



RESEARCH PAPER

# Dynamic swallowing study for globus patients



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## KEYWORDS

Dynamic swallowing study;  
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**Abstract** *Objective:* To examine whether pharyngeal swallowing function is impaired in globus patients with swallowing difficulty by dynamic swallowing study.

*Methods:* Dynamic swallowing studies were performed on 80 normal adult volunteers and 33 globus patients with swallowing difficulty. Objective parameters such as maximum displacement of the hyoid bone, pharyngeal transit time, pharyngeal constriction ratio, and maximum opening of the esophageal entrance were measured, which were closely associated with the pharyngeal swallowing function in the swallowing process.

*Results:* There were no significant differences between globus patients and normal adults in hyoid bone displacement, pharyngeal transit time, pharyngeal constriction ratio, or maximum opening of the esophageal entrance ( $p > 0.05$ ).

*Conclusion:* The results of the dynamic swallowing study indicated that the pharyngeal swallowing function of globus patients was not impaired.

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## Introduction

In the clinical setting, physicians often encounter patients who complain of an abnormal sensation like lump in the throat and sensation of swallowing difficulty. These patients are often considered of having globus sensation, which is a persistent or intermittent nonpainful sensation. In the past, many studies performed videofluoroscopic examinations on patients with globus sensation. Chung et al<sup>1</sup> studied 83 patients with globus sensation by videofluoroscopic examination and found that 13 patients had

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early closure of the cricopharyngeus, 31 patients had enlarged pharyngeal tonsils, and all patients had enlarged lingual tonsils. Using barium meal, Caylakli et al<sup>2</sup> found that the cervical osteophyte was the most common finding in globus pharyngeus patients. However, Mahrous et al<sup>3</sup> only found 5 patients with diverticulae and 3 patients with esophageal web in barium meals among 192 patients presenting with a sensation of "a lump in the throat". Luk et al<sup>4</sup> reported their 10-year experience on an Asian population: a total of 908 patients with globus sensation underwent barium meal, in which 783 patients had normal findings and 125 patients had abnormal findings, and all patients younger than 30 years old had normal results. All aforementioned studies show that the barium meal is of limited diagnostic value in patients with typical globus sensation. It is not recommended for these patients, especially patients at a young age.

The dynamic swallowing study has been used for patients with swallowing problems for over 20 years. It can measure some parameters that may indicate pharyngeal swallowing function such as maximum displacement of the hyoid bone (HmaxD), pharyngeal transit time (PTT), pharyngeal constriction ratio (PCR), and maximum opening of the esophageal entrance (EEmax). It can also quantify minimal changes in the swallowing function of patients.<sup>5</sup> Dynamic swallowing study has not been used in globus patients who have a sensation of swallowing difficulty. In this study, to determine whether globus patients have real changes in their pharyngeal swallowing function, we chose globus patients with sensation of swallowing difficulty who had no abnormal anatomic lesions or early closure of the cricopharyngeus to receive dynamic swallowing study. We also compared the results of the dynamic swallowing study between normal adults and globus patients.

## Materials and methods

### Subjects

Patients with a complaint of lump in the throat and a sensation of swallowing difficulty who presented to the laryngology clinic of Navy General Hospital (Beijing, China) from February 2012 to August 2013 were eligible for this study. There were 33 adult globus patients comprising 14 women and 19 men, whose ages ranged from 20 to 60 (mean age, 45.1). Eighty normal adult volunteers were collected in this study as the control group, including 40 women and 40 men ranging in age from 18 to 65 (mean age, 41.8). Before undergoing dynamic videofluoroscopic swallowing study, the patients and volunteers had undergone examinations such as laryngoscopy, repetitive saliva swallowing test, water swallowing test, and functional oral intake scale to rule out any diseases such as tumor, acute inflammation or functional change in the upper aerodigestive tract. Besides no anatomic lesion, early closure of the cricopharyngeus or abnormal esophageal clearing was detected. Patients would be excluded if they had a previous history of ankylosing spondylitis, cervical trauma, cervical surgery, radiotherapy on the neck, or neuromuscular diseases. All the volunteers and patients

had no smoking habits, or symptoms of reflux or heartburn. Other information of the patients and volunteers was shown in Table 1.

### Dynamic swallowing study

Before the study, the Institutional Review Board of the Navy General Hospital approved the study including the informed consent and the consent procedure. After all volunteers and patients signed informed consent, they received dynamic videofluoroscopic swallowing studies.

Radiographic studies were performed in the Medical Image Center of the Navy General Hospital. The Shimadzu X-ray gastrointestinal apparatus S/V3200HG (Shimadzu Corporation, Kyoto, Japan) was used to perform the dynamic videofluoroscopic swallow studies. This device can supply film photograph and digital photograph through ordinary and pulsed perspective. It has a high voltage generator of 100 kV, 800 MA and uses a charge-coupled device (CCD) camera with 1 million pixels. Therefore, it has become more convenient for performing radiography of the upper gastrointestinal tract. Fluoroscopy studies were recorded on high-quality digital recorder for playback and analysis. A time recorder (Horita Co, Inc., Capistrano Beach, CA, USA) with an accuracy of 0.01 s was used to record the time on the video. Digital video memory is very necessary. The volunteers and patients were placed at the erect and lateral position. They stood with their shoulders close to the standing bucky. The X-ray machine focused vertically to the standing bucky and directed horizontally to the cervical vertebrae, with the field covering the whole pharynx and the entrance of the esophagus.

The volunteers and patients were asked to swallow the 20 ml liquid bolus (60% barium sulfate solution) at one time. The whole process of swallowing from mouth to esophagus could be clearly observed and recorded.

Two radiologists were assigned to perform the dynamic videofluoroscopic swallowing study. Two postgraduates were blinded with regard to each other's measurements of the objective parameters in the swallowing function during the pharyngeal phase, and were also blinded to the groups they belonged to. Parameters of the HmaxD, PTT, PCR, and EEmax were measured by the methods of the Voice and Swallow Center of the University of California–Davis (Davis, CA).<sup>6</sup> A coin (diameter, 1.9 cm), which was placed on the

**Table 1** General information of the globus group and the control group (Mean±SD).

	Globus group (n = 33)	Control group (n = 80)	t	p
Age	45.10 ± 17.83	41.8 ± 14.90	1.41	0.16
BMI (kg/m <sup>2</sup> )	23.21 ± 1.82	22.63 ± 2.04	1.78	0.08
RSI	2.97 ± 0.64	0.00 ± 0.00	42.27	0.00
RFS	0.67 ± 1.05	0.54 ± 0.84	1.17	0.25
Gender			0.54 (χ <sup>2</sup> )	0.46
Male	19	40		
Female	14	40		

BMI: body mass index; RSI: reflux symptom index; RFS: reflux findings scores.

chin of the patients and volunteers during video-fluoroscopy, was used as the reference distance for measurements (Figs. 1–6).

### Statistical analysis

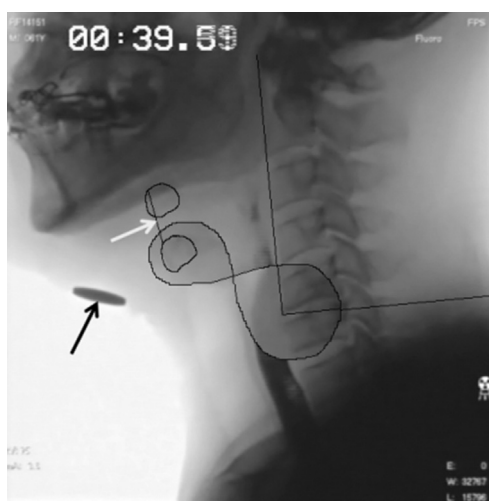
All parameters were recorded in the computer. The HmaxD, PTT, PCR, and EEmax of the two groups were analyzed by the two-sample *t* test. A value of  $p < 0.05$  was statistically significant.

### Results

There was no difference of age between the two groups ( $t = 1.41$ ,  $p = 0.16$ ). Among the 80 normal adults, the HmaxD, PTT, PCR, and EEmax were  $1.91 \pm 0.48$  cm,  $0.82 \pm 0.15$  s,  $94.9\% \pm 3.4\%$ , and  $0.91 \pm 0.15$  cm, respectively. Among the 33 globus patients, the HmaxD, PTT, PCR, and EEmax were  $1.93 \pm 0.42$  cm,  $0.86 \pm 0.10$  s,  $93.7\% \pm 2.8\%$ , and  $0.89 \pm 0.21$  cm, respectively. There were no significant differences between the two groups in these four parameters of pharyngeal swallowing function ( $p > 0.05$ ) (Table 2). Previous studies have confirmed that the HmaxD was greater in men than in women, but the PTT, PCR and EEmax showed no significant differences between genders.<sup>7</sup> Because of the different sex ratio of the two groups, we separately compared the two groups with regard to sex. There were no significant differences of the swallowing parameters between the two groups whether in the males (Table 3) or females (Table 4).

### Discussion

In humans, swallowing is the process that makes a bolus pass through the mouth, pharynx and finally esophagus. Normal swallowing is divided into three phases: the oral



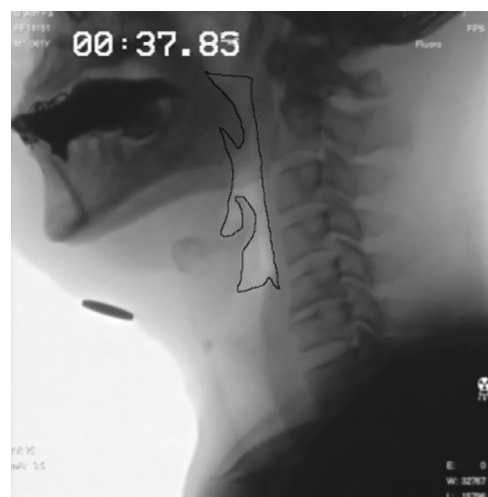
**Fig. 1** Two pictures of the highest position of the hyoid and the lowest position of the hyoid were copied into one picture. The maximum displacement of the hyoid bone (white arrow) can be measured. The black arrow indicates the jiao coin (i.e., renminbi [RMB], the 2010 version) with a diameter of 1.9 cm.



**Fig. 2** The beginning of the pharyngeal phase of swallowing.



**Fig. 3** The end of the pharyngeal phase of swallowing. The time between Figs. 2 and 3 is the pharyngeal transit time.



**Fig. 4** The maximum area of the pharynx before swallowing.



**Fig. 5** The minimum area of the pharynx after swallowing. The pharyngeal constriction ratio is (1 – the minimum area/ the maximum area)%.



**Fig. 6** The maximum opening of the esophageal entrance (white arrow).

**Table 2** Comparison of the swallow parameters between the globus group and the control group (Mean±SD).

Swallow indicator	Globus group (n = 33)	Control group (n = 80)	t	p
HmaxD (cm)	1.93 ± 0.42	1.91 ± 0.48	0.27	0.79
PTT (s)	0.86 ± 0.10	0.82 ± 0.15	1.58	0.12
PCR (%)	93.7 ± 2.8	94.9 ± 3.4	1.76	0.08
EEmax (cm)	0.89 ± 0.21	0.91 ± 0.15	0.88	0.38

EEmax: maximum opening of the esophageal entrance; HmaxD: maximum displacement of the hyoid bone; PCR: pharyngeal constriction ratio; PTT: pharyngeal transit time.

phase, the pharyngeal phase, and the esophageal phase.<sup>8</sup> Laryngologists pay more attention to the pharyngeal phase.

Some videofluoroscopic studies demonstrate that the causes of globus sensation may be early closure of the

**Table 3** Comparison of the swallow parameters between the globus group and the control group in males (Mean±SD).

	Globus group (n = 19)	Control group (n = 40)	t	p
Age (y)	42.00 ± 18.43	40.92 ± 14.08	0.25	0.81
HmaxD (cm)	1.98 ± 0.31	2.04 ± 0.46	0.51	0.17
PTT (s)	0.87 ± 0.12	0.81 ± 0.16	1.41	0.12
PCR (%)	93.8 ± 2.7	94.4 ± 3.8	0.59	0.56
EEmax (cm)	0.89 ± 0.21	0.92 ± 0.15	0.87	0.39

EEmax: maximum opening of the esophageal entrance; HmaxD: maximum displacement of the hyoid bone; PCR: pharyngeal constriction ratio; PTT: pharyngeal transit time.

**Table 4** Comparison of the swallow parameters between the globus group and the control group in females (Mean±SD).

	Globus group (n = 14)	Control group (n = 40)	t	p
Age (y)	49.36 ± 12.67	42.75 ± 13.36	1.61	0.11
HmaxD (cm)	1.88 ± 0.55	1.78 ± 0.48	0.63	0.53
PTT (s)	0.86 ± 0.09	0.83 ± 0.14	0.76	0.45
PCR (%)	93.8 ± 2.8	95.3 ± 2.9	1.67	0.10
EEmax (cm)	0.89 ± 0.22	0.91 ± 0.15	0.35	0.73

EEmax: maximum opening of the esophageal entrance; HmaxD: maximum displacement of the hyoid bone; PCR: pharyngeal constriction ratio; PTT: pharyngeal transit time.

cricopharyngeus, enlarged pharyngeal or lingual tonsils, cervical osteophyte, diverticulae, esophageal web, laryngopharyngeal reflux, etc.<sup>1–4,9</sup> Globus patients with swallowing difficulty have no anatomic lesions aforementioned that can cause globus or swallowing problems, however, it is unknown whether the pharyngeal swallowing function of these patients is really impaired. Many methods can evaluate pharyngeal swallowing function such as the repetitive saliva swallowing test, water swallowing test, functional oral intake scale, penetration–aspiration scale, videoendoscopy (i.e., fiberoptic endoscopic evaluation of swallowing), and videofluoroscopy. However, these methods can only assess major changes in the swallowing function of a patient, but cannot measure minimal changes in a patient’s swallowing function. A dynamic videofluoroscopic swallowing study can measure some parameters such as HmaxD, PTT, PCR, and EEmax that may indicate pharyngeal swallowing function, and can quantify the minimal changes in the swallowing function of patients.<sup>5,10–12</sup>

Our study found no significant difference between the globus group and the control group in the parameters of the dynamic swallowing study. This finding indicates that globus patients with swallowing difficulty have no swallowing dysfunction of the pharyngeal phase, based on the view of dynamic swallowing study. Because these patients had no anatomic or functional changes, we should consider other reasons causing their symptoms. In the literature, investigators have reported that globus patients have higher level of depression, anxiety, and somatic concerns.<sup>13</sup> For example, globus patients who complain of a sensation of a

foreign body in the throat often worry about having throat cancer. Eyigör et al<sup>14</sup> performed a control study between patients who had persistent symptoms of chronic pharyngitis and healthy individuals and then suggested that patients who frequently presented to ear, nose, and throat departments with repeated symptoms of chronic pharyngitis should receive a psychiatric assessment and support.

## Summary

The previous studies have showed that dynamic swallowing study can quantify the pharyngeal swallowing function. Technically it can be performed on globus patients with a sensation of swallowing difficulty and on normal adults. However, there was no significant difference of the swallow parameters between the globus patients and normal adults in our study. This finding indicated that the pharyngeal swallowing function of the globus patients may not be impaired. Dynamic swallowing study is not suggested for patients with globus symptom, in consideration of its radiation and cost.

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