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Review Article

History, application, procedures, and effects of intermittent oral catheterization (IOC)

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ABSTRACT
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Intermittent catheterization (IC), developed in Japan, involves inserting a catheter or feeding tube from the patient's mouth or nose for the purpose of dysphagia rehabilitation or feeding. Among the various IC methods, intermittent oral catheterization (IOC) involves inserting a catheter from the mouth to the lower part of the esophagus or stomach. Because the gag reflex is decreased in encephalopathy patients with dysphagia, oral insertion of a catheter is generally easy, and can be applied to patients who are capable of complaining of incorrect insertion or showing an objective symptom (regardless of dementia, etc.). IOC is effective for dysphagia patients, including those with cancer of the oral cavity or head and neck, neuromuscular disease, and for stroke patients in the acute convalescent, and chronic stages. Stroke patients receiving IOC showed higher oral intakes of regular meals than patients fed by a gastrostomy tube or continuous nasogastric catheterization (CNG). IOC care requires less monitoring and restraining time than CNG and results in better stomach discharge function than a gastrostomy. Gastrostomy should be applied to patients for whom IOC is not applicable or those in the convalescent stage who previously received IOC but who require alternative nutrition over a long period because only small amounts can be ingested via IOC.
Key words: intermittent oral catheterization (IOC), dysphagia, gastrostomy, continuous nasogastric catheterization

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History of IOC

Intermittent oral catheterization (IOC) was first reported in 1985 by Funahashi et al. [1] as an "oral Nelaton method" (named for the kind of tube used) for feeding severely multiply handicapped children. They reported cases in which indigenous *Pseudomonas aeruginosa* disappeared from the pharynx when the feeding method was changed from continuous nasogastric catheterization (CNG) to IOC as well as a reduction in fatal cases. In 1988, Taylor et al. [2] reported in a short, two-page communication a technique similar to IOC, using the name "intermittent oro-esophageal tube feeding." The method was characterized by feeding liquid nutrient into the esophagus via high-speed injection (50 ml/min), which was five to six times faster than the ordinary feeding speed using CNG [3]. In 1991, Kisa et al. [4] conducted a replication study of the "oral Nelaton method" on encephalopathic children with dysphagia and obtained favorable results. A replication study was also conducted on an elderly patient with dysphagia due to stroke, which became the first adult application of IOC in Japan. In 1992, Kisa et al. [5] reported the outcome of using the "oral Nelaton method" for dysphagia following stroke. In 1993, Fujishima [6] referred to Taylor et al.'s intermittent oro-esophageal tube feeding technique as the "OE method". In 1994, Saitoh et al. [7] praised the significance of IOC by assuming the concept of IOC for intermittent tube feeding (ITF). In 1997, Tsujiuchi et al. [8] applied the idea of ITF and reported on intermittent tube feeding via the nose for oculopharyngeal muscular dystrophy patients with dysphagia. In 1997, an English report by Kisa et al. [9] described the outcome of using IOC for adult stroke patients with dysphagia. Here, they gave the general name "IOC" to the techniques ("oral Nelaton method" and "OE method") that involve

inserting a catheter from the oral cavity. The following are descriptions of the three major replication study reports on IOC in the medical field excluding nursing. Nohara et al. [10] reported successful the application of this method for five of six patients who had undergone oral tumor removal: the one exception had a strong gag reflex. Fujimoto et al. [11] reported that independent oral intake was achieved in 25 of 32 patients, for whom recovery from dysphagia after removal of head and neck cancer was difficult. Nozaki et al. [12] reported that IOC was effective for helping an amyotrophic lateral sclerosis patient to accept a gastrostomy.

Classification of tube feeding methods including IOC

Kisa et al. [9] organized the system of tube feeding methods, classifying them based on 1) where the catheter is to be inserted and positioned, and 2) whether the catheter is to be replaced intermittently or retained continuously over a certain period. According to these principles, the intermittent oro-esophageal (IOE), and oral Nelaton method, and intermittent oro-gastric catheterization (IOG), where the tip of the catheter is positioned in the gastrium are both included in IOC. The current classification of tube feeding methods, excluding gastrostomy and intestinal fistula, was organized by the authors based on the classification by Kisa in 1999 [13], and is shown in Fig. 1.

IOC as a tube feeding method for dysphagia rehabilitation as well as feeding

As with a gastrostomy, IOC can prevent the adverse effects of a transnasal catheter on swallowing by removing the catheter used for CNG [14–16]. A possible advantage of IOC compared to gastrostomy is that a catheter causes contact stimulation of the lips, tongue, and pharynx when it is inserted. As shown in Fig. 2, as the catheter advances it pushes the retropharyngeal wall and thus possibly increases the sensory stimuli for inducing swallowing movements [9]. Saegusa et al. [17] focused on IOC as a means of dysphagia rehabilitation that does not use food and devised a method of dysphagia rehabilitation that involves inserting a catheter from the nasal cavity to the esophagus and moving the tube synchronously with swallowing movements such that the tube remains in the pharyngeal cavity. Using this method, they improved the subjective evaluation of swallowing in 24 of 26 patients with dysphagia of the pharyngeal stage and obtained improved pharyngolaryngeal diagnosis under an endoscope. For three patients, long past disease onset and with backgrounds in which the natural course was not-likely involved, the movement of elevating the epiglottis was compared before and after the treatment. Based on the results, they

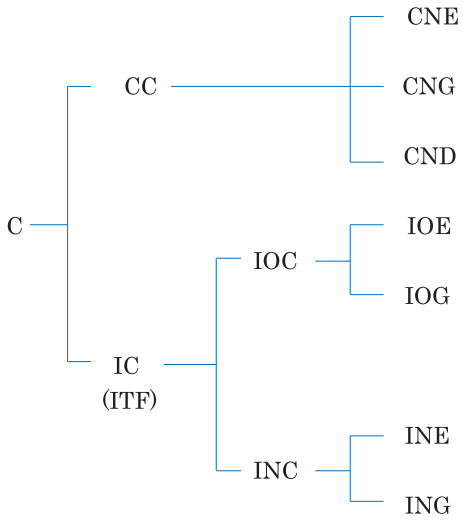

Figure 1. Classification of tube feeding procedures.
CND that positions the tip of the catheter in the jejunum is continuous naso-jejunal catheterization (CNJ). IC in which patients inserts the catheter by themselves should be indicated by "self".
C, catheterization (catheter feeding); CC, continuous catheterization; IC, intermittent catheterization; ITF, intermittent tube feeding; IOC, intermittent oral catheterization; INC, intermittent nasal catheterization; CND, continuous naso-duodenal catheterization; CNE, continuous naso-esophageal catheterization; CNG, continuous naso-gastric catheterization; IOE, intermittent oro-esophageal catheterization; IOG, intermittent oro-gastric catheterization; INE, intermittent naso-esophageal catheterization; ING, intermittent naso-gastric catheterization.

concluded that the sensory stimulus input from the tube possibly stimulated the part of the medulla oblongata responsible for the swallowing pattern and its output system. Some patients treated with IOC show movements that resemble sucking the tube, and thus IOC possibly improves oral cavity movements [9, 18]. To use an IOC-like feeding tube for dysphagia rehabilitation, "sucking a noodle" training has been proposed [18].

Thus, IOC is useful not only for feeding but also for rehabilitation. When administering IOC, it is easy to check for signs of improved swallowing at each insertion, such as a gag reflex at the time of inserting the catheter and an improved swallowing reflex, and to judge the patient's ability to ingest food. Therefore, IOC can be an effective means for rehabilitating ingestion and swallowing by combining it with an indirect dysphagia rehabilitation program that uses specially prepared food in stages [19]. —IC, including IOC and ING (Fig. 1), is an option in the course of rehabilitating ingestion and swallowing while monitoring respiratory tract protective reflexes against aspiration, and can also be used as an alternative means of providing nutrition to a patient who has difficulty ingesting a sufficient amount

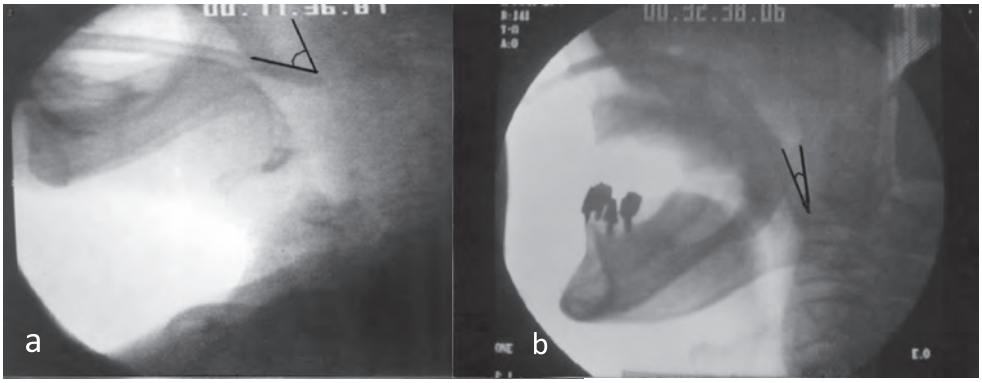

Figure 2. Advantage of wide insertion angle of the catheter to the wall of the pharynx in IOC. The insertion angle is wider in IOC (a) than in CNG (b). Therefore, in IOC the catheter, which tends to become straight, progresses by pushing against the wall of the pharynx, tends to move toward the esophagus, and has a low risk of incorrect insertion into the trachea.

of food. The Japanese Society of Dysphagia Rehabilitation has presented special foods for dysphagia rehabilitation (2013), which are in the forms of jellies and pastes. If a patient in the rehabilitation stage cannot ingest a sufficient amount of food, alternative nutritional feeding via IOC can be used.

Application of IOC

To tube-feed food as an alternative way of providing nutrition to a rehabilitating patient, the applicability of IOC should first be investigated. For patients with a strong gag reflex, for whom IOC is not applicable, ING is a possible option. If the patient is expected to require tube feeding over a short period, the use of CNG, which uses a thin tube, should be considered. For a patient expected to require prolonged tube feeding, a gastrostomy should be considered. For a patient for whom IOC was used in the convalescent stage but requires alternative nutrition provision over a long period due to the inability to ingest a sufficient amount of food, a gastrostomy should also be suggested [20]. In Izumo District, there are cases in which patients are cared for at home by continuing with IOC, but most patients who had a gastrostomy leave the hospital showing smooth progress after correctly deciding on the gastrostomy procedure [21].

Among pediatric and adult dysphagia patients that require some sort of tube feeding, IC is only applicable for those patients who are capable of complaining of incorrect catheter insertion or showing some objective symptom. Dementia, higher brain dysfunction, or other similar disorders are not a problem as long as the patient can cooperate in the implementation [7]. Among IC methods, IOC is applicable only for patients who have a decreased gag reflex. According to Tokuda et al. [22], of 67 patients undergoing videofluorography (VF), 67% had no gag reflex, and 12% showed a decreased gag reflex. Paralysis, dementia, and bilateral and multiple lesions affected the degree of gag reflex reduction. This suggests that IOC is likely applicable to a large percentage of patients with encephalopathy or one of the aforementioned diseases. On the other hand, it is difficult to apply IOC to patients with normal gag reflexes. For such patients, ING is a suitable alternative IC for feeding nutrition.

Questioning the need to perform X-ray photography each time a catheter is inserted is a moot point, as IOC is not applicable for patients with severe consciousness disorder or severe dementia, and those in a vegetative state or other states from whom signs of incorrect insertion of the catheter into the trachea are difficult to detect.

After the catheter is inserted, the patient must produce a sound, and the voice should be checked for hoarseness. The intra-gastric liquid should then be sampled using a syringe and is checked that it is indeed gastric juice. IOC is applicable only for those patients who can undergo such procedures so that the position of the catheter can be confirmed. Other patients are not within the scope of IOC application, and the procedure must be avoided.

IOE is capable of high-speed feeding (50 ml/min), however, high-speed feeding of liquid nutrients into the esophagus of a patient with reflux esophagitis, and weak or absent esophageal peristalsis, causes the risk of the nutrients flowing backward toward the oral cavity and thus causing aspiration. Therefore, IOE is applicable for patients with normal esophageal peristalsis [23, 24]. IOE is an option for those patients who cannot undergo a gastrostomy.

Methods of performing IOC

The various procedures and demonstrations of IOC are shown in Table 1 and Fig. 3 [23, 24]. A catheter that is widely used in IOC is shown in Fig. 4. Figure 5 shows helpful tools used when smooth IOC is inhibited by the masseter or extrusion reflexes. The key to safe and smooth performance of IOC is correctly

Table 1. Procedures for IOC

1. Catheter to be used. ● A flexible but not too soft catheter that does not transmit X rays should be used. The manufacturer is not important as long as the product is appropriate for the purpose. ● For patients with no gag reflex, a rubber nutrient catheter (IZUMO Health) No. 6 (18Fr) for adults and No. 3 or 4 for children, to induce swallowing reflex movement. ● If the gag reflex remains and it is difficult to insert the catheter, a No. 5 (15Fr) should be used. New enteral feeding tubes (Coviden Japan) 8−12Fr are also easy to use. They have a spherical end (weight part) and a stilet, are flexible but not too soft, and are easy to insert even though they are thin.
2. Preliminary treatment of the catheter before insertion. ● Wet the surface of the catheter, check that the oral cavity and the pharyngeal mucous membrane are sufficiently moist, and insert the catheter without applying anesthetic jelly (lidocaine jelly). ● For patients with no risk of impaired swallowing, saliva, honey, or fragrance may be applied to the catheter to encourage the patient to swallow it. ● The swallowing reflex is easy to induce by cooling the catheter in advance.
3. Posture while inserting the catheter and insertion method. ● Guide the patient to an seating or reclining sitting position for inserting the catheter into the moistened mouth. ● Guide the patient to open their mouth about 1 cm. Insert the catheter from the healthy corner of the mouth so as to slide it along the wall of the pharynx on the paralyzed side. The catheter may be obstructed by the epiglottis when it is inserted from the middle. ● For patients who have lost a tooth and have a window-like opening between the teeth, it is convenient to insert the catheter through the opening. ● Guide the patient to rotate their head in the direction of the corner of the mouth through which the catheter is to be inserted and pull their chin forward, which should open the pharynx and facilitate insertion of the catheter. ● Inserting the catheter at too small an angle may cause it to twist in the mouth, so the angle should be controlled. ● If the catheter twists, insert a stilet or guide wire to increase the firmness of the catheter. ● A gag reflex tends to be induced by the catheter hitting the posterior wall of the pharynx. In most patients the reflex disappears or decreases to a level that does not constitute a problem after practicing several times. ● For patients who have some gag reflex remaining, the initial insertion should be performed by an expert, as the experience of the first insertion has a great impact on the patient. ● When a slight resistance is felt (entrance of the esophagus), guide the patient to swallow the catheter and move it forward along with the movement. ● Even if the patient cannot swallow the catheter, it can usually be inserted just by pushing it. ● When the tongue root blocks the route of the catheter, pull the lower jaw frontward and insert the catheter.
4. Method of checking the placement position of the catheter. ● Checking the position of the catheter just by listening for the sound of air bubbles is unreliable, mistakes have not been reported for IOC, but they have been reported for CNG. The position should thus be confirmed by sampling the contents of the stomach (such as gastric juice). If the juice cannot be sampled, wait 30 min so that gastric juice accumulates in the stomach and then take a sample. ● When it is difficult to judge whether the specimen is gastric juice or a secretion from the trachea, measure the pH of the specimen. (This method is not reliable for patients to whom an antacid is administered because the pH of the gastric juice may exceed 6 in such a case.) ● When the position of the catheter cannot be confirmed by these methods, suspend IOC. ● Prior to feeding nutrients or other agents, check that the patient's voice is not hoarser than prior to the insertion, and reconfirm the position of the catheter in the oral cavity by the marking on the catheter. For further assurance, feed 10 ml of a physiological saline solution or cooled boiled water, observe the conditions and auscultate the chest of the patient, and then feed the nutrients or other agents.
5. Feeding via the catheter and storage of the catheter. ● For IOE (OE method) retract the opening of the catheter to the lower part of the esophagus. ● When the position is determined, fix the catheter. Start feeding the nutrients. ● At the first feeding, a physician should decide the feeding speed by observing the state of the patient. Normal speeds are 20 to 50 ml/min (20 ml/min in IOG, 50 ml/min in IOE). Keep the patient in a reclining sitting position for 30 min after feeding. ● The catheter should be used exclusively for a given patient. After use, remove, wash with water, dry in shade, and store for the next use.

There is no conflict of interest with any manufacturers mentioned. (adapted from References 9, 23, and 24)

Figure 3. Examples of administering intermittent oral catheterization (IOC).
(a) Preparing to drip the nutrient in IOE (an IOC methods that can drip nutrient at a high speed).
(b) Oral insertion of the catheter being orally inserted with an aid.
(c) Self-insertion of the catheter.

appropriately judge its applicability to the patient. When used on the appropriate patient, the procedures are not difficult or complicated.

Among the IOC methods, IOG positions the tip of the catheter in the stomach as in CNG and thus is easy for beginners. Compared with IOG, IOE requires an additional procedure of retracting the tip of the catheter, which has been inserted into the stomach, to the middle or lower part of the esophagus.

In IOC, the insertion angle of the catheter toward the wall of the pharynx is wider than in CNG, unless the cervical spine is hyperextended at the neck (Fig. 2). The catheter used for IOC is flexible but not too soft, and thus it moves forward along the wall of the pharynx [9], reducing the risk of the catheter progressing toward the laryngeal aperture compared to CNG. Taylor et al. [2] reported that there had been no incorrect insertion into the trachea in 8,000 insertions, there were no incorrect insertions into trachea. We have performed IOC more than 10,000 times for home-care patients, and have not faced this problem. According to Umaki [25], who performed and instructed IOC for 40 home-care patients, family members mastered the skill after practicing 1 to 3 times and were able to continue the treatment without any problems.

Possible problems with IOC

IOC should be suspended or carefully performed in any of the following situations: 1) the patient exhibits a masseter reflex and does not open their mouth during insertion of the catheter or bites the catheter when it is inserted in the mouth, and 2) there is involuntary tongue movement, causing the catheter to twist inside the oral cavity, which inhibits its insertion. Measures against these problems [26, 27] and tips [28] for performing IOC are shown in Table 1. For patients with oral dyskinesia, which causes the catheter be gradually moved back toward the oral cavity, it is safer to insert the catheter down to the stomach rather than to the esophagus.

In patients with a cervical osteophyte notably projecting to the pharyngeal cavity, there is a risk of the catheter tip injuring the pharyngeal mucous membrane at the osteophyte [7]. In the case of Zenker's diverticulum, there is a risk of the tip of the catheter entering into the diverticulum. If there is an ulcer in the esophagus or stomach, there is a risk of injury to the ulcer caused by the tip of the catheter [7]. Such complications are rare but should be examined in advance by imaging, etc.

Figure 6 shows ulcers in the lower part of the esophagus caused by reflux esophagitis. In such patients, esophageal peristalsis and stomach discharge function are low [29]. To administer IOC under these circumstances, the disease should be treated in parallel, liquid nutrition should be fed slowly, and IOG should be the selected methods, as it positions the tip of the catheter inside the stomach where the storage capacity is larger than at the esophagus, and is thus safer. Moreover, medication for preventing gastroesophageal reflux and improving the stomach discharge function [30] should be used as well as semi-solid food [29], Taking these factors into consideration, the first

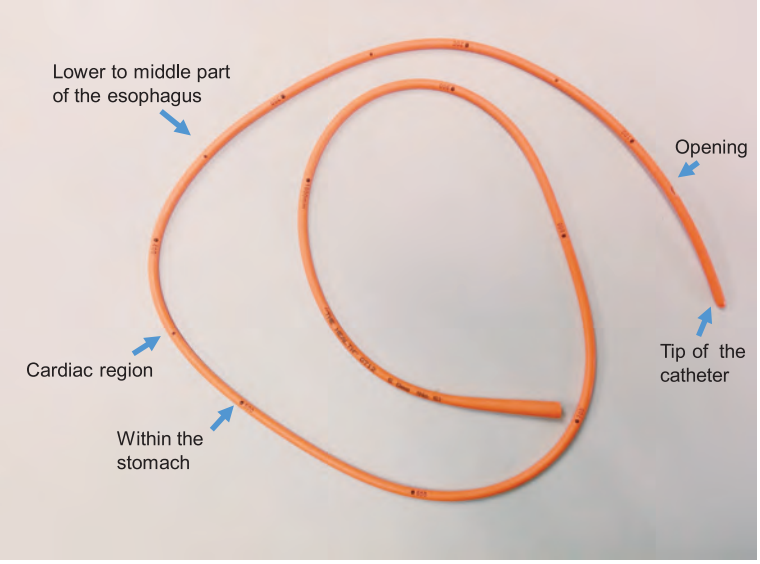

Figure 4. Example of a catheter appropriate for IOC.
Rubber nutrient catheter No. 5 (15 FR) manufactured by IZUMO Health. The catheter is flexible but not too soft and is easy to insert. Some products have a widened outer flange to facilitate joining with the pack of nutrients to be tube fed. The catheter has marks spaced at 10-cm intervals so that it easy to know the insertion depth. The arrow shows the standard depths.

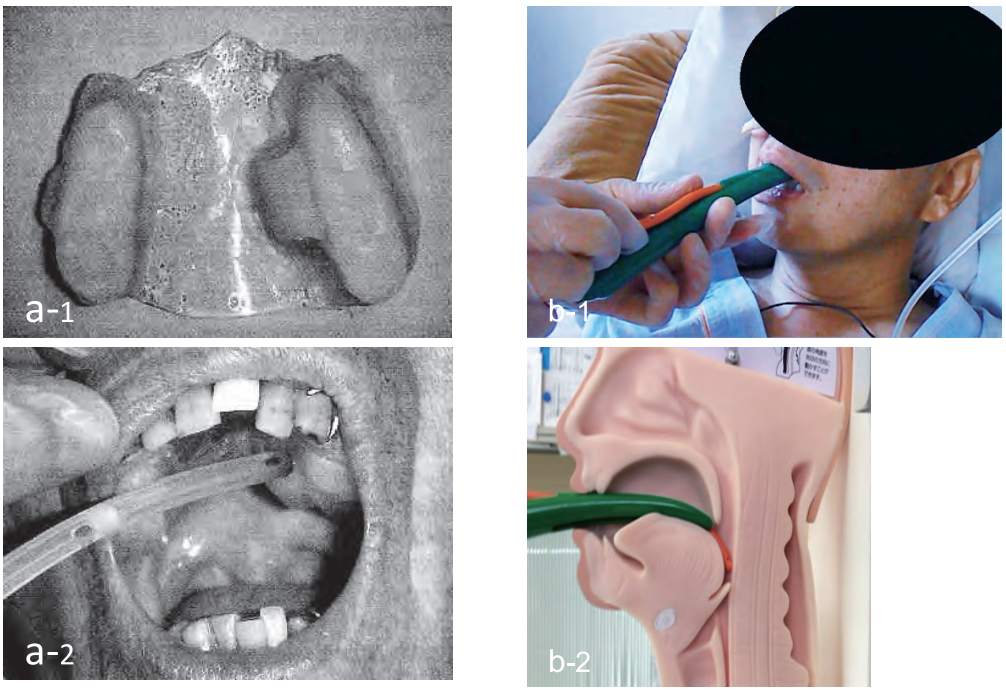

Figure 5. Aids to help with the insertion of IOC catheters.
When it is difficult to insert a catheter into the oral cavity due to masseter reflex, an oral catheter holding bed (a) and an oral cavity device (b) may be useful.

feeding via IOC should be performed under the supervision of a physician.

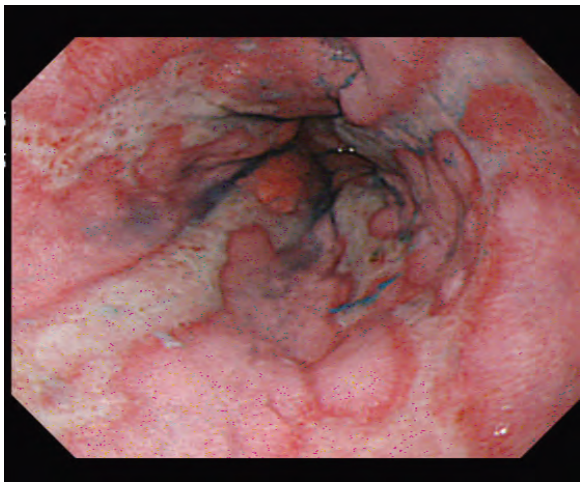

Figure 6. Multiple ulcers in the lower part of the esophagus developed after reflux esophagitis.
Staining showing severe belt-like ulcers (grey areas; Class D in the Los Angeles Classification) in many places. Inflamed mucous membrane (red) looks red due to the increased transparency of blood vessels. In this state, esophageal peristalsis is likely to be almost completely absent, and it is dangerous to feed food via IOE as it may cause reflux in the esophagus.

Comparison between IOC and other tube feeding methods

1. Ability to ingest regular meals

In 1997, Kisa et al. [9] compared 30 stroke patients with dysphagia treated with IOC and 29 treated with CNG, and reported that oral intake of regular meals was significantly higher in the IOC group (69.0%) than in the CNG group (36.7%). In 2009, Kisa et al. [31] compared the percentage of oral intake of regular meals among IOC, CNG and gastrostomy groups with similar clinical backgrounds and reported that IOC showed the best results (Fig. 7).

Kisa [21] followed the progress of 168 patients in the Izumo District (population: 170,000), who were hospitalized in acute care hospitals after experiencing a stroke and who suffered from dysphagia over a long period (Fig. 8). According to the survey, who covered a period of four years, oral intake of regular meals was lower in patients who were tube fed for at least one month at the time of leaving the acute care hospital (22.6%), compared to those who were transferred to a care facility at the time of leaving the hospital (41.8%). Oral intake of regular meals was highest in patients fed via IOC (54.5%), slightly lower in those fed via CNG (36.7%) and lowest in those fed via gastrostomy (12%).

Sugawara et al. [32] classified dysphagia patients who were hospitalized in a convalescent or rehabilitation institute due to a cerebrovascular disease into those who

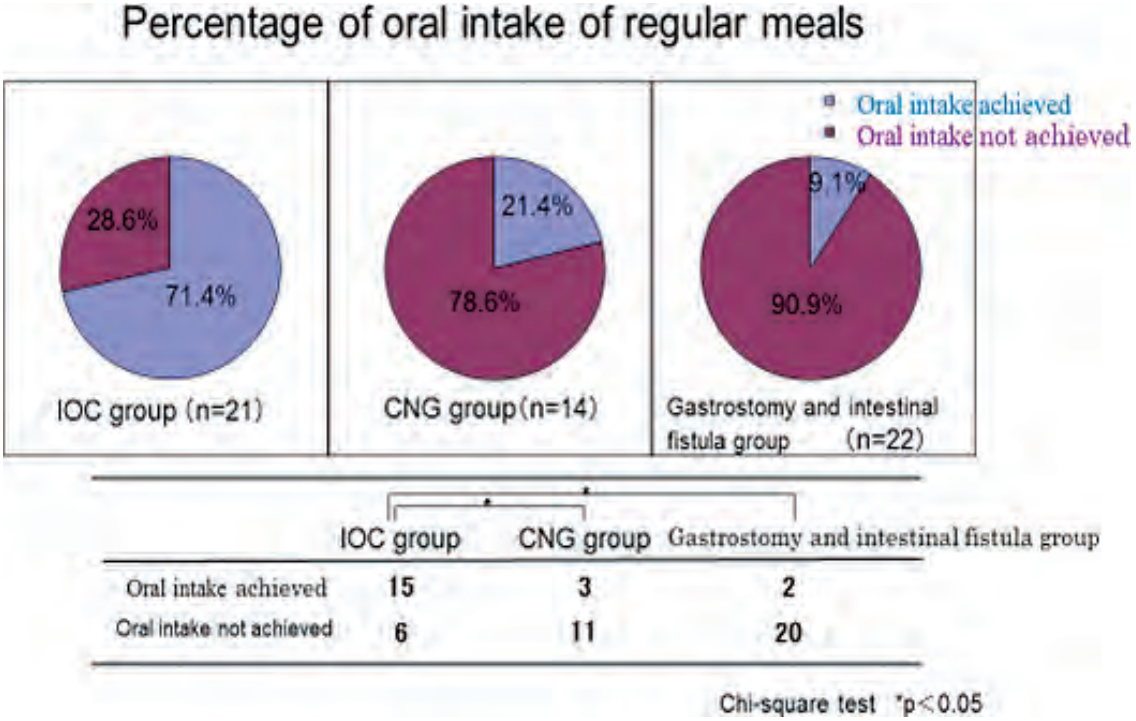

Figure 7. Oral intake of regular meals (% of patients) among nutrient feeding methods.
Among the three patients groups with similar clinical backgrounds, the oral intake of regular meals was significantly higher in the IOC groups than in the other alternative nutrition groups.

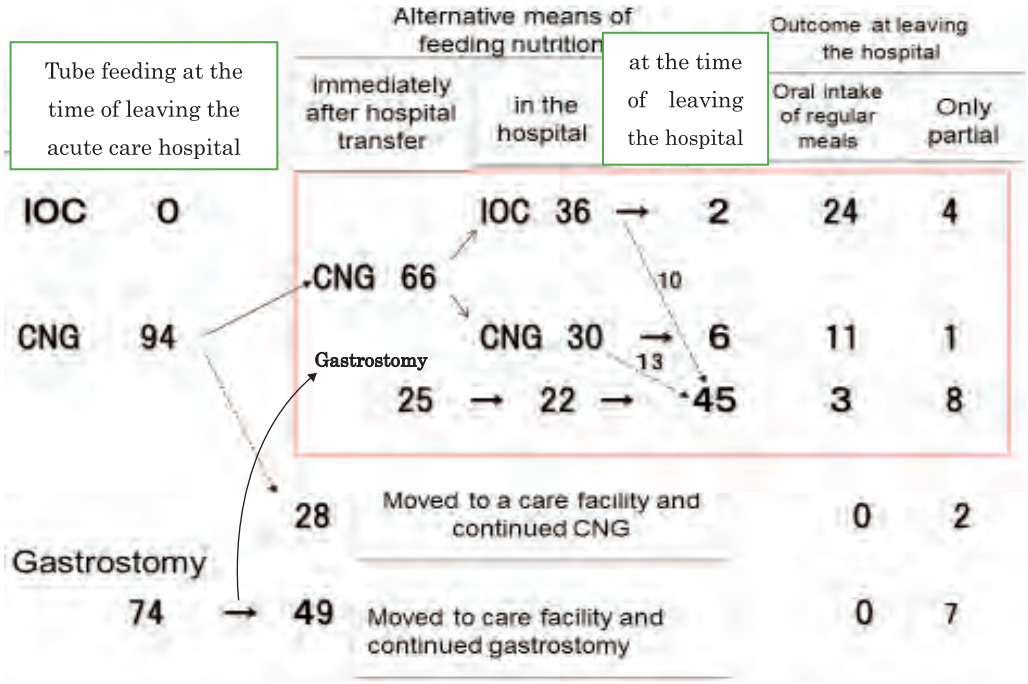

Figure 8. Oral intake of regular meals by tube-fed stroke patients in Izumo District.
The progress of 168 patients was followed for about 4 years. The range within the solid lines denotes the progress in a rehabilitation institute.

were fed via CNG (398 patients, NG group) and those via IC (114 patients, ITF group) and compared their of swallowing outcomes. The percentage of patients who received their necessary nutrients entirely via oral intake was significantly higher in the ITF group (71%) than in the NG group (53%).

Also, in a report on the dysphagia rehabilitation of patients in the chronic phase, the percentage of those who regained oral intake was higher in the IOC (37.2%) than in the gastrostomy (12.1%) group [33].

2. Aspiration pneumonia and stomach discharge function

A number of reports have compared aspiration pneumonia and stomach discharge function outcome in patients who underwent a gastrostomy and CNG, but there are few that compared gastrostomy and IOC. In a report comparing the—5-year mortality in long-term care patients fed via gastrostomy and IOC, the percentage of patients with aspiration pneumonia and mortality was significantly higher in the gastrostomy group than in the IOC group [33] (Fig. 9). Kisa et al. [31] investigated the underlying reason for the higher ratio of aspiration pneumonia in patients fed via gastrostomy than via IOC by feeding barium balls via the gastrostomy catheter (Fig. 10) and found that the stomach discharge function was significantly lower in the gastrostomy group than in the IOC group. Barium balls [34, 35] are a contrast medium consisting of flexible spheres several millimeters in diameter used for evaluating gastrointestinal motility. They are inexpensive and available in various sizes, enabling an appropriate size to be chosen for the purpose of each test.

There have been several studies on reduced stomach discharge function due to gastrostomy. In a 4-week follow-up of percutaneous endoscopic gastrostomy (PEG) by Ono et al. [36], no reduction in the stomach discharge function was observed. On the other hand, Ogawa et al. [37] reported that feeding a patient via a PEG tube over a long period, particularly via a reconstructed PEG tube, can possibly lead to lowered stomach discharge function and resultant gastroesophageal reflux. An investigation by Kisa et al. [31] also suggested that by fixing the gastric wall to prevent the fistula from being damaged when changing the tube and the tube from being accidentally removed, it is possible to inhibit peristole and to lower stomach discharge function. Ono et al. [36] also mentioned that it is not possible to deny the negative effects of fixing the gastric wall at three or four points (large-area adhesion) on the stomach discharge function. Even after the gastrostoma is no longer necessary and the catheter is removed, the stomach remains adhered and fixed to the abdominal wall [38]. Moreover, the sluggish feeding of liquid nutrients through the gastrostomy tube does not extend the gastric wall, resulting in the delayed discharge of stomach contents [31, 39]. However, delays in stomach discharge function have been reported in patients fed via CNG (barium balls being retained in the gastric cavity even two hours after feeding) [35] (Fig. 11). Thus, it is

likely that CNG already lowers the stomach discharge function, and the gastrostomy lowers it further.

On the other hand, Tsukamoto et al. [40] conducted imaging in two patients to investigate whether the OE methods promoted peristalsis, which starts from the esophagus, and reduced diarrhea. It is possible that IOC promotes the stomach discharge function by the inserted catheter, expanding and stimulating the wall of the esophagus and by stimulus that induces peristole [41]. It is also possible that IOE, which involves feeding nutrients into the esophagus, further leads to high-speed discharge. In fact, according to Kisa et al. [35], nutrients were mostly discharged through the gastric cavity 25 min after feeding and entirely discharged in 50 min as shown in Fig. 12, and thus the stomach discharge function was judged not to have been reduced not lowered in elderly patients fed via IOG. IOC methods, including IOG and IOE, are likely to be enteral nutrition methods that can prevent decreased stomach discharge function.

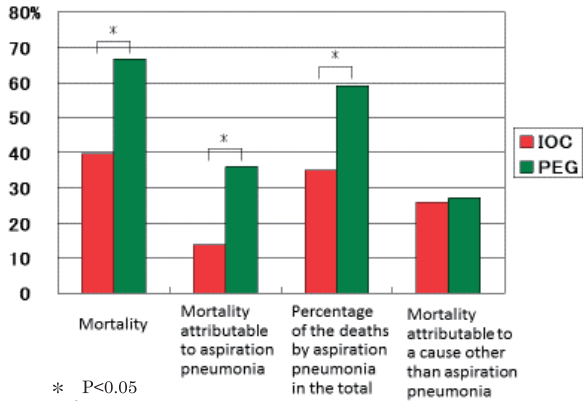

Figure 9. Mortality of patients in convalescent wards in a general hospital over 5 years and percentage of the deaths by aspiration pneumonia in the total number of deaths.
Both the mortality and the percentage of deaths by aspiration pneumonia were significantly lower in the group fed via IOC than in those fed via gastrostomy (using PEG).

3. Other complications

It is now easy to perform a gastrostomy using an endoscope, but it is still a surgical procedure that involves puncturing the abdomen. Although the frequency of occurrence is low, a complication may occur when performing a gastrostomy or exchanging the catheter [42]. Some of these complications can be life-threatening, and gastrostomy is reported to have a direct risk of about 10% [20]. Increased risk of recurrent stroke due to suspended application of antiplatelet or anticoagulant agents prior to the surgery is one such risk [43]. Rehabilitation may need to be suspended when the risk is actualized. Possible complications after PEG are shown in Table 2.

Control and exchange of the PEG catheter are also troublesome. Ordinary catheters must be exchanged every 3 to 6 months. The balloon type requires monthly exchange. The balloon also needs to be checked for expansion. On the other hand, IOC does not require visits to the hospital for catheter exchanges, thus making it low cost.

The risk of developing a complication is also low in IOC. Out of a total of 202 IOC cases in Izumo District until 2013, only four showed a complications (2%, consisting of overspill of liquid food from the mouth at the first IOC feeding or its incident in two cases, injury to an ulcer on the esophagus causing hemorrhage at the time of inserting the catheter in one case, and

Figure 10. Feeding test of barium balls through gastrostomy catheter.
To investigate the underlying reason for the high percentage of aspiration pneumonia in gastrostomy compared to IOC, barium balls were pressure fed through the gastrostomy catheter (a) by pushing the cylinder (b) with which the stomach discharge function was to be measured.

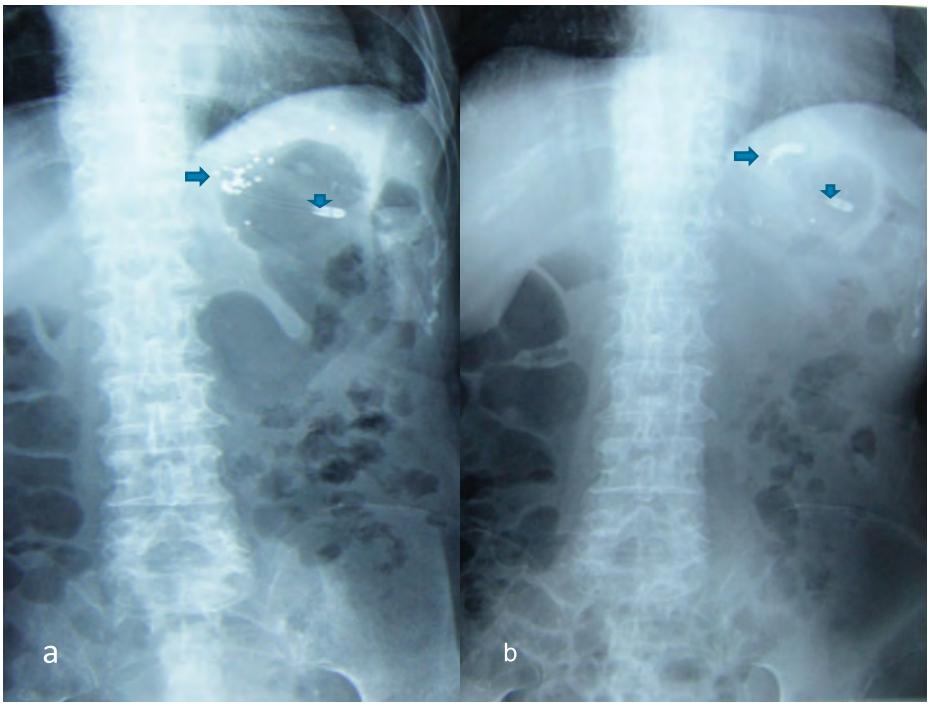

Figure 11. Stagnated stomach discharge function in a patient fed via continuous nasogastric catheterization (CNG).
X-ray imaging showing (a) Barium balls (long arrow) fed into the stomach. (b) Two hours after feeding, the barium balls still remained in the stomach. The shot arrow shows the tip of the CNG catheter.

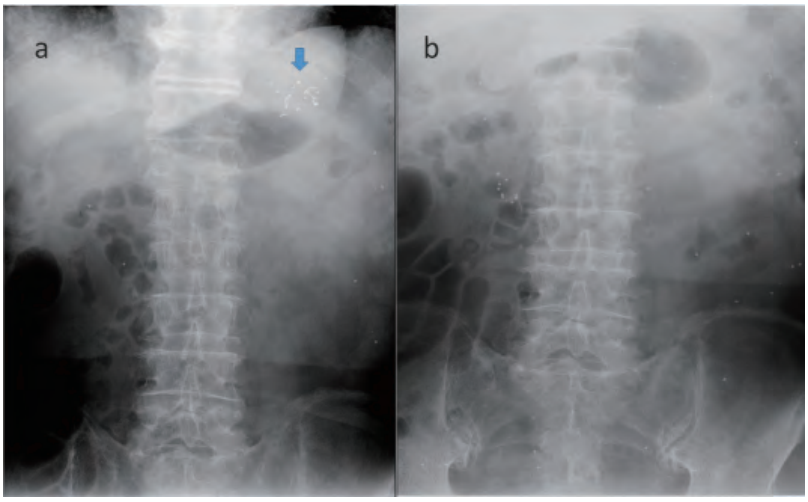

Figure 12. Stomach discharge function of an elderly patient fed via IOG.
X-ray imaging showing that the barium balls (blue arrow) were mostly discharged from the gastric cavity in 25 min (a) and entirely discharged in 50 min (b). The stomach discharge function of the patient was judged to not have been reduced.

injury to the epiglottis causing microhemorrhage in one case) [23]. On the other hand, based on data analysis [20, 42], 41% of gastrostomy patients are likely to develop some kind of complication during catheter placement and maintenance. There have been no fatal cases using IOC [4–12, 19, 21, 25].

4. Physical restraining and duration of nursing care

A disadvantage of CNG (Table 3) is that a patient with disturbed consciousness or dementia must be physically restrained to control the risk of catheter removal (either intentionally or accidentally). Physical restraining can be reduced by switching from CNG to

gastrostomy. It has also been reported that physical restraining can be significantly reduced by switching from CNG to IOC. [44] (Fig. 13). Duration of nursing and nursing care for controlling gastrostomy has been reduced by recent developments in techniques and instruments [45]. However, it has been reported to still require considerable labor and time [46].

Increased use of IOC for the purpose of rehabilitating swallowing

According to a 2005 questionnaire survey by the Japan Society of Dysphagia Rehabilitation, IOC was used in only 4% of all the facilities surveyed (81 facilities including 66 hospitals). IOC had just started to receive the attention of advanced hospitals in swallowing rehabilitation, and the results of a comparative study on ITF (IC) including IOC and CNG were published in 2015 [32]. However, IOC is not included in the options for alternative nutrition. This is likely due to insufficient enlightenment about IOC and misunderstandings concerning its application. Therefore, to avoid the disadvantages of CNG, including those shown in Table 3, gastrostomy is widely implemented even for patients in the convalescent stage of dysphagia accompanying stroke. This is situation is as common in Japan as in the USA.

Disuse of ingestion and swallowing functions due to NPO (*nil per os*, or nothing by mouth) status

It is easily imagined that a person on NPO status would not often move their mouth or swallow, which may lead to reduced conversation and accelerate disuse of ingestion and swallowing functions. Thus, feeding a patient via gastrostomy and putting them on NPO status should present a risk of causing disuse of the swallowing function, however, there are no reports of this risk. It

Table 2. PEG placement and post-placement complications.

- Respiratory arrest from the use of sedatives
- Infection at the wound around the gastrostoma and septicemia
- Pneumonia from aspiration of saliva, etc. during endoscope insertion
- Aspiration pneumonia from gastroesophageal reflux
- Hemorrhage from erroneous puncture to a tissue other than the gastric wall, liver, etc.
- Gastrocolic fistula due to erroneous puncture from the digestive track and peritonitis
- Damage to the mucosal layer of the stomach wall by the puncture needle or gastrostomy kit
- Gastric perforation (peritonitis) from the catheter deviating from the gastric cavity
- Peritonitis caused by dissociation between the gastric wall and abdominal wall (by removal of the catheter by the patient or accidental removal)
- Peritonitis caused by balloon explosion, deaeration, etc.
- Buried bumper syndrome
- Risk of bacterial propagation in the nutrient upon tube closure and continuous feeding
- Increased vomiting and diarrhea from the fed enteral nutrient
- Persisting discomfort (dermatitis around the gastrostoma, necrosis, ulcer, abnormal granulation)

(adapted from Reference 42)

Table 3. Disadvantages of continuous naso-gastric catheterization (CNG).

- Insertion is difficult, and there is a risk of accidental insertion into the trachea. (Particular attention is needed in larynx anesthesia patients.)
- Poor appearance gives the impression of a serious illness, and discourages the patient from going out.
- Replacement of the catheter is painful to exchange the catheter.
- It is unpleasant because the catheter must be replaced regularly. There is a risk of the patient removing the catheter.
- The catheter may cause the oral cavity to become unclean, which may lead to infection.
- Secretion of saliva is reduced causing the oral cavity to become uncleanly.
- Reduced saliva secretion poses a risk of disuse of the swallowing function.
- Gastroesophageal reflux is prone to occur along the catheter.
- Long-term retention of the catheter may result in the development of a peptic ulcer at the tip of the catheter.
- The catheter is constantly in contact with the pharynx, causing the pharynx to become insensitive and thus making it difficult to induce the gag and swallowing reflexes.
- Inclined insertion of the catheter tends to inhibit swallowing movement.

(adapted from References 14–16, and 23)

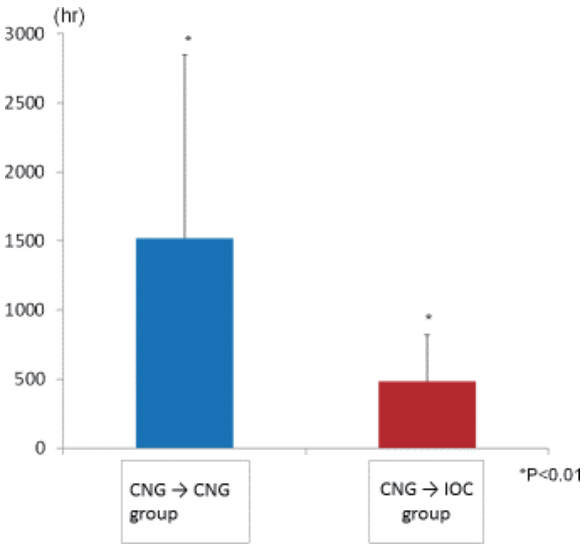

Figure 13. Reduction in duration of physical restraining by shifting from CNG to IOC.
In the group for which CNG was switched to IOC after the patients were transferred to a convalescent or rehabilitation institute, the total duration of physical restraining in the institute was reduced to about one-third.

has been reported that among patients put on NPO status and recumbency to control disease, excluding those with a disease that directly affected swallowing, tracheotomy, or disturbance of consciousness, 30 showed lowered swallowing function in 3 to 40 days (mean: 14 days) to a level that required rehabilitation [47]. A follow-up study is needed to compare the swallowing functions of patients who underwent a gastrostomy based on presuming NPO with those who continued IOC under NPO.

Effects of IOC on the concept of ideal gastrostomy

IOC has been deployed as a feeding method that promotes dysphagia rehabilitation. On the other hand, gastrostomy was recently promoted under the slogan "gastrostomy for eating" as an alternative way of feeding nutrition until the patient reaches a late stage of dysphagia rehabilitation. However, in the flow chart for gastrostomy, there are only two choices given: gastrostomy and CNG; IOC, which is between the two, is not mentioned. The most effective method for patients to regain oral intake of food is reported to be IOC in the convalescent stage of stroke [31] as well as in the chronic stage [33]. Investigation is needed to add IOC to the gastrostomy flow chart.

Via IOC, a liquid nutrient pack can be fed to the patient in 15 min [6, 48]. On the other hand, the feeding speed via gastrostomy is very slow, requiring several hours to feed one pack, and such "feeding all day long" inhibits rehabilitation of the patient. To solve these problem, a method was devised that involves pressure feeding the patients with gel nutrient [49], aimed at preventing gastroesophageal reflux and other syndromes related to liquid nutrient that may cause aspiration pneumonia and to achieve fast feeding by using semi-solid food. However, while the use of pressurized bags enabled fast feeding, it caused an unpleasant feeling of fullness in some patients, requiring a supplementary agent to improve the digestive tract function [30]. Mizuno et al. [46] confirmed the effectiveness of fast feeding of thickened liquid food via a gastrostoma by placing the bag at a certain height and using the natural gravitational force. This has led to the development of nutrient that becomes semi-solid in the stomach.

Future directions

Some patients require CNG control before using IOC due to a severe disturbance of consciousness, etc. For such a case, a simple device for checking the inserted position of the catheter needs to be developed. Thomas and Falcone [50] have examined the possibility of a clinical test based on carbon dioxide detection during exhalation. The results of such studies are also expected to also help in clinical practices.

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