualified endoscopists (EE and KK), working independently of each other, thoroughly studied all the remaining articles describing major complications: vascular injuries-intra/retroperitoneal bleeding, colon injuries, liver injuries, and splanchnic organ injuries. For each article they studied, they asked themselves: “Was this complication preventable?” and “what was the wrong maneuver on the part of the endoscopist which resulted in this complication?” Based on their 35+ years’ experience each and the large number of procedures they had performed, they separately judged

and then discussed and agreed which of the complications could have been avoided had the endoscopist strictly followed the guidelines for a gastrostomy insertion

RESULTS

A total of 88 complications out of the 575 cases screened were identified, *i.e.* those which both endoscopists agreed could have been avoided (Figure 1). They are classified according to the organ/anatomical structure injured, as follows (Table 1).

There was a total of 50 reports on transverse colon accidental penetration by the gastrostomy tube before it entered the stomach. In detail: 29 patients remained for between 6 wk and 4 years with a PEG tube in their stomach, after it had passed through the colon; this complication was recognized only during the process of changing the gastrostomy tube, when the new one failed to be inserted into the stomach and remained in the colon^[16-46]. Mainly diarrhea and fecal odor sent the patient to hospital for investigation^[16,17,22,23,25,28,30,32,34-44,46]. Another 11 cases of a similar complication were recognized early, from 25 h to 2.5 mo, mainly due to fecal material exiting from the tube and/or around the gastrostomy tube^[18-21,24,26,27,29,31,33,45]. The same complication occurred in 4 patients with previous abdominal surgery: two cases with a history of surgical jejunostomy^[34] and an exploratory laparotomy^[45], diagnosis only occurring upon gastrostomy tube replacement; in one case^[17] with a right hemicolectomy in the past and difficulties in transillumination-the PEG tube was inserted through the colon and one week later the internal bumper had moved within the colon lumen. A poly-trauma patient previously subjected to splenectomy^[32] received a PEG inserted through the splenic flexure, recognized two years later within the colon lumen due to fecal odor. Two infants presented with fecal emesis 2 to 3 mo after a PEG, which was passed from the skin, through the colon, into the posterior stomach wall^[47]. Finally, there were 4 more cases: one presenting 10 d later with rectal bleeding^[48]; one, a year after PEG insertion, when the tube was obstructed^[49], one presented 3 d after PEG with abdominal distention, the bumper being in the splenic flexure^[50]; and, the last case, presenting with diarrhea 15

d after PEG placement, was found to have a colo-jejuno-gastric communication after the PEG tube had been passed through the colon and jejunum before entering the stomach^[51].

Liver injuries (n = 14)

In the cases where the PEG tube penetrated the liver prior to insertion into the stomach without causing severe bleeding, patients experienced pain either a few hours later, upon feeding induction^[52], or within a week-5 cases^[53-56], or after two weeks in the case of a patient having total colectomy and ileostomy^[57]. In three patients the liver injury was only recognized later as a liver abscess, after the gastrostomy internal bumper accidentally moved out of the stomach^[58-60]. In another patient, during the process of changing gastrostomy tube, the new one failed to be inserted into the stomach and remained in the liver, thus becoming symptomatic^[61]. Finally, it is of interest to separately mention the unfortunate case of an obese patient scheduled for gastrostomy by means of radiology. However, the presence of a colonic loop anterior to the stomach caused the radiologic procedure to be aborted and endoscopic gastrostomy was thus decided on and performed uneventfully. On day 3 post-procedure a computed tomography scan was performed to totally exclude the possibility of colon injury - this revealed that the gastrostomy tube had traversed hepatic segment 3, making a large adjacent hematoma, resulting in the patient's death a few days later^[62].

Additionally, there were 4 cases in which the passage of the gastrostomy tube through the left hepatic lobe parenchyma caused severe hemorrhage (hemoperitoneum), requiring surgical intervention^[56,63-65].

Vascular injuries/bleeding (n = 12)

Ectopic insertion of the needle in the anatomical area of the major gastric curvature caused injury of the gastric artery-2 cases^[66], or its left branch^[67], of the splenic artery^[68], and of the gastro-epiploic artery-2 cases^[68,69]. Needle puncture at the lesser curvature led to: A huge retroperitoneal hemorrhage due to rupture of the splenic and superior mesenteric veins near the confluence to the portal vein^[65] and severe injury to the splenic

artery and pancreas^[70], both occurring in previous cholecystectomy patients; massive hemoperitoneum after injury of small vessels on the lesser curvature, probably related to a first failed attempt to insert the needle into the stomach, followed by a second attempt^[71]; and severe injury to the pancreas and the pancreatic branch of the superior mesenteric artery after needle insertion from the anterior stomach wall and penetration of the posterior wall towards the pancreas being just behind^[72].

The formation of a pseudo-aneurysm after puncture of the gastro-epiploic artery^[73]; of the left gastric artery^[73,74]; and of the gastro-duodenal artery^[75] was also reported. An intra-mural hematoma of the gastric wall also developed in a patient with platelet dysfunction and on a low dose of aspirin^[76].

Splanchnic injuries (n = 12)

Two cases of esophageal catastrophic damage related to PEG placement were reported. In a 3-mo boy weighing 3.7 kg, the pulling of a 18CH gastrostomy tube immediately led to esophageal intussusception towards the stomach and thus complete esophageal transection^[77]. The other case was an obese, multi-trauma patient, on whom PEG procedure was difficult^[78]. Without the help of transillumination, and only using finger pressure, 3 attempts, at a 45° angle, were made to insert the needle into the stomach. The patient became tachycardic, hypotensive, and progressively febrile, with upper abdominal tenderness, mediastinitis, thickening of the pericardium and bilateral pleural effusions, leading, finally, on day 14 to an urgent left lateral-posterior thoracotomy which revealed a small hole on the anterior esophageal wall at the esophagogastric junction, covered by omentum. Additionally, the PEG was dislocated in the subcutaneous adipose tissue.

A case of gastric volvulus was reported in a 10-mo infant; PEG was performed at the age of one-month, under general anaesthesia. Unfortunately, the gastrostomy tube passed between the gastric curvature and the transverse colon to be inserted finally into the posterior gastric wall, causing the stomach to twist along its organo-axis and compromising the gastric outlet^[79].

Four cases of PEG tube passage though the jejunal lumen prior to entering the stomach were also found. These cases remained silent from 8.5 to 24 mo, and were only discovered by symptoms occurring upon tube replacement^[80-83].

Microbial peritonitis occurred in 3 cases; one following PEG on the posterior gastric wall^[66]; and another two after penetration of the jejunum^[66] and transverse colon^[68], both being between the abdominal and the gastric wall. Finally, there are two cases of severe spleen injuries^[76,84] in patients with previous surgeries.

DISCUSSION

Critical analysis of events

The PEG procedure is a well-established method for safe creation of a gastrostomy, without surgery, and in most cases, without general anaesthesia. The goal of PEG is to endoscopically insert a flexible gastrostomy catheter *via* the mouth-esophagus-stomach route - by pulling it from the outside - to be externalized in the mid-abdomen, which allows easy delivery of commercially available liquid nutrients to the patient. While most PEG procedures have yielded positive long-term outcomes, there are substantial adverse events associated with their performance; some of them, directly related to the technical part of the operation itself, and which would have been avoided if the manipulations for tube implantation had been carried out in accordance with the generally accepted guidelines^[2-4,6-9]. In our opinion, only an inexperienced or super-experienced endoscopist would dare to ignore these rules: the former from ignorance of danger and of basic rules and the latter from excessive self-confidence or arrogance.

In the present study, we decided to review and comment on the adverse events reported in the literature, irrespective of their being either major or minor, early or late, after two experienced endoscopists, each with almost 40-years experience in performing PEG, were tasked to critically examine the literature and identify those complications that could have been prevented.

Colonic injuries

The displacement of the transverse colon in close proximity to or over the anterior gastric wall, due mainly to stomach and small bowel overinflation at the beginning of the procedure, can predispose the patient to colonic injury during the needle puncture for PEG placement^[8,10,24,85-87]. The endoscopist must take into consideration that the laxity of the colonic mesentery is more common among elderly patients^[50] and that both chronic constipation and previous abdominal surgery are serious parameters which further increase the risk of colon penetration if the colon interposes between abdominal wall and stomach, creating colo-gastric communication^[88,89]. Although colon perforation is considered a severe trauma needing emergency treatment due to incipient fecal peritonitis, in most cases it is totally asymptomatic. Some transient episodes of fever or ileus may occur in a few patients, the diagnosis of which is often difficult, given the problems in communication due to underlying altered mental status^[3]. In most cases, colon compression between the external and internal bumpers of the gastrostomy tube partially closes the opening and thus minimizes the leakage, while the artificial liquid enteral formulas given for feeding further minimize the existence of colon over-distension due to a bulk mass of feces.

On the other hand, when the PEG is removed for replacement or accidentally pulled back a little, it is almost impossible to reinsert the replacement tube through the colon, into the stomach; for this reason, the technique of exchanging the tube over a guidewire can prove a safe solution. Once feeding restarts, diarrhea occurs, due to the acceleration of increased motility of the colon and thus the rapid passage of undigested food to the anus, this being the most common symptom for referral of the patient to the treating physician, leading to recognition of the complication. In a few cases, leakage of feces through the cutaneous opening helps diagnosis, while in the case of total removal of the tube a colo-cutaneous fistula is created^[8,11,89].

Liver injuries

Passage of the gastrostomy tube through the liver may happen in a similar way to that occurring with the colon, when the left lateral liver lobe interposes between the

abdominal wall and the stomach. Although such an injury, that is puncture of the “bloody” liver and ¹ passage of the PEG tube through into the stomach, would be expected to be associated with severe intraperitoneal bleeding, most of the cases have no prominent hemorrhage, probably because of liver compression between the internal and external bumpers of the gastrostomy tube. However, bleeding occurs both at the time of PEG tube removal for replacement, and more extensively as the endoscopist tries to insert and inflate the balloon of the new tube^[8,10,11,85,89].

The main reason for this complication is the violation of standard rules: (1) When liver tissue exists between the abdominal wall and the stomach it is impossible to identify an area of maximum trans-illumination on the abdominal wall, since there is only a rather diffuse light, only visible in thin individuals; (2) Even more distinctly, the finger imprint from the outside palpation is not clearly identifiable as a “point” but rather only as an extra-lumen pressure moving the anterior wall of the stomach; (3) Regarding the “safe tract” technique - that is the technique involving constant aspiration while advancing the needle - it is my personal opinion that it proves more reliable when performed in such cases; In case the needle enters the liver accidentally it is much easier to aspirate blood - and be aware of the complication. On the contrary, if the needle enters the colon, fecal matter may not be aspirated, making the endoscopist unaware of the complication until it is possibly too late; and (4) Finally, liver hilum palpation is a good practice, totally forgotten nowadays^[3,11,90].

Bleeding

Significant bleeding happens when the needle “blindly” punctures the underlying tissues; large or small arteries of the great and lesser gastric curvature or the gastric incisura may occasionally - and easily - be found on the route of the needle. Of course, just below the epigastrium is located the anterior gastric wall, which does not have large vessels; when excess air volume over-inflates the stomach, it can be twisted either clockwise or counterclockwise along its organ axis, thus exposing the great or the lesser curvature and their vessels, and more extremely, perhaps the posterior gastric wall - there

were at least 5 cases of PEG performed in the posterior gastric wall^[47,66,72,79]. This stomach rotation has been fully documented by Croaker *et al*^[91], who inserted a laparoscopic camera into the abdomen in order to study the movement of the viscera when inflated^[86,92].

Another dangerous condition for bleeding is the previously operated abdomen. Thick adhesion bundles, sometimes containing a large vessel, pull and rotate the stomach and the gut, changing their orientation in the abdominal cavity. Characteristic are the cases of previous cholecystectomy patients, in whom shrinkage of the area between the liver, duodenum and gastric insisura led to severe needle-induced splenic artery and pancreatic tissue injury^[65,70]. Much more dangerous is the situation after a previous colectomy or gastrectomy of any type, pancreatic surgery or aortic surgery^[88]. However, in these cases there is the surgical incision scar to warn the operator that some anatomical alterations may exist in the abdominal cavity - they must, however, notice it.

Finally, there are reported injuries of the splenic artery, the mesenteric veins and even the aorta, all leading to hemo-peritoneum and/or retro-peritoneal hematomas. Additionally, but of less seriousness, are injuries to abdominal wall vessels and the rectus sheath, which, fortunately, are immediately recognizable and therefore, generally, stopped by applying constant pressure for a few minutes between the internal and external gastrostomy bumpers and over the abdominal wound^[3,8]. A negative paradigm is if the operator, despite recognizing a large intramural hematoma in progress, stops the procedure. The expansion of the hematoma would be controlled if, it was immediately compressed by the bumpers after finishing PEG insertion^[76].

On the other hand, although there are detailed guidelines and strict warnings to stop some antiplatelet drugs there are cases where these are not heeded. When the endoscopist decides to perform the PEG simply at the request of the treating physician, despite the ⁵ European Society of Gastrointestinal Endoscopy (ESGE) recommendations on anti-coagulant use^[4,93,94], the responsibility rests is entirely with the endoscopist. There is no case for an urgent endoscopic gastrostomy.

Splanchnic viscera injuries

Among the described injuries to the small bowel and colon causing peritonitis, as well as to the spleen and pancreas due to over-inflation of the stomach followed by rotation along the organ axis, three cases of great importance need to be noted^[8,86,87]. The first is an esophageal intussusception and then transection in a 3 mo boy, of 3.7 kg body weight, to whom insertion of an adult gastrostomy tube of 18Ch was attempted^[77]. The second case is a gastric volvulus, following insertion of the PEG into the posterior gastric wall, due to stomach over-inflation, finally causing compromised gastric emptying^[79]. The third is the case of an obese, multi-trauma patient; without trans-illumination, 3 puncture attempts at a 45° angle, resulted in a gastrostomy placement but also to an esophageal perforation which were fortunately recognized after 14 d suffering mediastinitis^[78].

Further comments

It is common sense that PEG-procedure-related complications are undoubtedly associated with the endoscopist's skill and adherence to the basic principles of good practice; both an inexperienced and a super-expert endoscopist, based on the one hand on lack of skill and the other on an excess of confidence are likely to be implicated in an iatrogenic injury. While the inexperienced practitioner would probably persist longer, possibly resulting in a serious complication, likely to remain temporarily unrecognized, an expert might consider that he could rush the rules, because of his skill, and thus also involve the patient in severe complications, only recognized much later.

But what is the meaning of 'inexperienced' and 'super-expert' in relation to the endoscopist? Practically, an experienced practitioner is somebody well-trained in the past, who continuously renews his skills and maintains his competence by means of frequent, repetitive practice over the years. Officially, there is no standard curriculum for endoscopy training in performing PEG, as with many other, much newer interventional techniques. The latest curricula, from 2019 thereafter, issued by the ESGE are those for training in performing endoscopic retrograde cholangiopancreatography (ERCP), endoscopic ultrasound and electrostatic discharge (ESD), which highly recommend a

minimum, non-interrupted training period of 12 mo in a high volume, qualified, training center and involving the performance of more than 300 ERCPs. As a foundation, the endoscopist should have previously achieved competence in upper gastrointestinal endoscopy, through personal experience of at least 300 gastroscopies, followed by at least a further year, and ideally 3 years, of dedicated training is likely required to reach competence. For ESD, initial experience of at least 20 procedures in animal or *ex vivo* models are highly recommended, and in order to maintain proficiency ESGE recommends a minimum case load of 25 ESD procedures per year to demonstrate maintenance of competence. The attainment of competence in interventional or therapeutic endoscopy is not a single event, but a career-long process - meaning that endoscopists should be continually performing such procedures^[95-97].

In this commentary review, we discuss the existing evidence of major procedural complications after a PEG insertion, while focusing on the exact cause of malpractice, as documented by cases meticulously collected from the literature over a period of more than 35 years. In other words we have tried to find and underline the errors in the manipulations made which result in each specific complication.

Initially we note that the serious complications may occur related mainly to the type and location of the needle puncture^[62,63]. However, to the best of our knowledge, few reports have addressed the relationship between PEG site and complications. Lee *et al*^[13] found by a multivariate analysis that PEG tube insertion in the upper body of the stomach was a significant risk factor for complication occurrence, the most obvious reason being the relatively long distance between the gastric and abdominal walls in the upper body as compared with the lower gastric body; this distance producing stronger tension between the abdominal and gastric walls during stomach contraction, inducing slow or incomplete adherence and thus fistula formation^[92].

An experienced endoscopist, prior to performing the PEG procedure, lays the patient in a reverse or anti-Trendelenburg position, so that viscera moves downward to the pelvis. He/she also avoids overfilling the stomach and small bowel with air which may 'lift' the transverse colon and increase the probability of colon, or even intestinal injury.

She/he then checks thoroughly for the proper trans-illumination ¹ through the abdominal wall of the light source of the distal tip of the endoscope, and ensures the endoscopically ¹ visible imprint of his finger palpation on the patient's skin, at the center of the site of maximum illumination^[7,85,90,98,99]. He/she is also extra cautious in the case of previous abdominal surgery, which remains a relative contra-indication for the young and inexperienced endoscopist^[88], as is also obesity. In every case, he is careful to insert the needle strictly at a 90° angle to the skin, to ensure both the shortest route of the tube within the body and, mainly, so the abdominal opening is in line with the gastric opening, both of which will facilitate the proper adhesion between stomach and abdominal walls. When the two openings are not aligned, the tension is likely to lead to tube dislodgement and peritonitis. Finally, he/she avoids multiple needle punctures - failure means that there is a violation of rules of trans-illumination and finger palpation, and even one additional puncture may be the cause of peritonitis or severe bleeding.

When transillumination or visible imprint or both are not clear, the endoscopist must understand that she/he violates the standard requirements and take full responsibility for any subsequent complications. Phrases such as "I have the feeling the stomach is just behind the xiphoid" are absolutely inappropriate, indeed ¹ wrong, and a bad example for younger endoscopists. The same applies to the use of the ¹ "safe tract" technique, which is endoscopic visualization of the ¹ needle and simultaneous return of air into the fluid-filled ^[85]. Return of fluid or gas prior to endoscopic visualization of the tip of the needle in the stomach lumen ⁶ when it is inserted under continuous suction, means that the needle has passed through another organ ⁶ interposed between the stomach and the abdominal wall, although a negative test does not provide a hundred percent certainty of no viscera in-between^[45].

CONCLUSION

As a conclusion, we have to accept that complications will continue to occur, even in high volume centers with well qualified practitioners; however, both young and experienced endoscopists must understand and deeply believe that they will not be blamed for

stopping a PEG procedure in the case of obscure trans-illumination and an unsatisfactory palpation test; and much more in the case of a previously operated abdomen. On the contrary, they will and should be blamed in the case of a preventable injury, which may finally cost even the life of an albeit high risk patient.

ARTICLE HIGHLIGHTS

Research background

This study was carried out by specialists who are involved on a daily basis both in the performance of gastrostomies and in the management of their complications, which often have disastrous consequences. this study aims to identify the problem internationally and to find possible methods of preventing them

Research motivation

Trying to figure out and analyze the percutaneous endoscopic gastrostomy (PEG) tubes' complications, and focus on those that could be predicted and furthermore avoided.

Research objectives

To investigate the international literature in order to clarify the importance and the severity of these complications, and the possible ways of avoiding them

Research methods

A 30-year database research was carried out, investigating the literature on PubMed, using the terms “percutaneous endoscopic gastrostomy” AND “complications”, and all the case reports or case series were included, with the only language restriction being the Chinese.

Research results

They were identified 2308 articles. Only 575 were included according to the research criteria placed. After expertise investigation, 88 articles were in the final selection.

Research conclusions

The complications that can arise from the potentially simple technique of the PEG are of great concern to the international scientific community

Research perspectives

Avoid complications of PEG tube placement.

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