Swallow-induced syncope in 5 patients

Electrophysiologic evaluation during swallowing

Ibrahim Aydogdu, MD; Can Hasdemir, MD; Ahmet Acarer, MD; Sezin Alpaydin, MD; Cumhur Ertekin, MD

Abstract

Background: We sought to characterize a cohort of participants with swallow-induced syncope (SIS) with clinical and electrophysiologic evaluations.

Methods: Using electrocardiographic monitoring and neurophysiologic methods of swallowing, we evaluated a cohort of 5 patients with SIS, 4 of whom had longitudinal follow-up. **Results:** We determined electrophysiologically that the duration between the onset of swallow and a bradyarrhythmia or asystole is extremely short (2–3 seconds) in SIS. Most participants with SIS do not have a neurologic or esophageal disorder. SIS can occur with different food types, in sitting or standing position, and has varying frequency in different participants. Permanent pacemaker placement is a curative measure in SIS.

Conclusions: Our findings suggest that SIS is elicited by reflex afferent pathways originating in the oropharynx, rather than an esophageal origin, as previously proposed. Our longitudinally followed cohort with detailed clinical and electrophysiologic characterization should aid the clinician in the diagnosis and treatment of this potentially life-threatening condition. *Neurol Clin Pract* 2017;7:316–323

Swallow-induced syncope (SIS) or deglutition syncope is a very rare condition and a form of neurally mediated situational syncope. It is characterized by a variety of symptoms, ranging from lightheadedness and dizziness to loss of consciousness and occurs during or immediately after swallowing. SIS and concomitant upper gastrointestinal tract and cardiac pathologies such as esophageal spasm, achalasia, hiatal hernia, gastroesophageal reflux disease, coronary artery disease, atrial fibrillation, and carotid sinus hypersensitivity have been reported in patients.^{1–3} Among the causes or concurrent problems, neurologic disorders such as glossopharyngeal neuralgia, carotid artery stenosis/endarterectomy, or metastatic brain tumors were also infrequently reported.^{4–6} It is believed that SIS is caused by upper gastrointestinal–cardiac vagovagal reflexes. However, in a considerable number of reported patients (about 40% of the 80 cases), no underlying disease could be found. The clinical diagnosis of SIS relies upon establishing a clear temporal relationship between oral intake and syncope.^{2,3}

Departments of Neurology and Clinical Neurophysiology (IA, CE), Cardiology (CH), and Neurology (AA, SA), Ege University, Bornova/Izmir, Turkey.

Funding information and disclosures are provided at the end of the article. Full disclosure form information provided by the authors is available with the **full text of this article at Neurology.org/cp.**

Correspondence to: ibrahimxaydogdu@gmail.com

All cases were investigated during swallowing by using electrophysiologic tests.

We recruited a cohort of 5 patients with SIS within the last 10 years, even though SIS is a rare disorder. We sought to demonstrate the cardiac rhythm changes and neurophysiologic characteristics during swallowing in this cohort by using electrocardiographic monitoring and neurophysiologic methods of swallowing and to systematically investigate swallowing physiology in SIS.

METHODS

We investigated 5 patients (4 women, 1 man) with syncopal episodes during swallowing. Their mean age was 55.2 years (range 39–68). They were collected from the inpatient and outpatient clinics at the Departments of Neurology and Cardiology at Ege University Medical School Hospital.

Standard protocol approvals, registrations, and patient consents

Institutional ethical committee on human experimentation approved the study and written informed consent was obtained from each participant.

In addition to neurologic and cardiac examinations, endoscopic examinations, EEG, brain MRI, routine EMG, and nerve conduction/autonomic tests were done. Routine biochemical and hematologic tests were also performed. In 2 patients, 24-hour Holter monitoring was performed in the home environment and patients were asked to record meal times.

All patients were particularly asked about dysphagia and examined with focus on tongue, oropharynx, and larynx.

All cases were investigated during swallowing by using electrophysiologic tests. These methods have been described previously.⁷ The upward and downward laryngeal movements during swallowing were recorded using a mechanical sensor placed on the coniotomy region at the midline. For recording of the submental EMG (SM-EMG) activity during swallowing, silver chloride EEG electrodes are placed under the chin over the submental muscle complex. ECG was also simultaneously recorded with SM-EMG activity or laryngeal sensor to determine the heart rate during sequential water swallowing (SWS). The ECG signal was recorded via surface electrodes taped onto the left intercostal spaces and was interfaced with the EMG machine. The SWS recordings were obtained during rest and during 2 cup swallows. Patients were given a paper cup containing 100 mL of liquid. They were requested to drink continuously as in their daily life.⁷ The total analysis time was 50 seconds. Recordings were also evaluated within 10-second windows from the onset to the termination of the whole trace of 50 seconds⁷ (figure e-1 at Neurology.org/cp).

Sequential swallowing of 100 mL water was performed by all patients. Patients described different types of foods and liquids as the causative factors for their symptoms. Therefore, alternative liquids and foods were also tried in some patients. Drinking from a cup has been recorded during swallowing cold water, carbonated beverage, and ayran (traditional Turkish cold beverage of mixed water, salt, and yogurt). In 3 patients, solid and semisolid foods were also used, such as bread, meats, and rice. Examination was performed at the position where symptoms occurred most frequently. In 3 patients, swallowing examination was performed during standing.

RESULTS

In the 5 patients investigated, the time between the onset of syncopal attacks and clinical investigations ranged from 4 months to 21 years. The clinical and laboratory features of the cases are summarized in the table. Their clinical profiles are detailed in appendix e-1.

Supplemental Data

Neurology.org/cp

Table Clinical and laboratory features and long-term follow-up of cases

	Cases (sex/age, y)				
	1 (F/51)	2 (F/65)	3 (F/39)	4 (F/53)	5 (M/68)
Disease duration	21 y	5–6 y	6 mo	4 y	4 mo
Clinical presentation	Presyncope and syncope	Syncope	Presyncope and syncope	Presyncope and syncope	Presyncope and syncope
Frequency of syncopal episodes	Many times	10–15 times (4/last year)	2 times totally	3–4 times/year	4 times totally
Position and time	Standing only; any time	Standing; any time	Sitting; meal times	Sitting; meal times	Standing; any time
Bolus type	Solid > semisolid	Liquid, carbonated beverages	Solid/semisolid	Solid/semisolid	Liquid
Pharyngo-esophagography	Normal	Tertiary contractions	ND	Normal	Normal
Esophageal manometry	Normal	Normal	Normal	ND	ND
12-lead ECG	Normal SR; normal PR-interval and QRS duration	Normal SR; normal PR-interval and QRS duration	Normal SR; normal PR-interval and QRS duration	Normal SR; normal PR-interval and QRS duration	Atrial fibrillation
ECG monitoring during swallowing	Atrioventricular block for 4 s Bradycardia (6 s)	Sinus arrest and complete atrioventricular block for 7 s	Complete atrioventricular block for 7 s	Asystole (3 s)	Asystole (5 s)
Treatment	Pacemaker implantation was rejected	Permanent pacemaker implantation	Permanent pacemaker implantation	Pacemaker implantation was rejected	Permanent pacemaker implantation
Long-term follow-up	No syncopal episodes with diet modification	No syncopal attacks for 4 y	No syncopal attacks for 3 y	NA	No syncopal attacks for 2 y

Abbreviations: NA = not available; ND = not done; SR = sinus rhythm.

Two of the patients did not report any medical history of neurologic, cardiac, or gastroenterologic disorders. In 3 patients, medical history of vascular disease or vascular risk factors were reported, including hypertension, diabetes mellitus, myocardial infarction, coronary artery disease, stroke, carotid artery stenosis, or endarterectomy. There was no history of illicit drug use for any of the patients.

All patients had deglutitional syncopal attack and swallowing-associated lightheadedness and near-syncope. Attack frequency was variable, such as 7 times in 2 months to twice in 6 months. The symptoms were triggered by ingestion of large boluses of food, cold liquid, and carbonated beverages in 2 patients. In others, solid and semisolid foods were described as causative factors. SIS occurred especially in standing position in 3 and during sitting position in another 2 cases. Taste of the swallowed bolus had no effect on the symptoms. None of the patients described painful swallowing, heartburn, or chest pain. Dysphagia was reported in only 1 patient with stroke history and chronic cerebral infarcts on MRI. Dysphagia was not detected in the remainder of the patients. Routine laboratory tests, including hematologic and biochemical tests, were within normal limits except for high glucose levels in patients with diabetes mellitus.

Neurologic examination and investigation

Neurologic examination was normal in 4 patients. One patient with stroke history had sequelae of facial palsy. Brain MRI was normal in all patients except for one with stroke history. EEG was normal in all patients without any evidence of epileptiform discharges. Magnetic resonance

Figure 1 Swallowing-induced asystole in deglutitional syncope (patient 2)

(A) Sequential cold beverage swallowing (100 mL). Upper trace: ECG and laryngeal sensor signals before swallowing (at rest). Middle trace: Sequential swallowing and ECG synchronous recording during swallowing of cold beverage. Lower trace: Same traces but faster recording in order to see the asystole denoted by horizontal lines. (B) Thirty milliliters liquid single swallow attempt (upper trace: laryngeal sensor; middle trace: submental conventional EMG; lower trace: ECG). Underlines denote the asystole. Note the onset of asystole is 2 seconds after the onset of single swallow (underlined with arrows at the middle trace).

angiogram or duplex scanning of the carotid arteries revealed findings consistent with internal carotid artery stenosis/occlusion in 1 patient and atherosclerotic plaques in the carotid arteries without stenosis in 2 other patients. Electroneuromyography and autonomic tests were normal in all patients.

Cardiologic examination and investigation

ECG revealed normal sinus rhythm in most of the patients, and only one patient had atrial fibrillation. Twenty-four-hour ambulatory ECG was done in 4 patients, only one of whom showed atrioventricular block. Transthoracic echocardiogram was unremarkable in 3 patients. In 2 patients, mild abnormalities were demonstrated such as mitral and tricuspid insufficiency and atrial dilation. None of the patients had heart failure. One patient was diagnosed with coronary artery disease.

Gastroenterologic examination and investigation

Barium pharyngo-esophagography was done in 5 patients and no structural pathology was detected. Only one patient showed mild esophageal dysmotility as tertiary contractions.

Neurophysiologic findings during SWS

None of the patients developed syncope during the swallowing investigation. All patients were able to complete drinking a cup of liquid containing 100 mL water, ayran, or carbonated beverages without aspiration or any difficulty. During simultaneous recording with ECG, only one patient showed arrhythmia at rest. While 4 patients demonstrated abrupt asystole lasting 3–7 seconds, this was usually at the end of sequential swallowing (figure 1A). Three of these patients experienced lightheadedness and feeling of tightness in the throat. Sinus bradycardia developed in one patient during SWS. In this patient, heart rate dropped from 90 beats/min to 45 beats/min. In 3 patients, increasing R-R interval occurred during discrete swallows of large volume bolus (figure 1B). One patient demonstrated about a 4-second asystole during Holter recording, just after eating bread (figure 2).

A permanent pacemaker was implanted in 3 patients, resulting in the resolution of syncopal attacks. These patients were symptom-free during 2–4 years of follow-up.

We postulate that the afferent signals resulting in swallowing-induced bradyarrhythmias are likely elicited during the pharyngeal phase of swallowing.

DISCUSSION

Swallowing tachycardia is a physiologic phenomenon induced by drinking water in normal adults. Drinking water causes an immediate and transient drive in sympathetic activities, which gives rise to an increase in both mean arterial pressure and heart rate. Such rapid rise in blood pressure and heart rate might also be caused by internal swallowing-induced factors or correspond to arousal responses related to central descending influences from higher brain centers.⁸ With any of these mechanisms at play, it is obvious that the cardiac rhythm can indeed be changed by swallowing. For example, deglutition-induced atrial tachycardia and atrial fibrillation were reported especially in patients with recent stroke and dysphagia.⁹

On the other hand, SIS is effectively the opposite of the conditions mentioned above. The strong vasovagal reflex during deglutition is thought to be the major cause of cardiovascular suppression. In most cases, bradyarrhythmia or transient asystole may lead to cerebral hypoperfusion and syncope. SIS is known to occur in patients with organic or functional disorders of the esophagus. However, esophageal disorders were reported in only about 40% of patients with SIS.¹⁻³ Thus, gastroesophageal disorders is not a prerequisite for SIS. Similarly, we could not find important clinical or laboratory evidence of esophageal pathology in our cases. SIS may also occur in patients with cardiac disorders, and cardiac disease was encountered in about 15% of the reported cases. Importantly, in a considerable number of cases (up to 43%), no underlying disease could be found.¹⁻³

In our cohort of 5 cases, we also did not identify any disease process that would contribute to the SIS. Only one participant had history of stroke; however, this was not related to the onset of SIS. Carotid artery stenosis or atherosclerotic plaques in the carotids were identified in

Figure 2 Holter recording during bread eating

The deglutitional asystole is about 4 seconds (patient 1).

Figure 3 Schematic diagram of onset of asystole/bradyarrhythmia according to the first swallow (first SW) (interval 1) and last swallow (last SW) (interval 2) during sequential swallowing

The mean is 7.5 sec for interval 1 (range: 2.0–13.3 sec). The mean is 1.1 sec for interval 2 (range: 0.7–2.1 sec).

the majority of our patients. SIS was reported following endarterectomy and carotid artery stenosis in some patients.^{6,10} Endean et al.⁶ suggested that increased sensitivity of the carotid baroreceptor and transient increase in afferent activity to the nucleus tractus solitarius during swallowing can cause amplified and increased vagal efferent output leading to cardioinhibition.

The pathogenesis of SIS is almost always attributed to the peripheral factors. Mechanical stimulation of the esophagus during swallowing has been thought to be the potential causal factor in some patients.^{1,11} However, tachyarrhythmias can be induced even with saliva swallowing.^{12,13} The presence of an adrenergic reflex originating in the esophagus has been postulated as the cause for swallowing-induced tachyarrhythmias.^{12,14} Many reports have postulated that vasovagal reflexes play a major role for the cardioinhibition in SIS. Although the pathology of SIS is not completely understood, several different causative mechanisms may exist.^{1,2,10,15,16}

Understanding the pathomechanism for SIS requires a detailed investigation of the temporal relationship between swallowing and the onset of asystole or bradyarrhythmias, using sequential or continuous polygraphic recordings of swallowing. Our detailed electrophysiologic evaluation of swallowing and ECG in patients with SIS revealed that the duration between the onset of the last swallow in SWS and the onset of asystole is only about 2.5 or 3 seconds (figure 1). This time is not enough to transfer the water into the esophagus.¹⁷ This finding argues against an esophageal mechanism as a cause of SIS. The duration of the oropharyngeal phase of swallowing is short (in the range of 1.0 seconds) and remarkably constant in humans, especially during water swallowing. In contrast, the esophageal phase of swallowing is slower and may exceed 10 seconds in the conscious human.¹⁷ In all of our patients, the duration between the last swallow to the first block of the ECG in asystole was not more than about 3 seconds (figure 3). Saliva swallows were previously reported to induce tachyarrhythmias.^{12,13}

We have observed that a single swallow can induce a 2- to 3-second asystole in ECG (figure 1B).

Given these findings, we postulate that the afferent signals resulting in swallowing-induced bradyarrhythmias are likely elicited during the pharyngeal phase of swallowing. The electrophysiologic data collected in our patients suggest that the afferent arc leading to SIS may be in the pharynx or upper esophagus. The extreme short duration between the end of swallow and the onset of bradyarrhythmia makes it highly unlikely that an esophageal disease is the cause of SIS. Occurrence of esophageal disease and SIS without supporting electrophysiologic relationship suggests that these 2 events are likely coincidental rather than consequential. Our findings support the following mechanism for SIS. The afferent signals from the pharyngeal nerves would reach the nucleus tractus solitarius and nucleus ambiguus. The swallowing central pattern generator would send the efferent signals to the vagal nucleus of the Xth cranial nerve. This would be followed by dense impulse volleys resulting in bradyarrhythmia or asystole. The end result is cerebral hypoperfusion and syncope. A similar mechanism was proposed in prior reports^{1,6}; however, we provide the first electrophysiologic evidence in support of this pathomechanism in our cohort of 5 participants with SIS.

We have also confirmed that permanent pacemaker implantation is the most efficacious method of resolving symptoms and preventing life-threatening asystole or bradyarrhythmias.^{1,2} In our cohort, the 3 out of 5 participants who were offered and accepted pacemaker placement remained symptom-free for the duration of their follow-up.

Our longitudinally followed cohort of 5 participants with SIS who underwent detailed clinical and electrophysiologic evaluation provides support for an oropharyngeal and not esophageal trigger for this condition. The detailed clinical, laboratory, and electrophysiologic data collected on this cohort should provide important information to the neurologist and other clinicians regarding this relatively rare condition, which should enhance its ready diagnosis and treatment.

REFERENCES

1. Omi W, Murata Y, Yaegashi T, Inomata J, Fujioka M, Muramoto S. Swallow syncope: a case report and review of the literature. *Cardiology* 2006;105:75–79.
2. Mitra S, Ludka T, Rezkalla SH, Sharma PP, Luo J. Swallow syncope: a case report and review of the literature. *Clin Med Res* 2011;9:125–129.
3. Gawrieh S. Swallow syncope. In: Shaker R, Belafsky PC, Postma GN, Easterling C, eds. *Principles of Deglutition: A Multidisciplinary Text for Swallowing and Its Disorders*. New York: Springer; 2013: 445–448.
4. Levin B, Posner JB. Swallow syncope: report of a case and review of the literature. *Neurology* 1972; 22:1086–1093.
5. St John JN. Glossopharyngeal neuralgia associated with syncope and seizures. *Neurosurgery* 1982;10: 380–383.
6. Endean ED, Cavatassi W, Hansler J, Sorial E. Deglutition syncope: a manifestation of vagal hyperactivity following carotid endarterectomy. *J Vasc Surg* 2010;52:720–722.
7. Aydogdu I, Tanriverdi Z, Ertekin C. Dysfunction of bulbar central pattern generator in ALS patients with dysphagia during sequential deglutition. *Clin Neurophysiol* 2011;122:1219–1228.
8. Endo Y, Yamauchi K, Tsutsui Y, et al. Changes in blood pressure and muscle sympathetic nerve activity during water drinking in humans. *Jpn J Physiol* 2002;52:421–427.
9. Chaudhuri G, Hildner CD, Brady S, Hutchins B, Aliga N, Abadilla E. Cardiovascular effects of supraglottic and super-supraglottic swallowing maneuvers in stroke patients with dysphagia. *Dysphagia* 2002;17:19–23.
10. Garg S, Girotra M, Glasser S, Dutta SK. Swallow syncope: clinical presentation, diagnostic criteria, and therapeutic options. *Saudi J Gastroenterol* 2014;20:207–211.
11. Kalloor GJ, Singh SP, Collis JL. Cardiac arrhythmias on swallowing. *Am Heart J* 1977;93: 235–238.
12. Wilmshurst PT. Tachyarrhythmias triggered by swallowing and belching. *Heart* 1999;81:313–315.
13. Tada H, Kaseno K, Kubota S, et al. Swallowing-induced atrial tachyarrhythmias: prevalence, characteristics, and the results of the radiofrequency catheter ablation. *Pacing Clin Electrophysiol* 2007;30: 1224–1232.

14. Goldberger AL, Johnson AD. Swallowing-induced paroxysmal supraventricular tachycardia. *J Electrocardiol* 1980;13:83–84.
15. Deguchi K, Mathias CJ. Continuous hemodynamic monitoring in an unusual case of swallow induced syncope. *J Neurol Neurosurg Psychiatry* 1999;67:220–222.
16. Shirayama T, Hadase M, Sakamoto T, et al. Swallowing syncope: complex mechanisms of the reflex. *Intern Med* 2002;41:207–210.
17. Ertekin C, Aydogdu I. Neurophysiology of swallowing. *Clin Neurophysiol* 2003;114:2226–2244.

Received February 17, 2017. Accepted in final form April 17, 2017.

AUTHOR CONTRIBUTIONS

I. Aydogdu: study concept and design, acquisition, analysis and interpretation of data. C. Hasdemir: acquisition of data, analysis and interpretation of data. A. Acarer: recruitment of patients, acquisition of data. S. Alpaydin: recruitment of patients, acquisition of data. C. Ertekin: study supervision, critical revision of the manuscript for important intellectual content.

ACKNOWLEDGMENT

The authors thank Dr. Nilufer Taner for reviewing the English.

STUDY FUNDING

No targeted funding reported.

DISCLOSURE

I. Aydogdu has received speaker honoraria from UCB. C. Hasdemir, A. Acarer, S. Alpaydin, and C. Ertekin report no disclosures. Full disclosure form information provided by the authors is available with the [full text of this article at Neurology.org/cp](#).

Related articles from AAN physician and patient resources

Neurology® ● Neurology.org

Clinical Reasoning: An unusual cause of indeterminate spells

December 6, 2016;87:e275–e280.

Tilt-induced vasovagal syncope and psychogenic pseudosyncope: Overlapping clinical entities

December 8, 2015;85:2006–2010.

Midodrine for orthostatic hypotension and recurrent reflex syncope: A systematic review

September 23, 2014;83:1170–1177.

Continuum® ● ContinuumJournal.com

Syncope

April 2017;23:335–358.

Neurology Today® ● Neurotodayonline.com

Is Midodrine Effective for Symptomatic Orthostatic Hypotension and Recurrent Reflex Syncope?

September 18, 2014;14:5–6.