Supraglottic Swallow, Effortful Swallow, and Chin Tuck Did Not Alter Hypopharyngeal Intrabolus Pressure in Patients with Pharyngeal Dysfunction

Margareta Bülow, SLP, MSc, Rolf Olsson, MD, PhD, and Olle Ekberg, MD, PhD
Department of Diagnostic Radiology, Malmö University Hospital, Lund University, Malmö, Sweden

Abstract. Simultaneous videoradiography and solid-state manometry (videomanometry) were performed in 8 patients (4 women, 4 men; age range = 46–81 years, mean age = 70 years) with pharyngeal dysfunction in order to disclose any changes in intrabolus pressure during swallowing maneuvers. Five of the patients had severe pharyngeal dysfunction with frequent misdirected swallows. Three of the patients had moderate pharyngeal dysfunction with delayed initiation of pharyngeal swallow. Three different swallowing techniques were applied: supraglottic swallow, effortful swallow, and chin tuck. Pharyngeal intrabolus pressure was analyzed at the level of the inferior pharyngeal constrictor. Supraglottic swallow, effortful swallow, and chin tuck did not alter peak amplitude or duration of the intrabolus pressure.

Key words: Intrabolus pressure — Dysphagia — Videomanometry — Swallowing techniques — Supraglottic swallow — Effortful swallow — Chin tuck — Pharyngeal dysfunction — Deglutition — Deglutition disorder.

Intrabolus pressure is a term used to describe the pressure within a fluid when a manometric sensor is completely surrounded by a bolus [1–4]. It is a hydrodynamic pressure dependent on bolus volume and flow rate but also on the characteristics of the pharyngeal walls in terms of contraction and opening of the esophageal inlet. Intrabolus pressure should have great potential for determining the effects of swallowing therapy. In particular, an improved opening of the esophageal inlet would result in a lower pharyngeal intrabolus pressure. Swallowing therapy techniques often allow for a safe and efficient swallow in neurologically impaired patients [5–7]. Techniques often used are supraglottic swallow, effortful swallow, Mendelsohn’s maneuver, and different head-positioning techniques such as the chin tuck. There are few reports in the literature that describe the effects on bolus passage and pharyngeal pressure achieved by these techniques [8–14]. In this study simultaneous videoradiography and intraluminal manometry were applied on three swallowing techniques to evaluate changes in intrabolus pressure.

Materials and Methods

Simultaneous videoradiography and solid-state intraluminal manometry (videomanometry) were used in 8 patients (4 women, 4 men; age range = 46–81 years, mean age = 70 years), with pharyngeal dysfunction resulting from cerebrovascular accident (6 pts) and head and neck cancer (2 pts). The clinical examination by the speech-language pathologist revealed that 5 of the patients had severe pharyngeal dysfunction with a high frequency of misdirected swallows into the airways and that 3 of the patients had moderate pharyngeal dysfunction with delayed initiation of pharyngeal swallow. No patient had language disabilities.

The manometry system was an intraluminal solid-state transducer system. The manometry catheter had a diameter of 4.6 mm, with four solid-state pressure transducers positioned 2 cm apart. The two proximal sensors were standard microtransducers (Konigsberg Instruments, Inc., Pasadena, CA) with a single recording site oriented radially to measure 120°. The two distal transducers (Konigsberg Instruments) were circumferential, allowing 360° measurements. The system was noncompliant; the
volumetric compliance was $7 \times 10^{-6}$ mm$^3$/mm Hg, and the pressure rise rate was over 2000 mm Hg/s. The analog signal was digitized by a Polygraph A/D converter (Medtronic, Synectics, Stockholm, Sweden). The software was the Polygram Upper-GI Edition by Gastrosoft Inc./Medtronic (Synectics). All pressure values were expressed in millimeters of mercury (1.0 mm Hg = 133 N/m$^2$, 7.5 mm Hg = 1 kPa, 50 mm Hg = 68 cm H$_2$O). The system was calibrated at 0 mm Hg and at 50 mm Hg. The calibration was done at 37°C. All given values are referred to atmospheric pressure. The sampling frequency was 64 Hz.

The manometry catheter was introduced through the nose and fluoroscopically positioned with its distal transducer in the pharyngoesophageal sphincter (PES). All sensors were radiopaque and easy to identify during fluoroscopy. The two proximal transducers were positioned with the recording sites in a dorsal direction. During swallow, the pharynx–larynx elevation moved the PES in a cranial direction. When the catheter was correctly positioned in the cranial part of the PES, a characteristic M-shaped configuration of the manometry wave appeared during swallowing.

The videoradiography and pharyngeal manometry were performed simultaneously in an upright position. With the manometry catheter in place, all participants were instructed to swallow 10 mL of barium contrast medium (60% weight/volume). At least three wet swallows of each technique were recorded. The videofluoroscopic image and the manometric registration were mixed using a Microeye Video Output Card (Digihurst Ltd., Roystone, UK), displayed together on a monitor, and recorded on videocassette (S-VHS). Slow motion and frame-by-frame analysis performed video analysis. To ensure that the patient performed each technique correctly, the instructions applicable to each technique were repeated immediately before each swallow. Intrabolus pressure was defined as the hydrodynamic pressure within the swallowed barium bolus. This was confirmed with simultaneous videoradiography to ensure that the manometric sensor was completely within the barium with no contact with the pharyngeal walls. The peak amplitude (mm Hg) and the duration (ms) of the intrabolus pressure were registered at the level of the pharyngeal posterior constrictor.

Experimentally we also measured the hydrostatic intrabolus pressure in a column with the barium suspension. The circumferential manometric sensor was placed at different levels below the surface of the barium solution in a glass column.

Instructions for the different swallowing techniques were given as follows: Every patient was given individual instructions for at least 10 minutes half an hour before the procedure. None of the patients had received any swallowing therapy before. The procedure started with three normal wet swallows followed by the three swallowing techniques, each also performed three times, and all with 10 mL of thin barium liquid. When performing the supraglottic swallow, the patients were told to take the barium liquid into the mouth, take a deep breath, hold the breath after inhalation, and then swallow while keeping the breath. Immediately after swallowing, they were instructed to cough or clear the throat before breathing again. In the effortful swallow, the patients were instructed to swallow very hard while squeezing the tongue in an upward–backward motion toward the soft palate. The third technique was the chin tuck (head-positioning technique) swallow. After taking the barium liquid into the mouth, the patients were instructed to tuck the chin downward, swallow in that position, and after the swallow raise the head again.

**Statistics**

All values are means of three swallows repeated for every single swallowing technique in every patient (± SEM, standard error of the mean). All variables were plotted on a histogram and found to be normally distributed and thus parametric statistics were used. Repeated measures analysis of variance (ANOVA) and multiple comparisons with Schefle’s and Newman–Keuls’ methods were used to determine exactly which “treatment” means were significantly different. The significance level was 0.05.

All statistical calculations were made using STATISTICA® (StatSoft Inc., Tulsa, OK, USA).

**Results**

The results are presented in Table 1.

Supraglottic swallow, effortful swallow, and chin tuck did not alter peak intrabolus pressure or duration of this pressure when measured at the level of the inferior pharyngeal constrictor. There was a tendency to higher intrabolus pressure when the different swallowing techniques were performed, espe-