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Basic Study for Aspiration Pneumonia Prevention

-Examination of Gastric Emptying Time and Posture by Nuclear Medicine Method-

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Abstract

For elderly persons or post-apoplectic patients during convalescence, aspiration as one of the causes of fatal pneumonia is important problem. The gastric contents in particular include infective materials as well as chemical substances, therefore aspiration of them induces serious pneumonia. Gastroesophageal reflux due to failure of the lower esophageal sphincter relaxation and contraction is an important element to lead to aspiration pneumonia. Also the association with the posture during and after eating is noted as an external factor of gastroesophageal reflux.

We focused on early evacuation of gastric contents (fluid food) to prevent these patients from aspiration pneumonia. To reveal the relation between gastric emptying time and posture, we fundamentally examined postprandial posture, in particular semi-sitting position often observed clinically, in healthy subjects by nuclear medicine examination. In this examination, food mixed with isotope with short half-time was administered orally to the subjects. After that we evaluated the gastric radioactivity decrement quantitatively and measure gastric emptying time by acquiring the images of the abdomen using gamma camera over time, which allowed us to follow-up in vivo normal post-prandial kinetics. Although the institution capable of performing radioisotope method is limited, we used it because it was the most effective method to evaluate gastrointestinal motility precisely. The gastric emptying time for food (100% rice gruel) varied depending on the posture. The results of time in the supine and sitting position were shorter than that in the semi-sitting position and the food was evacuated constantly in the semi-sitting position. The study suggested that it was needed to maintain a posture for more than one hour. Since the gastric emptying time is also affected by the test food type, it is necessary that we should apply various quality and form foods in many cases to raise reliability.

Key Word : Gastric Emptying Time, Positioning, Isotope, fluid food

INTRODUCTION

For elderly persons or post-apoplectic patients during convalescence, aspiration as one of the causes of fatal pneumonia is

important problem. The gastric contents in particular include infective materials as well as chemical substances, therefore aspiration of them induces serious pneumonia.

Gastroesophageal reflux due to failure of the lower esophageal sphincter relaxation and contraction is an important element to lead to aspiration pneumonia. Also the association with the posture during and after eating is noted as an external factor of gastroesophageal reflux. One study reported that silent aspiration could be prevented by maintaining a sitting position during and for two hours after a meal to allow food to pass into the lower digestive tract¹⁾. There is also another study which showed that the prevention of aspiration-induced inflammation was possible by maintaining that position for one hour after a meal. In all the above studies, it is considered that the gastric emptying time is crucial. In addition, different study which investigated the relationship of gastric emptying time for solid food and postprandial posture to improve functional dyspepsia as gastropathy, reported that right lateral position is superior to sitting position or supine position after a meal in order to evacuate solid food²⁾. In postprandial period, elderly persons and post-apoplectic patients tend to slouch sitting on a wheelchair or maintain a semi-sitting position lowering their heads, which is considered as effective for prevention of somnolence or disuse syndrome. We focused on early evacuation of gastric contents (fluid food) to prevent these patients from aspiration pneumonia.

To reveal the relation between gastric emptying time and posture, we fundamentally examined postprandial posture, in particular semi-sitting position often observed clinically, in healthy subjects by nuclear medicine examination. In this examination, food mixed with isotope with short half-time was administered orally to the subjects. After that we evaluated the gastric radioactivity decrement quantitatively and measure gastric emptying time by acquiring the images of the

abdomen using gamma camera over time³⁾, which allowed us to follow-up in vivo normal post-prandial kinetics. Although the institution capable of performing radioisotope method is limited, we used it because it was the most effective method to evaluate gastrointestinal motility precisely.

II. Methods

- 1) Subjects: Three adult "females with an average of 36.8 years old
- 2) Methods of examination: The test food was 250 g of packed and sterilized rice gruel (SHIROGAYU, Ajinomoto Co., Inc.; 250g, 85 Kcal, including protein 1.5 g, lipid 0.3 g, carbohydrates 19 g, natrium 1.5 mg) mixed with isotope (^{99m}Tc - o 0₄-185MBq).

The subjects should have been fasting from 9 p.m. on the day before the examination. After they maintained a sitting position while eating, they were monitored in a sitting, semi-sitting, and supine position under the collimator for 60 minutes.

The semi-sitting was 30-degree head-up position, and the supine position was the posture of a person laying one's head on a pillow (height 14cm). On the acquired imaging data, a region of interest (ROI) was placed over the stomach to measure the gastric radioactivity decrement over time.

2) Study Ethics

(a) Study consent

The purposes and hazards of this study was approved by the Ethics Review Board at the University. We also explained to the subjects of the purposes and hazards of this study and obtained informed consent from them.

(b) Health care and safety management

The subjects were interviewed by a physician prior to the examination, and we

confirmed they were in good health. The used radioactive isotope medicine was entered into the management register and stored in the radiation controlled area according to the Medical Service Law.

III. Results

1. Measured gastric emptying time by posture
 We calculated mean gastric emptying time and the gastric emptying ratio for three

subjects.

1) Gastric emptying time in supine position (Figure 1)

The gastric emptying in supine position started at 5-6 minutes after food intake. Approximately 50% and 81% of gastric contents were evacuated about 30 minutes later and 50 minutes later, respectively.

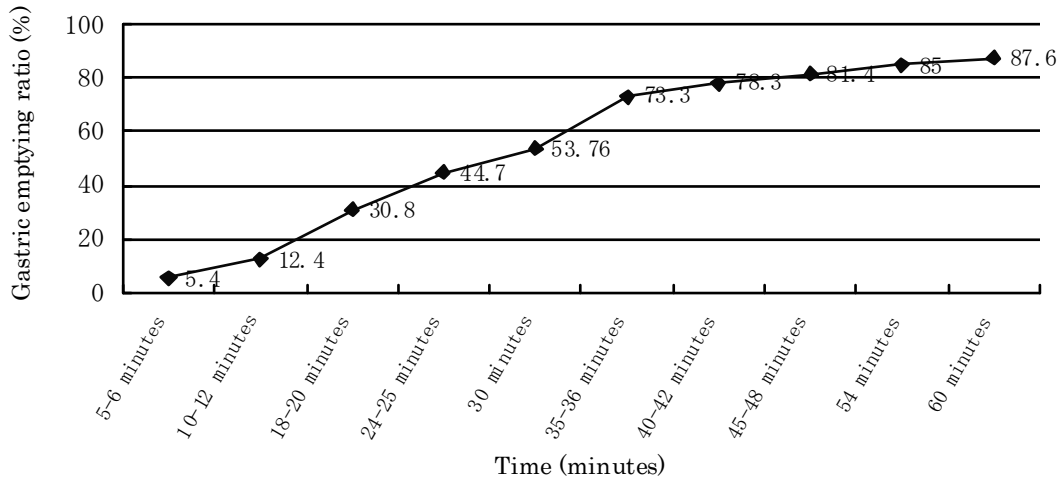


Figure 1. Gastric emptying time in supine position

2) Gastric emptying time in semi-sitting position (Figure 2)
 In semi-sitting position, 7.5% and approximately 50% of gastric contents

were evacuated at 6-7 minutes and 55 minutes after food intake, respectively. Approximately 5% of gastric contents was evacuated constantly every about 10

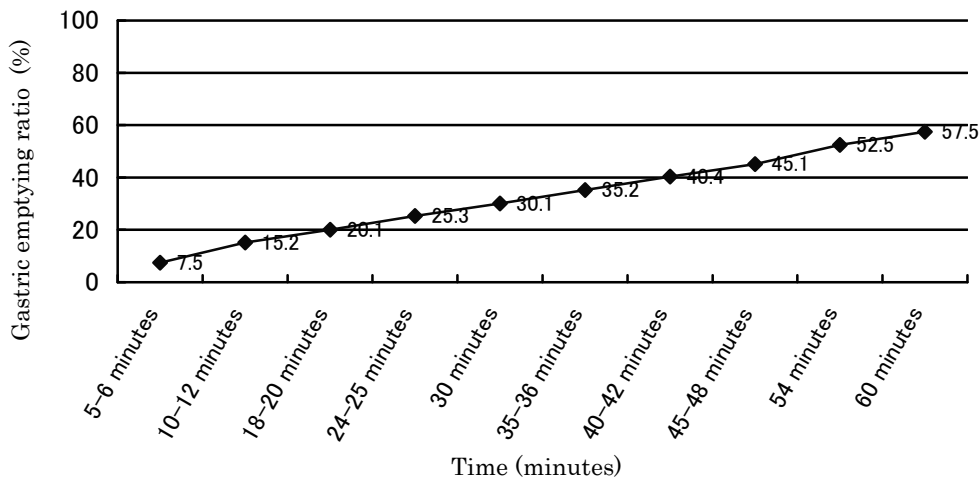


Figure 2. Gastric emptying time in semi-sitting position

minutes and gastric emptying ratio was also approximately 55% one hour later.

3) Gastric emptying time in sitting position (Figure 3)

In sitting position, approximately 10%,

50%, 80% of gastric contents were evacuated at 5-6 minutes, 50 minutes, and 60 minutes after food intake, respectively.

However the evacuation proceeded slowly 40 minutes later.

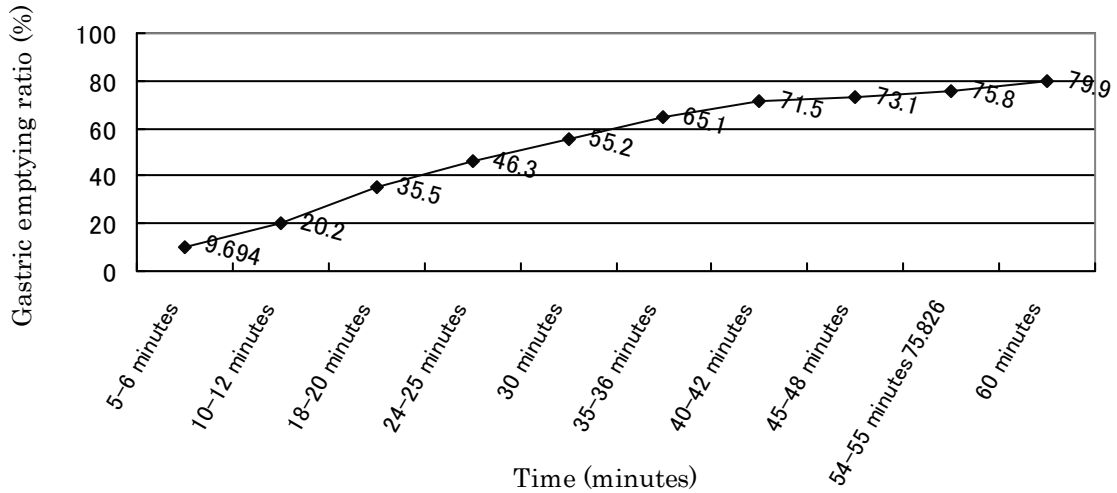


Figure 3. Gastric emptying time in sitting position

2. Comparison of gastric emptying times for fluid food by posture (Figure 4)

The results of the comparison of gastric emptying times by posture are shown in Figure 4. There is no difference in amount of

evacuation about 15 minutes after food intake.

However, more than 80% was evacuated about 60 minutes later in both supine and sitting position similarly, while approximately 60% was evacuated in semi-sitting position.

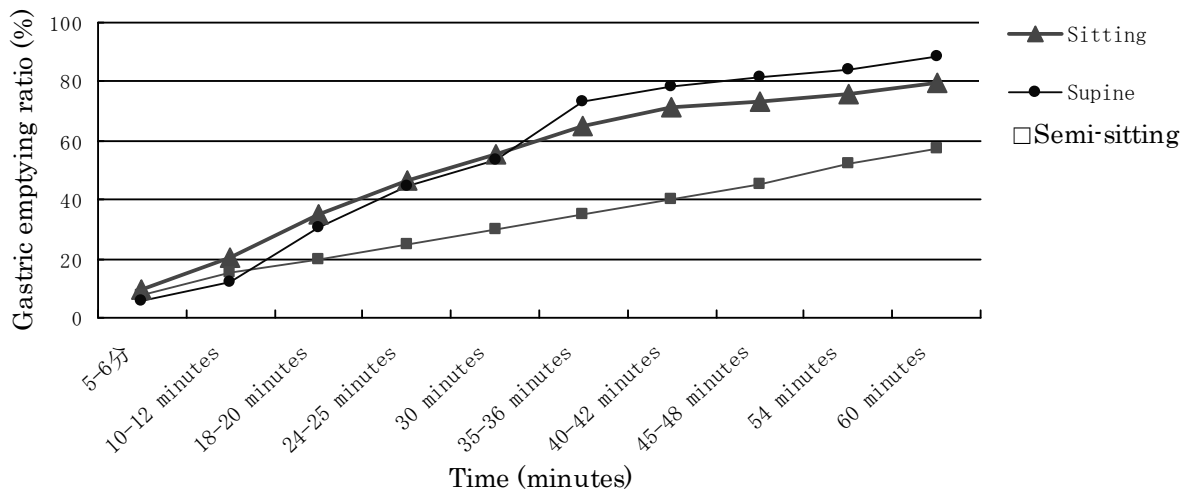


Figure 4. Gastric emptying time by posture

IV. Discussion

The role of the stomach includes: to reserve a large amount of food until it reaches a proper form for the lower gastrointestinal tract; and to mix it with gastric juice by the action of the stomach to produce chyme and evacuate it into the small intestine at proper rate. The rate of gastric emptying into the duodenum varies depending on a peristaltic wave towards the pylorus. One action allows several milliliters of chyme to evacuate into the duodenum. We observed 30 ml of fluid food (approximately 10%) was evacuated into the duodenum at about 5 minutes after a meal. The pylorus serves to pump out food into the duodenum, which may be controlled under some gastric factors caused by stomach fullness or peristaltic movement. The most important control is considered as a feedback signal from the duodenum including gastrointestinal reflex and hormonal regulation⁴⁾. The subjects underwent fasting for about 12 hours until they ate fluid food and then food flowed into the empty stomach, which promotes its peristaltic movement. In addition, it is thought that our test food did not induce gastrointestinal reflex and sent it into the duodenum smoothly in a short time because it was 100 % rice gruel.

Considering the relationship with the gastric emptying time and posture for the fluid food, we assumed that the gastric emptying time in the sitting position was the shortest due to gravity and abdominal pressure, followed by the semi-sitting position, and the time in the supine position was the longest. However, this study showed that there was no difference in the amount of evacuation among the posture by about 15 minutes after a meal and that the results of time in the supine and sitting position were shorter than that in the semi-sitting position for evacuating the food into

the duodenum since 20 minutes after a meal. Kawakami et al. reported that there was no significant difference between the sitting and the supine position after a meal using a solid food, and their results using a solid food were same as our study²⁾. Also Iwakiri reported that gastroesophageal reflux was not associated with the posture and there was no difference between the supine and the sitting position⁵⁾. On the other hand, another study showed that the supine position with longer gastric remaining time until the food was sent into the cecum was superior to the supine position with shorter gastric remaining time, in terms of digestion and absorption⁶⁾. Moreover, Inamori et al. revealed that fluid food tended to prolong the gastric emptying time in the decubitus position than the sitting position by continuous breath test with Breath ID system, and reported that the sitting position for one hour after a meal was desirable to prevent gastroesophageal reflux disease⁷⁾. We thought that the semi-sitting position after a meal was effective for the patients who took fluid food in view of prevention of aspiration regarding digestion and absorption because the semi-sitting position required the longest gastric remaining time and evacuated gastric contents constantly.

We need further studies with more cases because this study had fewer subjects and the gastric emptying time might be affected by the test food type³⁾ as well as the excretion or lifestyle of the subjects.

V. Conclusion

The gastric emptying time for food (100% rice gruel) varied depending on the posture. The results of time in the supine and sitting position were shorter than that in the semi-sitting position and the food was evacuated

constantly in the semi-sitting position. The study suggested that it was needed to maintain a posture for more than one hour. Since the gastric emptying time is also affected by the test food type, it is necessary that we should apply various quality and form foods in many cases to raise reliability.

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誤嚥性肺炎予防に関する基礎研究

－核医学法による胃排出時間と体位の検討－

要 旨 老年者や脳卒中回復期にある患者にとって、誤嚥は死に至る肺炎の原因のひとつとして重要な課題である。とくに胃内容物は化学物質とともに感染物質を含んでおり、その誤嚥は重大な肺炎を引き起こす。胃食道逆流は、下部食道括約部の弛緩及び収縮不全が原因で、誤嚥性肺炎に導く重要な要素である。胃食道逆流の外的要因として摂食時、後の体位との関連も指摘され胃内容物の排出時間が重要と考えられている。そこで本研究ではこれらの患者の誤嚥性肺炎を予防するために、流動食の胃内容物の早期排出に着目し、食後の体位のなかで特に臨床的に多く観察される半座位について、胃排出時間と体位との関連を明らかにすることを目的に、健康者を対象に核医学検査を用いて基礎的検討を行った。核医学検査法は、半減期の短いアイソトープを食物と混合して経口投与し、ガンマカメラを用いて経時的に腹部を撮影することにより、胃からの放射能の減少部を定量的に評価して胃排出時間を測定する検査方法である。健康成人女性3人、平均年齢36.8歳を対象に、レトルト食品の白粥、250 gにアイソトープ（ ^{99m}Tc -o 04,185KBq）を混入した検査食を用いて、それぞれ座位、半座位、仰臥位となり、60分間観察した。結果、体位別の胃排出時間は、食物摂取後15分頃までは体位による排出量に違いはなく、20分後から違いが生じ、仰臥位・座位が60分程度で80%以上が排出されるのに対して、半在位では60分間で約60%の排出と、仰臥位と座位よりも停滞時間が長かったが、コンスタントに胃内容物が排出されていた。従って、誤嚥の予防はもちろんであるが、消化吸收の観点からも半座位が効果的な体位ではないかと考えられた。今回の検査では被験者数が少なく、検査食により胃排出時間は異なることや排泄など生活習慣の影響も予測されることから、今後多数例の検討を行う必要がある。