Quantitative evaluation of age-related alteration of swallowing function: videofluoroscopic and manometric studies

I. Introduction

In Japanese aging society, dysphagia has increasingly become a critical issue, which leads to aspiration pneumonia and is now the third most common cause of death. In this study, we quantitatively evaluated the swallowing function in the elderly to elucidate the effect of aging on deglutition.

II. Materials and Methods

1. Subjects

The subjects were 70 healthy volunteers with no history of diseases that may affect swallowing function. They were divided into three groups based on age: a young group (21–32 years of age, 8 subjects), early elderly group (60–69 years of age, 39 subjects), and late elderly group (70–83 years of age, 23 subjects).

2. Examination procedures

1) Videofluorographic examination

In this study, four quantitative parameters were employed: 1) Maximum anterior and superior moving distances of the hyoid bone and thyroid cartilage, 2) Laryngeal elevation delay time (LEDT), 3) Pharyngeal transit time (PTT) of the bolus of contrast medium, 4) Percent laryngeal elevation (%LE).

2) Manometric examination

From the original pressure waveform, the swallowing pressures at the soft palate, mesopharynx, hypopharynx, and upper esophageal sphincter (UES) were measured. The
relaxation time at the middle of UES and pressure wave pattern during the pharyngeal swallowing phase were also measured.

3. Statistical analysis

The data were analyzed by one-way analysis of variance and the unpaired t-test. A p value of <0.05 was regarded as statistical significance.

III. Results

In the videofluorographic examination, the PTTs in the elderly group were significantly greater (p < 0.05) than those in the young group. Additionally, the %LEs were lower (p < 0.05) than those in the young adult group. In the manometric examination, the hypopharyngeal swallowing pressures were 142.18 ± 29.81 and 149.26 ± 22.72 mmHg in the early and late elderly groups, respectively, and these were significantly greater than those in the young adult group (p < 0.01). Furthermore, the relaxation time of the UES was significantly shorter in elderly groups than in the young group (p < 0.05 in early and p < 0.01 in late elderly groups). Interestingly, abnormal waveform patterns at the UES in swallowing pressure were identified in some aged subjects. Reduction of the UES pressure during the pharyngeal swallowing phase indicates sufficient relaxation of the UES; however, 15.4% (6/39) of subjects in the early elderly group and 30.4% (7/23) in the late elderly group showed insufficient reduction (>5 mmHg of residual pressure). In the young group, the UES zone was less than 3 to 4 cm in width vertically; however, 8/39 (20.5%) and 6/23 (26.1%) subjects in the early and late elderly groups, respectively, showed a broadened UES zone greater than 5 cm.

IV. Discussion

This study suggests that the onset of the swallowing reflex is delayed and the velocity of laryngeal elevation in the pharyngeal swallowing phase decreases with aging. We believe that the former chiefly results from pharyngolaryngeal sensory impairment and that the latter results from a decline in the contraction speed of muscles to elevate the larynx. In an investigation of the timing of deglutition, age-related swallowing disorders
occur due to both sensory and motor impairments related to the pharyngeal swallowing phase.

The present study revealed limited UES opening. This suggests that increased hypopharyngeal swallowing pressure is due to compensation against UES dysfunction. Taguchi et al. reported that aging leads to decreased function of the thyropharyngeal muscle as a driver of the food bolus. Also, it increases percentage of type 1 muscle fibers, which work as UES with aging. On the other hand, cricopharyngeal muscle maintains its sustained contraction function. We believe that these anatomical and functional alterations result in insufficient opening of the UES.

The present study implicates possible management approaches for age-related swallowing disorders. First, treatment should aim to stimulate the pharyngolaryngeal sensory function. Thermal-tactile stimulation or chemical stimulation using capsaicin or menthol may be efficient. Second, laryngeal levator muscle training such as the head-lift exercise maneuver (Shaker exercise) may contribute to prompt laryngeal elevation.