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Dysphagia

Cardiovascular Effects of the Supraglottic and Super-supraglottic Swallowing Maneuvers in Stroke Patients with Dysphagia

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Abstract. The prolonged voluntary closure of the glottis during the supraglottic and super-supraglottic swallowing techniques may create the Valsalva maneuver. The Valsalva maneuver has been associated with sudden cardiac death and cardiac arrhythmias. This study describes the effects of the supraglottic and super-supraglottic swallowing techniques on the cardiovascular system. Subjects included 23 patients from an acute inpatient rehabilitation hospital. Subject groups included recent stroke, dysphagia, and a history of coronary artery disease (Group 1, $N = 11$), recent stroke and dysphagia with no known coronary artery disease (Group 2, $N = 4$), and orthopedic diagnosis with no known dysphagia or coronary artery disease (Group 3, $N = 8$). Cardiac status was monitored for 4 hours during swallowing training, regular therapy sessions, and a meal. For Groups 1 and 2, 86.6% (13 out of 15) of the subjects demonstrated abnormal cardiac findings during the swallowing session including supraventricular tachycardia, premature atrial contractions, and premature ventricular contractions. Arrhythmia subsided within a few minutes after the session and did not occur during other activities. In Group 3 (control group), none of the subjects demonstrated abnormal cardiac findings except for bradycardia in one subject. It is suggested that the supraglottic and super-supraglottic swallow maneuvers may be contraindicated for patients with a history of stroke or coronary artery disease.

Key words: Dysphagia — Stroke — Supraglottic swallow — Cardiovascular effects — Valsalva maneuver — Swallowing — Deglutition — Deglutition disorders.

It has been well documented that the cardiovascular system undergoes additional stress in patients who have recently experienced a stroke [1–9]. Cardiac disease has been reported to be the third leading cause of death in the first 25 days after stroke, the second leading cause of death in the first year post-stroke, and the leading cause of death in long-term survivors of stroke [7]. In a study of patients with thromboembolic stroke, it was found that 27% ($N = 132$) of patients suffered cardiac complications during inpatient rehabilitation [7]. Dysphagia is another frequently encountered condition following a stroke [10–14]. Both of these complications may hinder the patient's recovery process if not proactively monitored and managed.

Aspiration of food or liquids is a common consequence of dysphagia in the stroke population [15–19]. The supraglottic and super-supraglottic swallow maneuvers provide airway protection from aspiration by utilizing voluntary prolonged airway closure followed by forced expiration [20–24]. Because of the effectiveness of these maneuvers in reducing or eliminating aspiration, they have been used with dysphagia patients from many diagnostic backgrounds who have the symptoms of laryngeal penetration or aspiration before or during the swallow [20,21]. During the supraglottic and super-supraglottic swallows, the vocal folds are voluntarily closed before and during the swallow, followed by a cough

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to clear any material from the airway. The super-supraglottic swallow maneuver provides additional closure to the entrance of the airway by using a breath hold with increased effort [25,26].

These maneuvers are similar to a technique called the Valsalva swallow because of the volitional act of "bearing down" during swallowing to create a Valsalva maneuver [27,28]. However, the Valsalva maneuver has been reported to be associated with cardiac arrhythmia, angina pectoris and sudden death [29–31]. Sperry [30] reported a case of sudden cardiac death attributed to arrhythmia that occurred in a patient with achalasia who was suspected of using the Valsalva maneuver while swallowing. Sudden cardiac death of a 12-year-old boy following swallowing a cold drink was reported by Burke et al. [31]. In this case, it was suspected that the cold-induced vasovagal reflex caused the terminal arrhythmia.

Although the supraglottic and the super-supraglottic swallow maneuvers are commonly used in dysphagia treatment, it is not known whether they produce associated cardiac effects such as arrhythmia or tachycardia like those associated with the Valsalva maneuver. The purpose of this prospective study was to evaluate the cardiovascular effects of the supraglottic and super-supraglottic swallowing maneuvers on patients with dysphagia following a stroke.

Materials and Methods

Subjects

Subjects were recruited from admissions to the stroke and orthopedic programs of an inpatient rehabilitation hospital across a 9-month period. Three groups of subjects were selected based on inclusion and exclusion criteria. Patients from the stroke program were approached for consent if they had a recent stroke, normal sinus rhythm at the time of admission (with or without medication), dysphagia with aspiration or laryngeal penetration, cognitive ability to follow instructions for the swallow techniques, and were between the ages of 25 and 90 years. Presence of dysphagia was determined based on the results of a videofluoroscopic swallow study (VFSS). Subjects were excluded from participation in this research study if they had a history of subarachnoid bleed, intracerebral bleed or cardiac arrhythmia, or were less than one-week postonset of stroke. For the two stroke groups, Group 1 subjects had a history of coronary artery disease (CAD) and Group 2 subjects had a history of negative for coronary artery disease. Group 3 (control group) subjects were recruited from the inpatient orthopedic program. Subjects were approached for consent for procedures if they had an orthopedic diagnosis and no known neurologic disease, dysphagia, or CAD. Additional inclusion criteria for the control group included normal sinus rhythm, no known history of significant oropharyngeal anomaly, and age 25–90 years.

Procedure

A baseline 12-lead electrocardiogram was obtained on each potential subject to rule out exclusionary criteria. Following medical clearance and informed consent for study participation, each subject's cardiac functioning was monitored during swallowing training and treatment sessions and routine daily activities via 4 hour Holter monitoring. Baseline blood pressure and heart rate were obtained at the start of the swallowing training and treatment sessions. During the swallowing training sessions, which were conducted by a speech-language pathologist, subjects were instructed on how to perform the supraglottic and super-supraglottic swallow maneuvers. Instructions for the supraglottic and super-supraglottic swallow maneuvers were adapted from Logemann [20]. The verbal instructions for the supraglottic swallow were "Take a deep breath and hold your breath. Keep holding your breath while you swallow. Immediately after you swallow, cough. Then, swallow again." The verbal instructions for the super-supraglottic swallow were "Inhale and hold your breath very tightly, bearing down. Keep holding your breath and bearing down as you swallow. Cough when you are finished. Swallow again." All subjects were first instructed on the supraglottic swallow followed by training in the super-supraglottic swallow. Each subject performed a minimum of four swallows for each procedure during the training session. The speech-language pathologist judged each subject's ability to perform the swallowing maneuvers based upon the following scale: *Good*—able to perform the swallowing maneuver several times (75% of the time or better); *Fair*—inconsistently able to perform the swallowing maneuver (50% of the time); *Poor*—unable to follow directions for the swallowing maneuver (25% of the time or less).

Following the swallowing training session, subjects proceeded to the swallowing treatment session where they performed either the supraglottic swallow or the super-supraglottic swallow, as determined by a "good" rating from the training. The same verbal instructions provided during the training sessions were given to the subjects. The subjects completed a minimum of eight swallows during the treatment session. Subjects were allowed to swallow thin liquids or, if indicated by their dysphagia diet, nectar thick liquids. Liquids were presented in a cup and bolus size was not controlled. The timing of each swallow was recorded by pressing the marker button for the Holter monitor to record the timing on the EKG strip. At the end of the treatment session, blood pressure and heart rate were measured.

After the treatment session, subjects proceeded with regular therapy and nontherapy routines, including the lunch meal. Activities and symptoms reported by the subjects were recorded during the 4-hour Holter monitoring period. The Holter monitor information was read by a cardiologist and by the primary attending medical doctor. Data were recorded for each subject based on frequency of normal and abnormal cardiac findings for the pretraining period, training session, swallowing treatment session, and post-treatment activities. For the treatment sessions, the type of swallow maneuver (supraglottic or super-supraglottic) was recorded.

Results

Subjects

A total of 23 subjects participated in this study. Age range was from 44 to 90 years, with a mean age of 71

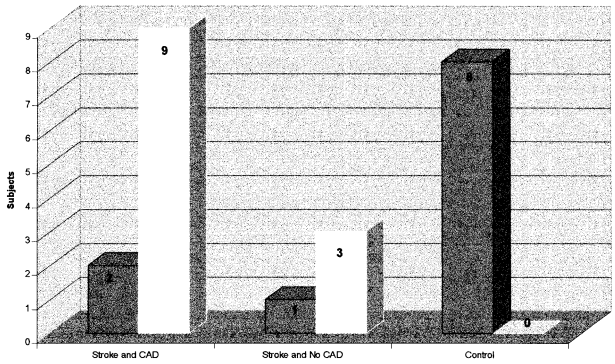

Fig. 1. Number of subjects with normal (filled) and abnormal (open) findings by group.

years. There were 18 female and 5 male subjects. Abnormal cardiac findings, including supraventricular tachycardia, premature atrial contractions, and premature ventricular contractions, were noted in 12 of the subjects with a history of stroke. Results are summarized by group in Figure 1.

Group 1 ($N = 11$) contained 3 male and 8 female subjects with an age range from 57 to 90 years (mean = 71). For this group with a history of CAD, 81.8% (9/11) of the subjects displayed supraventricular tachycardia (Fig. 2), premature ventricular contractions (Fig. 3), or premature atrial contractions during the training and/or treatment session. These arrhythmias subsided within a few minutes after the procedure and did not occur during the remainder of the monitoring period. Blood pressure increases (>20 mm Hg systolic or >10 mm Hg diastolic) were noted in 5 out of the 11 (45.5%) Group 1 subjects at the conclusion of the treatment session. No subject demonstrated a drop in blood pressure. Two out of 11 subjects had normal cardiac findings throughout the monitoring period along with normal blood pressure and heart rate responses. In this group, 6 subjects utilized the supraglottic swallow maneuver and 5 subjects utilized the super-supraglottic swallow maneuver.

Group 2 ($N = 4$) comprised females with an age range of 44–75 years (mean = 64). All (4/4) of the subjects in this group had premature ventricular contractions, premature atrial contractions, and/or supraventricular tachycardia (Fig. 4) during the training/treatment session. This arrhythmia subsided within a few minutes after the session and did not occur during the post-swallowing treatment activities. Additionally, all of these subjects complained of lightheadedness during the treatment session but no subject in Group 2 demonstrated changes in heart rate or blood pressure. The type of swallowing maneuver utilized during the treatment session was equally divided in this group.

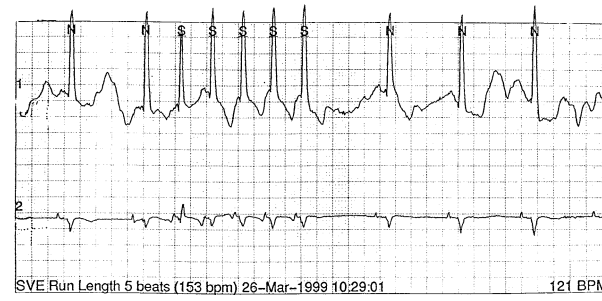

Fig. 2. Subject from Group 1, supraventricular ectopic (SVE) beats [153 beats per minute (BPM)] during supraglottic swallow.

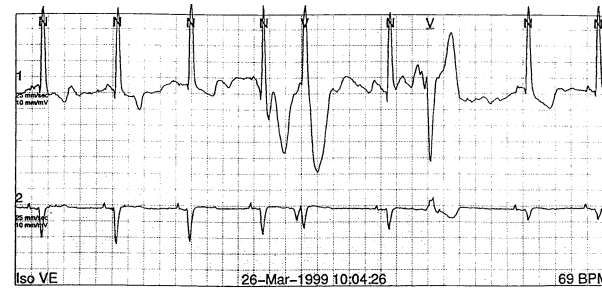

Fig. 3. Subject from Group 1, isolated ventricular ectopy (Iso VE) during supraglottic swallow.

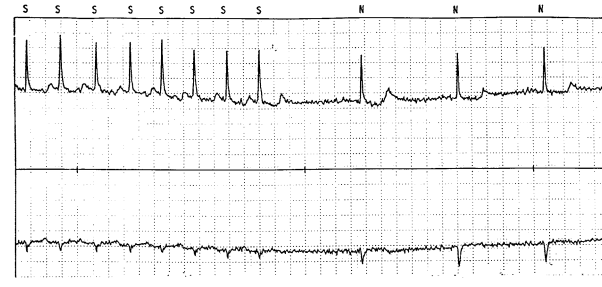

Fig. 4. Subject from Group 2, supraventricular tachycardia during supraglottic swallow.

Abnormal and normal cardiac findings for the type of swallow maneuver utilized in the treatment session are depicted in Figure 5. For Groups 1 and 2 combined, 7 out of 8 subjects utilizing the supraglottic swallow and 5 out of 7 subjects utilizing the super-supraglottic swallow had abnormal cardiac findings only during the treatment session.

Group 3 ($N = 8$) contained 2 male and 6 female subjects with an age range of 55–82 years (mean = 75). None of the subjects demonstrated arrhythmia although 1 subject exhibited bradycardia (<50 BPM heart rate) and 3 subjects complained of lightheadedness and had notable blood pressure elevation (>20 mm Hg systolic or >10 mm Hg diastolic) after the treatment session. The other five subjects had normal blood pressure and heart rates and no so-

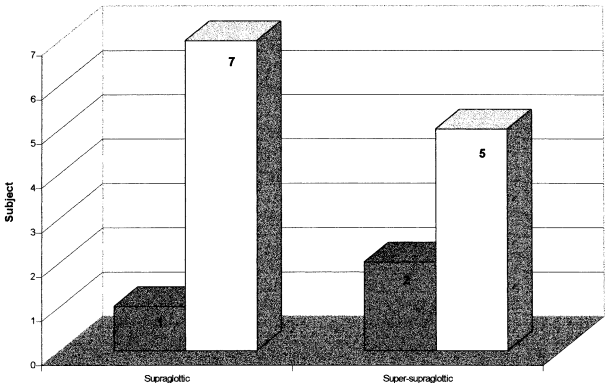

Fig. 5. Number of subjects with normal (filled) and abnormal (open) findings by swallow maneuver.

matic complaints. The type of swallowing maneuver utilized during the treatment session was equally divided in this group.

Discussion

Although this study was designed to investigate a larger population, the research was stopped to protect the safety of the subjects when it was found that a significant percentage displayed cardiac arrhythmia. Regardless of coronary artery disease history, 13 out of 15 (86.6%) subjects with a history of stroke and dysphagia displayed cardiac arrhythmia during the swallowing sessions.

It is of interest that the cardiac arrhythmia occurred during the swallowing sessions using either the supraglottic or super-supraglottic swallow maneuvers but did not occur during other activities such as walking, wheelchair transfers, or lunch. All of the subjects with dysphagia followed dietary or postural compensations for aspiration prevention during the lunch meal, but none of the subjects utilized the super-supraglottic or supraglottic swallow maneuver during meals. Most subjects completed a total of 16 supraglottic and super-supraglottic swallows during the swallowing training and treatment sessions. During a typical lunch meal, the swallow maneuver would likely be utilized many more times. This leads to the concern that if the supraglottic and super-supraglottic swallow maneuvers were performed during the entire meal, a patient might experience significant sustained arrhythmia with potentially dangerous cardiac consequences.

It is suspected that the swallow maneuvers studied are modifications of the Valsalva maneuver and thus, caused the associated physiologic responses. The Valsalva maneuver is defined as closure of the glottis at the end of a deep inspiration followed by physical exertion such as required for heavy lifting or straining for bowel elimination [29]. The Valsalva maneuver has been shown to increase intrathoracic pressure, which impairs venous return resulting in decreased cardiac output, fall in systolic blood pressure, and an increase in heart rate. These cardiac effects remain even after release of the breath hold and strain [29]. It can be surmised that the supraglottic and super-supraglottic swallows create the Valsalva maneuver during the voluntary glottal closure, effort of swallowing, and extended breath holding. Like the actual Valsalva maneuver, this may decrease cardiac output by decreasing venous return as the intrathoracic pressure increases. In addition, this Valsalva effect increases intracranial pressure, which can be detrimental to patients with intracerebral bleed or other cerebral pathology.

Of additional interest is that there were no apparent cardiac effect differences between the two swallow maneuvers. The super-supraglottic swallow includes the additional step of "bearing down" while swallowing. It could be assumed that this act of bearing down would increase the likelihood of a Valsalva maneuver and resultant cardiac effects. This was not evidenced in the data as abnormal cardiac effects occurred in nearly equal numbers of subjects for the two maneuvers (Fig. 5).

Due to the increased frequency of cardiac pathologies with advancing age, it could be hypothesized that age could have contributed to the findings of this study but this was not supported by the data. Group 3 had the oldest mean age (75 years vs. 64 years for the youngest group) but subjects in this group did not show abnormal cardiac findings via Holter monitoring.

Conclusion

The evaluation and treatment of dysphagia must be interdisciplinary in nature, comprising the expertise of multiple medical professionals including the physician for the medical diagnoses, medical treatments, and complications and the speech-language pathologist for the swallowing physiology and rehabilitative methods. When evaluating a patient and making treatment decisions, it is important to look at the entire medical history of the patient including potential cardiac effects of swallowing procedures. The findings of this study suggest a relationship between

specific swallowing maneuvers and cardiac arrhythmia. Therefore, the investigators suggest that the supraglottic and super-supraglottic swallow maneuvers should not be used for stroke patients with dysphagia, especially if they have a history of cardiac arrhythmia or coronary artery disease. In addition, these swallow maneuvers should not be used for patients who have acute congestive heart failure or uncontrolled hypertension.

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