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Gallbladder volume, contractility and gallstone formation in bed-ridden tube feeding dependent elderly patients. — A sonographic investigation —

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ABSTRACT

Background and Objectives: The gallbladder (GB) function in bed-ridden elderly patients whose lives depend on passive tube feeding was evaluated using ultrasonography (US). **Patients and Methods:** Twenty-eight bed-ridden patients and 89 controls were studied by US. GB volume changes in response to oral meal ingestion were assessed in 15 of 28 patients and 6 of 89 controls. The ultrasonographic images were obtained immediately before the ingestion of fatty meal, and 10, 20, 30, 45 and 60 minutes after the meal using the ellipsoid method. The resting volume, residual volume and the emptying times were determined and the ejection fractions were calculated. **Results and Conclusions:** The prevalence of GB stones in the patients was significantly higher than in the controls (35.7 vs. 16.85 %, $P \leq 0.05$). The emptying time was also significantly longer ($p=0.027$) in the patients than in the controls because the contractions were slower in the patients than in the controls. There were no differences in the resting volume, residual volume, each volume of time course and the ejection fractions between both groups. We therefore conclude that the slower GB contraction and the higher prevalence of GB stone formation in the bed-ridden elderly patients might be due to a dysfunction of central nervous system. *Ryukyu Med. J., 22(3,4) 103~107, 2003*

Key words: gallbladder function, bed-ridden, gallstone

INTRODUCTION

Due to the progressively aging society, advances in medical care and the shortage of nursing care facilities in Japan, an increasing number of elderly patients are being hospitalized for long periods of time due to non-medical reasons¹⁾. A large number of such bed-ridden elderly patients depend on passive tube feeding for proper alimentation. Most of these patients show a dysfunction in the central nervous system (CNS) with a cerebrovascular disease (CVD) and are defined as those who are unable to eat, urinate, defecate, or move about on their own without support. This abnormal condition may somewhat affect the function of the GB. It has been reported that CVD is a risk factor

of cholecystitis and that the incidence of acute cholecystitis is 1 % in CVD patients^{2,3)}. One cause of cholecystitis in these patients may be gallstone disease. One possible explanation for cholecystitis in CVD patients is that the GB does not contract and empty as well in these patients as in the controls. However, there have been only few reports on the GB function in such bed-ridden elderly patients.

The aim of the present study is to describe the GB volume responses to tube alimentation, GB contractility and cholelithiasis in bed-ridden elderly patients.

PATIENTS AND METHODS

After obtaining Informed consent, we performed

Table 1 Clinical characteristics of study groups

	Patients (n=28)	Controls (n=89)
SEX	Male 8, Female 20	Male 13, Female 76
AGE (mean +/- SD)	83.35 +/- 6.85	82.07 +/- 10.38
The prevalence of the GB stone	10/28 (35.7%)	15/89 (16.85%)
Background disease (including overlap cases)		
Orthopedic disease	8	78
Cerebro-vascular disease (CVD)	19	20
Respiratory disease	4	16
Other disease	5	21

*P≤0.05

ultrasonographic studies on the GB of 32 bed-ridden elderly patients with dementia and 140 controls. Four of the 32 patients and 51 of the 140 controls either had a past history of gastrointestinal operation or refused to discuss their history and thus were excluded from the study. As a result, 28 patients and 89 controls used for this study. In 15 of the 28 patients who did not have a flexion contracture or an infectious skin diseases that prevented us from doing a serial ultrasonographic studies of the GB function, and in 6 volunteers of the 89 controls, GB volume changes were studied in response to oral meal ingestion. None of the bed-ridden patients had a known or suspected past history of gastrointestinal disorders (for example, gastrectomy, vagotomy) that was said to cause the formation of gallstones on admission.

Each subject fasted at least 12 hr before the ultrasonographic examination. Real-time ultrasonography was performed using the Aloca SSD 650 device with a 3.5-MHz linear array transducer. Images were obtained immediately before the ingestion of a fatty meal, and 10, 20, 30, 45 and 60 minutes after the meal.

The fatty meal consisted of a commercially available elemental diet (ED) containing 10.8 g of fat.

The GB volumes were measured using the ellipsoid method (volume=0.52 X [width X height X

length])^{4,5}). The greatest GB length was obtained on the right intercostal frontal or subcostal anteroposterior echograms.

The following calculations were performed for each subject. The resting volume of the GB was measured after a 12-hr fast and before ED was ingested. The residual volume was the smallest GB volume observed at any time after the ingestion of ED. The ejection fraction was calculated as: $(1 - [\text{Residual volume}/\text{Resting volume}]) \times 100$. The emptying time was the time from ingesting the first mouthful of ED to the time at which no further contraction of the GB occurred⁵).

Statistical analyses were performed using Student's t test, the chi-square test, and an analysis of variance. Differences were regarded as significant at P<0.05.

RESULTS

The patients consisted of 8 males and 20 females with an average age of 83 years (Table 1). The prevalence of gallstone was significantly higher in the patient group than in the control group (35.7 and 16.85% respectively; P≤0.05). The background diseases that were the reason for admission are also shown in Table 1. Nearly 60% (19/32) of all bed-ridden patients had CVD. About 60% (78/140) of the controls, however, had some form of orthopedic

Table 2 Patients profile and comparison of measurements of gallbladder function

	Patients (n=15)	Controls (n=6)
SEX	Male 4, Female 11	Male 0, Female 6
AGE (mean \pm SD)	84.5 \pm 5.83	83.20 \pm 6.64
Resting Volume (ml)	23.28 \pm 12.52	29.57 \pm 12.93
Volume after the meal (ml)		
10 min.	18.03 \pm 10.23	19.18 \pm 12.11
20 min.	14.49 \pm 8.46	12.73 \pm 6.56
30 min.	11.73 \pm 7.74	8.82 \pm 5.20
45 min.	7.54 \pm 6.23	9.49 \pm 6.31
60 min.	10.94 \pm 6.78	10.94 \pm 5.33
Resting Volume (ml)	8.27 \pm 5.04	8.35 \pm 5.58
Ejection Fraction (%)	58.91 \pm 14.48	75.15 \pm 9.88
Emptying Time (min.)	44.3 \pm 8.4	31.0 \pm 5.6

*P \leq 0.02

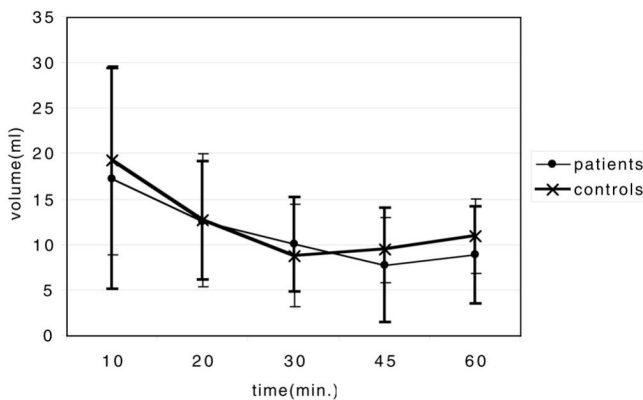


Fig.1 Comparison of measurements of gallbladder function after the meal

disease. The mean resting volume and the mean residual volume in the controls was 29.57 ± 12.93 ml and 8.35 ± 5.58 ml respectively, while it was 23.28 ± 12.52 ml and 8.27 ± 5.04 ml respectively in the patients (Table 2). Each volume of time course is also shown in Table 2, and Figure 1. The mean ejection fraction in the controls was $75.15 \pm 9.88\%$, while it was $58.91 \pm 14.48\%$ in the patients (Table 2). No significant differences were observed in the mean resting volume, the mean residual volume, the mean ejection fraction and each volume of time course. The emptying time was 31 ± 5.6 min in the controls and 44.3 ± 8.4 min in the patients. (P=0.027) (Table 2).

44.3 \pm 8.4 min in the patients. (P=0.027) (Table 2).

DISCUSSION

The number of bed-ridden elderly patients has dramatically increased in Japan due to the aging society. The present study is the first report to show the emptying time of the GB is significantly prolonged in bed-ridden elderly patients with dementia, and thus the prevalence of gallstone is also significantly high. The alimentation of such patients often depends on passive tube feeding. It remains unclear whether ED tube feeding affects the GB function or not. We can calculate the GB volume by the ellipsoid method using ultrasonography.

There are variations in the reasons for the patients becoming bed-ridden. It seemed that the patients who were bed-ridden as a result of a stroke maintain a dysfunction of the CNS. Other causes might also lead to a dysfunction of the CNS, because demented patients are not able to eat, urinate, defecate or move on their own.

A previous report showed that the GB contractility was normal in patients with spinal cord injury and the lower ejection fraction found in such patients was due to a small resting volume⁵⁾. If the level of spinal cord injury is high, they are not able

to move by themselves like our patients. Therefore, the difference between these spinal cord injury patients and our patients might be the dysfunction of the CNS⁶⁾.

Regarding the dysfunction of the CNS, it has been suggested that CVD is a risk factor in the pathogenesis of cholecystitis. Ushiyama *et al.*²⁾ reported that the incidence of acute acalculous cholecystitis was 1% in CVD patients and that the cause seemed to be multifactorial. It has also been reported that the anterior hypothalamic area plays an important role in GB emptying in the cephalic phase.³⁾ In our study, the prevalence of gallstone was significant higher in the patient group than in the control group. This result indicates that CNS dysfunction in patients who are confined to bed over a long period of time is likely to be the reason for the formation of gallstones.

It is known that vagotomy results in bile stasis in the GB. The role of the vagus nerve, which arises in the CNS, is clearly thought to play some roles in the contractility of the GB. Relaxation of the intestine is also maintained by vagus nerve inhibition.⁷⁾ It is possible that a dysfunction of the vagus nerve could promote gallstone formation through its inhibitory effect on GB and intestinal motility.⁸⁾

At the same time, an adenomyomatosis like change in the GB and an atrophy of the sphincter of Oddi that occurs with aging, which might be a barrier for bile emission, have all been reported to increase the lithogenic index of bile with age pathologically. Clinically however, irrespective of age in the normal controls, no statistically significant differences have been reported regarding the function of bile emptying investigated by ultrasonographic methods.⁹⁾ In addition, no difference in gallbladder emptying, volume or the ejection fraction have been reported between elderly and young subjects.¹⁰⁾

On the other hand, hypomotility of the GB during total parenteral nutrition and continuous enteral hyperalimentation may facilitate bile stasis and biliary complications.¹¹⁻¹⁴⁾ Regarding the administration method, it has been reported that the maximal contractile ratio of GB maintained during intermittent administration of ED in patients with Crohn's disease.¹¹⁾ ED was intermittently administered in all our patients and the maximal contractile ratios of the gallbladder were maintained at the same levels as described in a previous report.¹¹⁾ Based on the findings in this study and previous

data, enteral feeding itself is not considered to increase emptying time.

Regarding prevalence of GB stones, previous studies have demonstrated that the intake of PUFA (Polyenoic Unsaturated Fatty Acid) promotes inflammation and causes an increase in high molecular weight mucinous glycoprotein. It also cause a rise in the lithogenic index while accelerating the formation of GB stones.¹⁵⁾ ED is performed taking into account various factors such as lithogenesis, however, It remains unclear whether or not gallstone formation is enhanced in patients receiving ED.

Based on these findings, some other reason is suspected to play a role in the observed difference in emptying time.¹⁶⁾ The main factor responsible for the initiation of the GB contractions is the release of cholecystokinin from the duodenum in the presence of fatty foods. In this study, there was a significant difference between the emptying time of the bed-ridden elderly patients and the controls. Matilde⁵⁾ has reported that the emptying time in patients with spinal cord injuries was the same as in the controls. The intact mechanism for the release of cholecystokinin in our patients was similar to that in the patient with spinal cord injuries.

In conclusion, we found GB contractions to be slower and the prevalence of GB stones to be higher in bed-ridden elderly patients with dementia than in the controls. As it has been shown that gall bladder stasis may promote sludge formation. Our results might be due to the dysfunction of CNS.

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