Swallow syncope: a case report and review of literature

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Abstract

Background: Swallow or deglutition syncope is an unusual type of neurally-mediated syncope associated with life-threatening bradyarrhythmia and hypotension. It is a difficult condition to diagnose with commonly delayed diagnosis and management. There is lack of review articles that elucidate the basic demographics, clinical characteristics and management of this rare condition. This publication systematically reviews the 101 case reports published since 1793 on swallow syncope.

Case presentation: A 59-year-old man presented with the complaint of recurrent dizziness associated with meals. A 24-h ambulatory ECG recording confirmed an episode of p-wave asystole at the time of food intake. Oesophagogastroduodenoscopy with balloon inflation in the mid to lower oesophagus resulted in a 5.6 s sinus pause. The patient’s symptoms resolved completely following insertion of a permanent dual chamber pacemaker.

Conclusions: Swallow syncope is extremely rare, but still needs to be considered during diagnostic workup. It is commonly associated with gastro-intestinal disease. Permanent pacemaker implantation is the first line treatment.

Keywords: Swallow, Syncope, Deglutition, Bradycardia, AV block, Pacemaker

Background
Swallow syncope is a rare cause of a neurally mediated syncope that is frequently associated with life-threatening bradycardia [1]. The underlying mechanism is believed to be an exaggerated vagal stimulation during swallowing resulting in suppression of the cardiac conduction system. Swallow syncope has been reported in all age groups and occurs with or without underlying esophageal or cardiac pathology. A diagnosis of swallow syncope is frequently missed by physicians, often resulting in delayed diagnosis and treatment. The first case of swallow syncope was reported by Spens in 1793 [2]. Since then, another 117 cases have been reported in the literature.

We present a case of recurrent swallow syncope with a review and summary of the entire literature available regarding this rare condition.
sublingually, with reproduction of symptoms of syncope. The minimal blood pressure was 32.9/29.2 mmHg and the heart rate 75.3 bpm. No asystole was observed during tilt table testing (Fig. 2).

The patient’s symptoms resolved completely after implantation of a dual chamber PPM. A diagnostic workup to exclude gastrointestinal disease was performed. A barium swallow test was normal and effectively ruled out achalasia. The oesophagus appeared healthy with no structural disease on oesophagogastroduodenoscopy (OGD). The pacemaker was continuously interrogated during the OGD. Increased pacing requirements were noted when the endoscope was advanced into the esophagus (Fig. 3b). Subsequently, a 20 mm diameter TTS (through-the-scope), CRE™ (controlled radial expansion) balloon (Boston scientific) was sequentially inflated in the proximal, mid and distal esophagus while the pacemaker was programmed “OFF” to assess the physiologic response. Inflation in both distal and mid oesophagus resulted in significant sinus pauses of up to 5.6 s (Fig. 3c) confirming the cardio-inhibitory response to oesophageal distension as the underlying pathophysiological mechanism of this patient’s syncopal events.

Discussion
Swallow syncope is more common in males (59.4%, n = 60), and in the older age group (55.4%, n = 56, more than 60 years old). The mean age at presentation was 57.5 years with the youngest patient described in the literature being 5 years old [3] and the eldest 89 years old [4]. All of the patient presented with either presyncope or syncope. Only one patient was diagnosed incidentally, when a high degree atrioventricular (AV) block associated with meal times was found during a diagnostic workup for lung carcinoma [5]. Swallow syncope is strongly associated with gastrointestinal diseases (32.7%, n = 33). Hiatal hernia (18.8%, n = 19), oesophageal stricture (3%, n = 3), achalasia (3%, n = 3) and oesophageal
Fig. 3  

a Pacemaker recording of patient in sinus rhythm prior to OGDS procedure, intrinsic heart rate 65 beats/min. 
b Pacemaker recording during advancement of endoscope into distal oesophagus (Pacemaker ON), increasing ventricular pacing. 
c Pacemaker recording when balloon inflation in distal oesophagus (Pacemaker OFF), 5.6 s pause.
| Author/ Reference | Age/ Gender | Presenting Symptom | Underlying Diseases | Trigger Factor | Type of arrhythmia | Management | Effectiveness |
|-------------------|-------------|-------------------|---------------------|---------------|-------------------|------------|--------------|
| Padalia et al. 2018/ [6] | 65/ F | Presyncope, Dysphagia, Odynophagia/ | Candida Esophagitis, Metabolic Diseases | Solid and Liquid | Sinus bradycardia, Sinus arrest | Micafugin | Yes |
| Sammy et al. 2018/ [7] | 67/M | Syncope | End Stage Renal Failure | Ascension of Hyoid bone irritate carotid sinus | – | – | – |
| Yamaguchi et al. 2018/ [8] | 76/M | Syncope | No | Solid and Liquid (Citrus based) | Sinus arrest, AV block | – | – |
| Lipar et al. 2018/ [9] | 49/F | Syncope | Post whiplash neck injury | Solid and Liquid | – | – | – |
| Van Damme et al. 2017/ [10] | 39/F | Syncope | No | Solid and Liquid | 3rd degree AV block | PPM | – |
| Aydogdu et al. 2017/ [11] | 51/F | Presyncope, Syncope | No | Solid food | AV block | Rejected PPM | – |
| Aydogdu et al. 2017/ [11] | 65/F | Syncope | – | Liquid (Carbonated) | Sinus arrest, 3rd degree AV block | PPM | Yes |
| Aydogdu et al. 2017/ [11] | 39/F | Presyncope, Syncope | No | Solid food | 3rd degree AV block | PPM | Yes |
| Aydogdu et al. 2017/ [11] | 53/F | Presyncope, Syncope | No | Solid food | Asystole | Diet modification | – |
| Aydogdu et al. 2017/ [11] | 68/M | Presyncope, Syncope | Atrial Fibrillation | Liquids | Asystole | PPM | Yes |
| Patel et al. 2017/ [12] | 48/M | Syncope, Nausea, Tunnel vision | Hiatus Hernia | Solid and Liquid | Sinus arrest | Hiatus hernia repair surgery | Yes |
| Zaid et al. 2017/ [13] | 71/M | Syncope | Achalasia | Solid food | AV block | – | – |
| Bhogal et al. 2017/ [14] | 68/F | Presyncope | Hiatus Hernia, Metabolic Diseases | Solid food | Sinus Bradycardia, 1st degree AV block | Discontinuation of metoprolol + Proton Pump Inhibitor | No |
| 59/M | Pre-syncope & Syncope | No | Liquid diet | Premature atrial complexes & Asystole | PPM | Yes |
| Trinco et al. 2016/ [15] | 83/ M | Syncope | Carotid endarterectomy, Metabolic diseases | Solid and Liquid | Sinus bradycardia, 3rd degree AV block | PPM | Yes |
| Islam et al. 2016/ [16] | 60/ F | Presyncope, Syncope | No | Solid food (Large chunk of bread) | AV block | Avoidance of trigger | Yes |
| Chhetri et al. 2016/ [17] | 71/M | Syncope | Fundoplication for GERD | Solid and Liquid (Fizzy drink) | Sinus arrest | PPM | NM |
| Tiffany et al. 2016/ [18] | 80/F | Syncope, palpation, facial flushing | Metabolic diseases, Hypothyroidism | Solid and Liquid | Atrial Tachycardia | Catheter ablation | Yes |
| Manu et al. 2016/ [19] | 13/F | Syncope | Superior sinus atrial septal defect | Solid and Liquid | 3rd degree AV block | PPM | Yes |
| Author/ Reference | Age/ Gender | Presenting Symptom | Underlying Diseases | Trigger Factor | Type of arrhythmia | Management | Effectiveness |
|-------------------|-------------|--------------------|---------------------|---------------|-------------------|------------|--------------|
| Aaberg et al. 2015/ [20] | 62/M | Pre-syncope, Syncope | No | Solid and Liquid | 2nd and 3rd degree AV block | PPM | Yes |
| Kahn et al. 2015/ [4] | 89/M | Syncope | Transient Oesophageal dysmotility, Coronary artery diseases | Solid and Liquid (Carbonated) | 1st and 2nd degree AV block | PPM | Yes |
| Salih et al. 2015/ [21] | 70/M | Syncope | No | Solid food | Asystole | PPM | Yes |
| Erdogan et al. 2015/ [22] | 47/M | Syncope | Achalasia | Solid and Liquid | AV block, Asystole | Pneumatic dilation | Yes |
| Shashank et al. 2014/ [23] | 31/F | Presyncope & Syncope | No | Liquid (Carbonated) | Sinus bradycardia, Asystole | PPM | Yes |
| 78/M | Presyncope | Sick sinus syndrome, Metabolic diseases | Solid food | – | PPM + Coffee before meals | Yes |
| 80/M | Presyncope, Syncope | Hiatus Hernia AF, various cardiac Comorbid | Solid food (Sticky food) | – | Avoidance of trigger | Yes |
| Shah et al. 2014/ [24] | 57/M | Presyncope, Syncope | No | Swallow +Cold drink | Advanced heart block for 3–4 s | PPM | Yes |
| Witcik et al. 2014/ [25] | 70/M | Syncope, Weakness, Flushing | Mild AV regurgitation | Liquid (Carbonated) | Atrial Fibrillation with ventricular pause | PPM | Yes |
| Arihide et al. 2014/ [26] | 79/M | Syncope | Coronary artery disease, Metabolic diseases | Solid and Liquid | Sinus arrest | PPM | Yes |
| Moore et al. 2013/ [27] | 65/F | Presyncope, Syncope | No | Solid food | AV block | PPM | Yes |
| Lambiris et al. 2013/ [28] | 54/M | Presyncope, Shortness of breath | No | Solid and Liquid | 1st degree AV block | PPM | Yes |
| Rezvani et al. 2013/ [29] | 51/F | Syncope | Post Laparoscopic gastrectomy | Solid and Liquid | AV block | Atropine | Yes |
| Kim et al. 2012/ [30] | 39/M | Syncope, Chest tightness | No | Liquid (Cold) | 3rd degree AV block | Avoidance of trigger | Yes |
| Knopke et al. 2012/ [31] | 49/F | Syncope, Dysphagia, Regurgitation | Hiatus hernia, Diffuse oesophageal spasm | Solid food | 3rd degree AV block | PPM | Yes |
| Foreman et al. 2011/ [32] | 52/F | Presyncope, Chest pain | No | Solid food | 2nd degree AV block | PPM | Yes |
| Vanerio et al. 2011/ [33] | 84/F | Syncope | Hiatus Hernia | Solid and Liquid (Carbonated) | – | Nissen’s Fundoplication | Yes |
| Mitra et al. 2011/ [34] | 60/F | Presyncope, Syncope | Metabolic Diseases | Solid food | Sinus Bradycardia, 3rd degree AV block | PPM | Yes |
| Marina et al. 2010/ [35] | 37/M | Syncope | Megaesophagus, Extra Cardiac | Solid and Liquid | – | Deflation of | – |
| Author/ Reference           | Age/ Gender | Presenting Symptom | Underlying Diseases                                                                 | Trigger Factor   | Type of arrhythmia | Management | Effectiveness |
|-----------------------------|-------------|--------------------|--------------------------------------------------------------------------------------|------------------|---------------------|------------|---------------|
| GY Lee et al. 2010/ [36]    | 62/M        | Syncope, Dysphagia | Atrial Fibrillation, Metabolic diseases                                             | Liquid           | Asystole            | PPM        | Yes           |
| Endean et al. 2010/ [37]    | 61/M        | Syncope, Chest pain, Vision lost | Post Carotid entaterectomy                                                              | Solid food       | –                   | Glycopyrrolate | Yes           |
| Casella et al. 2009/ [38]   | 66/M        | Syncope            | Oesophageal dysmotility, Sick sinus syndrome                                         | Liquid only      | AV block            | PPM        | Yes           |
| Karamitsos et al. 2009/ [39]| 82/F        | Syncope            | Hiatus hernia                                                                        | Large meal       | NM                  | –          | –             |
| Favaretto et al. 2008/ [40] | 63/M        | Syncope, Oesophagia| Hiatus hernia                                                                        | Solid and Liquid | Asystole            | PPM        | Yes           |
| Bajwa et al. 2008/ [41]     | 51/M        | Presyncope, Syncope| Metabolic diseases, Inflammatory bowel diseases                                      | Solid food       | Atrial & Ventricular atopic beat | PPM        | Yes           |
| Christopher et al. 2008/ [42]| 25/F      | Syncope            | No                                                                                   | Solid and Liquid | 3rd degree AV block | PPM        | Yes           |
| Fahner et al. 2008/ [43]    | 75/M        | Syncope            | No                                                                                   | Solid and Liquid | AV block            | –          | –             |
| Patsilinakos et al. 2007/ [44]| 86/F       | Syncope            | Oesophageal stenosis, Ascending aorta aneurysm, Hypothyroidism                      | Solid and Liquid | Sinus arrest        | Avoidance of trigger | Yes           |
| Tuzcu et al. 2007/ [45]     | 16/F        | Syncope, Visual disturbance | No                                                                                   | Solid food       | 3rd degree AV block, Asystole | PPM        | Yes           |
| Omni et al. 2006/ [2]       | 66/F        | Syncope            | Metabolic Diseases                                                                   | Liquid           | AV block            | PPM        | Yes           |
| Gawrieh et al. 2005/ [46]   | 63/M        | Presyncope, Syncope, Dysphagia | Hiatus Hernia                                                                        | Solid food       | AV block, Asystole  | PPM        | Yes           |
| Turan et al. 2005/ [47] Kang et al. 2005/ [48] | 63/M | Presyncope, Syncope, Dysphagia | Hiatus hernia, Coronary artery diseases, Metabolic diseases | Solid and Liquid | –                   | Refuse treatment | –             |
| Turan et al. 2005/ [47] Kang et al. 2005/ [48] | 62/F | Presyncope, Syncope, Dysphagia | Nutcracker oesophagus, Coronary artery diseases | Solid and Liquid | Sinus bradycardia, Sinus arrest | PPM        | Yes           |
| Turan et al. 2005/ [47] Kang et al. 2005/ [48] | 48/M | Syncope, Dysphagia | Achalasia                                                                           | Solid food       | Sinus bradycardia   | PPM        | Yes           |
| 59/M                        | Syncope     | Metabolic diseases                                         | Solid and Liquid                                                                 | Sinus bradycardia | PPM                  | –          | –             |
| 59/M                        | Syncope, Dysphagia | Compression fracture thoracic spine, Graves diseases | Solid food                                                                 | Sinus bradycardia | Diet habit modification | –          | –             |
| Sreekant et al. 2004/ [49]  | 85/M        | Syncope            | Coronary artery diseases, Peripheral vascular diseases                               | Solid and liquid | Asystole            | PPM        | Yes           |
| 61/F                        | Presyncope  | Metabolic diseases                                         | Liquid (Carbonated)                                                               | Sinus Bradycardia | –                   | –          | –             |
| Yoshihumi et al. 2004/ [50] | 76/F        | Syncope            | Hiatus hernia                                                                        | Solid food       | –                   | –          | –             |
| Srivathsan et al. 2003/ [51]| 26/M        | Presyncope         | No                                                                                   | Solid food       | Systole             | PPM        | Yes           |
| Author/ Reference | Age/ Gender | Presenting Symptom | Underlying Diseases | Trigger Factor | Type of arrhythmia | Management | Effectiveness |
|-------------------|-------------|--------------------|---------------------|---------------|-------------------|------------|--------------|
| Mekawa et al. 2002/ [52] | 76/ F | Syncope | Hiatus hernia | Solid and liquid | – | Hemia repair surgery | Yes |
| Gordon et al. 2002/ [53] | 26/ F | Syncope, Central chest discomfort | Hiatus hernia | Solid and liquid | Paroxysmal Atrial fibrillation, Ventricle atopic beat | Diet habit modification | Yes |
| Takeshi et al. 2002 [54] | 69/ F | Presyncope, Syncope | Metabolic diseases | Solid food | Sinus arrest | – | – |
| Rasmi et al. 2001/ [55] | 16/ M | Syncope | No | Liquid (Carbonated) | Asystole | PPM | Yes |
| Haumer et al. 2000/ [56] | 67/ M | Syncope | Coronary artery disease | Liquid | Sinus arrest | Temporary Pacemaker | Yes |
| Kakuchi et al. 2000/ [57] | 21/ M | Syncope | Vasovagal syncope | Solid and liquid | AV block | PPM | – |
| Kazushi et al. 1999/ [58] | 69/ M | Syncope, Facial flushing, Profuse diarrhoea | Metabolic disease, Stroke | Solid food | – | Cessation of Enalapril | Yes |
| Olshasky et al. 1999/ [59] | 72/ M | Presyncope, Syncope | – | Liquid (Cold carbonated) | Sinus bradycardia | PPM | – |
| Dante et al. 1997/ [60] | 78/ M | Syncope | Oesophageal carcinoma | Solid food | AV block, Asystole | PPM | Yes |
| Bellori et al. 1992/ [61] | 69/ M | Syncope | – | Liquid | Sinus arrest | – | – |
| SY AO et al. 1991/ [5] | 70/ M | Incidental | Lung carcinoma | Solid and Liquid | High grade AV block | Atropine before meal | Yes |
| Shapira et al. 1991/ [62] | 63/ M | Presyncope, Syncope | Hiatus hernia, Coronary artery disease | Solid and Liquid | 2nd degree AV block | PPM | Yes |
| Kunimoto et al. 1990/ [63] | 65/ M | Presyncope, Syncope | No | Liquid (Cold) | 2nd degree AV block, Asystole | PPM | Yes |
| Elam et al. 1989/ [64] | 44/ M | Syncope | No | Solid and Liquid | 3rd degree AV block | PPM | Yes |
| Engelhardt et al. 1986/ [3] | 5/ F | Syncope | No | Solid and Liquid/ Brush teeth | 3rd degree AV block | Close Observation | Yes |
| Ausubel et al. 1987/ [65] | 26/ M | Syncope | Heart murmur | Solid food | Sinus bradycardia, AV block | PPM | Yes |
| Nakano et al. 1987/ [66] | 67/ M | Syncope, Retrosternal discomfort | Aneurysm descending thoracic aorta | Solid and Liquid | Sinus bradycardia, Sinus arrest | Atropine before meal | Yes |
| Nakagawa et al. 1987/ [67], Guberman et al.1986/ [68] | 48/ M | Syncope | No | Solid and Liquid | AV block | Atropine | – |
| | 62/ F | Syncope | No | Oesophageal balloon inflation | 2nd degree heart block | Propanthelene bromide | No |
| | 62/ M | Syncope | Congestive heart failure | Solid food | 2nd degree heart block | Discontinuation of digoxin | Yes |
| Alan et al. 1986/ [69] | 56/ M | Syncope | Inferior myocardial infarction | Liquid | 1st degree heart block | PPM | Yes |
| Golf et al. 1986/ [70] | 15/ F | Syncope | No | Solid and Liquid | SA node blockade | – | – |
| Author/Reference | Age/Gender | Presenting Symptom | Underlying Diseases | Trigger Factor | Type of arrhythmia | Management | Effectiveness |
|------------------|------------|--------------------|---------------------|---------------|--------------------|------------|--------------|
| Armstrong et al. 1985/ [71] |
| 53/F  | Syncope, Dyspnoea, Retrosternal discomfort |
| 58/F  | Syncope, Pulseless, Apnoea |
| 58/F  | Presyncope |
| 81/F  | Syncope |
| 53/M  | Syncope |
| Kunis et al. 1985/ [72] | 60/M | Presyncope, Syncope, Chest pain |
| Drake et al. 1985/ [73] | 76/F | Syncope |
| Mauro et al. 1985/ [74] | 65/F | Presyncope, syncope |
| Golf et al. 1977 [75] | –/ M | Syncope, Convulsion |
| Weaddington et al. 1975/ [76] | 71/M | Syncope |
| B Wik et al. 1975/ [77] | 43/M | Syncope, Retrosternal chest pain |
| Poul et al. 1973/ [78] | 64/ F | Syncope |
| Edgar et al. 1972/ [79] | 84/M | Syncope |
| Keith et al. 1971/ [80] | 45/M | Syncope, Dysphagia, Heart burn |
| Rajendra et al. 1971/ [81] | 29/ F | Syncope |
| Edgardo et al. 1970/ [82] | 73/M | Syncope, Chest pain |
| R P Sapru et al.1968/ [83] | 29/ F | Presyncope |
| George et al. 1958/ [84] | –/– | Syncope |
| Correll et al. 1949/ [85] | 67/M | Syncope, Choking sensation |
| Correll et al. 1949/ [85] | 67/M | Syncope, Choking sensation |

**Table 1** Literature review of 101 cases of Swallow Syncope from 1949 to 2018 (Continued)

| Author/Reference | Age/Gender | Presenting Symptom | Underlying Diseases | Trigger Factor | Type of arrhythmia | Management | Effectiveness |
|------------------|------------|--------------------|---------------------|---------------|--------------------|------------|--------------|
| Armstrong et al. 1985/ [71] | 53/F | Syncope, Dyspnoea, Retrosternal discomfort |
| 58/F  | Syncope, Pulseless, Apnoea |
| 58/F  | Presyncope |
| 81/F  | Syncope |
| 53/M  | Syncope |
| Kunis et al. 1985/ [72] | 60/M | Presyncope, Syncope, Chest pain |
| Drake et al. 1985/ [73] | 76/F | Syncope |
| Mauro et al. 1985/ [74] | 65/F | Presyncope, syncope |
| Golf et al. 1977 [75] | –/ M | Syncope, Convulsion |
| Weaddington et al. 1975/ [76] | 71/M | Syncope |
| B Wik et al. 1975/ [77] | 43/M | Syncope, Retrosternal chest pain |
| Poul et al. 1973/ [78] | 64/ F | Syncope |
| Edgar et al. 1972/ [79] | 84/M | Syncope |
| Keith et al. 1971/ [80] | 45/M | Syncope, Dysphagia, Heart burn |
| Rajendra et al. 1971/ [81] | 29/ F | Syncope |
| Edgardo et al. 1970/ [82] | 73/M | Syncope, Chest pain |
| R P Sapru et al.1968/ [83] | 29/ F | Presyncope |
| George et al. 1958/ [84] | –/– | Syncope |
| Correll et al. 1949/ [85] | 67/M | Syncope, Choking sensation |

F Female, M Male, (–) Not Stated, AV Atrioventricular, PPM Permanent Pacemaker
carcinoma are the most common associated gastrointestinal disorders. Thirty-three patients (32.7%) had underlying cardiac diseases including coronary artery diseases (13.9%, \( n = 14 \)), atrial fibrillation (5%, \( n = 5 \)), sick sinus syndrome (3%, \( n = 3 \)), aortic aneurysm, rheumatic heart disease and digitalis toxicity. Twenty-eight patients (27.7%) had metabolic diseases like hypertension, diabetes mellitus, dyslipidaemia or obesity.

In most patients (54.5%, \( n = 55 \)), any type of food – be it liquids or solids - triggered syncope. Atrioventricular conduction blocks (34.7%, \( n = 35 \)) including first, second and third-degree AV blocks are the most common electrophysiological problems, followed closely by sinus node dysfunctions (33.7%, \( n = 34 \)) including sinus bradycardia, sinus arrest and asystole. Second degree AV block, complete heart block (=3rd degree AV block) and asystole were the most frequently reported bradyarrhythmia in the literature. However, there are several cases where both sinus and atrioventricular dysfunction concurred. Paroxysmal atrial fibrillation and atrial tachycardia were rare causes of syncope. Table 1.

Pacemaker implantation is the most popular treatment modality. More than half of the patients (55.5%, \( n = 56 \)) were treated with a permanent pacemaker. Almost all (98.1%, \( n = 52 \)) of the patients treated with pacemakers reported resolution of syncopal symptoms. One patient passed away shortly following a PPM implant due to asystole despite a reportedly normal functioning pacemaker [71]. Treatment of an underlying causative factor (15.8%, \( n = 16 \)) was the second most common treatment modality. Treatment of an underlying gastrointestinal

Table 2 Characteristics of 101 reviewed cases of swallow syncope

| Age Group \((n = 101)\) | Frequency \((n=)\) | Percentage (%) |
|--------------------------|------------------|----------------|
| Childhood/Adolescent [0–19 years] | 6 | 5.9 |
| Younger adults [20–59 years] | 37 | 36.6 |
| Older adults [60 years and above] | 56 | 55.4 |
| Not stated | 2 | 2.0 |

| Gender \((n = 101)\) | Male | Female | Not Stated |
|---------------------|------|--------|------------|
| Frequency \((n=)\) | 60 | 40 | 1 |
| Percentage (%) | 59.4 | 39.6 | 1.0 |

| Clinical Presentation \((n = 101)\) | Syncope | Dysphagia | Asymptomatic (incidental diagnosis) |
|-------------------------------------|---------|----------|----------------------------------|
| Frequency \((n=)\) | 100 | 12 | 1 |
| Percentage (%) | 99.0 | 11.9 | 1.0 |

| Underlying Diseases \((n = 100)\) | Gastrointestinal Diseases | Hiatal Hernia | Achalasia | Esophageal stricture | Cardiac Diseases | Coronary artery diseases | Atrial Fibrillation | Sick Sinus Syndrome | Comorbidities* |
|----------------------------------|---------------------------|--------------|-----------|--------------------|-----------------|------------------------|------------------|------------------|----------------|
| Frequency \((n=)\) | 34 | 19 | 3 | 3 | 33 | 14 | 5 | 3 | 28 |
| Percentage (%) | 33.7 | 18.8 | 3.0 | 3.0 | 32.7 | 13.9 | 5.0 | 3.0 | 27.7 |

| Trigger Factor \((n = 101)\) | Any (Solid and Liquid) | Solid only | Liquid only |
|-------------------------------|------------------------|------------|------------|
| Frequency \((n=)\) | 55 | 23 | 23 |
| Percentage (%) | 54.5 | 22.8 | 22.8 |

| Type of Arrhythmia \((n = 101)\) | Sinus Dysfunction| Atrioventricular Dysfunctionc | Combination Sinus and AV Dysfunction | Not Stated | Othersd |
|---------------------------------|------------------|-----------------------------|----------------|----------|--------|
| Frequency \((n=)\) | 34 | 35 | 16 | 13 | 3 |
| Percentage (%) | 33.7 | 34.7 | 15.8 | 12.9 | 3.0 |

| Management \((n = 101)\) | Pacemaker Implantation | Pharmacotherapy | Atropine | Treatment of Underlying causative factor | Surgical correction of hiatal hernia | Dilation of achalasia | Dilation of esophageal stricture |
|---------------------------|------------------------|-----------------|----------|--------------------------------------|-----------------|------------------|------------------|
| Frequency \((n=)\) | 56 | 11 | 9 | 16 | 4 | 1 | 1 |
| Percentage (%) | 55.5 | 10.9 | 8.9 | 15.8 | 4.0 | 1.0 | 1.0 |

*Comorbidities defined as hypertension or diabetes mellitus or dyslipidaemia or obesity or chronic kidney disease

b Sinus Bradycardia, Sinus Arrest, Asystole; c First, Second, Third degree Atrioventricular block; d Atrial Tachycardia, Atrial Fibrillation and others
disorder has been shown to carry a good likelihood of resolving the swallow syncope. For example, all four cases of hiatal hernia that were corrected surgically had a complete resolution of the swallow syncope. Likewise, dilatation of an oesophageal stricture and an achalasia resulted in complete resolution of swallow syncope. Other reported successful treatments of underlying gastrointestinal diseases included surgical cauterisation of the vagal nerve, long term proton pump inhibitors and surgical excision of an oesophageal carcinoma. Pharmacological management was the preferred treatment option in the 19th and early twentieth century prior to the era of pacemakers. From the limited numbers, atropine was the most widely used, with about 90% efficacy. Table 2.

Various mechanisms regarding the pathogenesis of swallow syncope have been postulated. The most common postulated mechanism is increased and excessive vagal reflex activation during swallowing causing cardio inhibition [86]. During swallowing, the afferent impulses from the oesophageal plexus travel via the vagus nerve to the nucleus solitarius tract in the
medulla oblongata. Subsequently, a corresponding signal that regulates involuntary peristalsis will travel down the parasympathetic efferent fibers through the oesophageal branch of the vagus nerve [87]. The presence of reflex arcs between afferent sensory fibers and efferent parasympathetic fibers of the cardiac branch results in inappropriate vagal activation with bradycardia, disturbance to the conduction system and hypotension secondary to vasodilation [27, 88]. The exact mechanism remains to be elucidated, however, excessive parasympathetic stimulation to the heart seems to be the central mechanism. The fact that atropine, a potent anticholinergic agent, prevents bradycardia effectively in cases of swallow syncope supports the theory of excessive vagal stimulations [5, 29, 66, 79].

Abnormal oesophageal mechanoreceptors have been postulated to be the primary cause of swallow syncope in individuals with underlying structural and functional disorders of the gastrointestinal system. We demonstrated a reproducible cardio-inhibition with balloon inflation in the mid to lower oesophagus in our patient [48, 89]. The bradycardia was terminated upon deflation of the balloon suggesting that mechanoreceptors in the mid-lower oesophagus may play a role in the pathogenesis of swallow syncope.

Investigations of neurally-mediated syncope should be tailored based on actual precipitants. While a tilt-table test confirmed the presence of a vasovagal response with reproduction of syncope, it did not demonstrate any periods of asystole. The diagnosis in this case was confirmed during OGD with cardiac monitoring and hence investigation with an OGD with haemodynamic monitoring should be considered for individuals with suspected swallow syncope. A diagram depicting a proposed approach to the diagnostic work-up and management of patients with symptoms suggestive of swallow syncope is depicted in (Fig. 4).

Conclusions
Swallow syncope is a rare cause for syncopal events and should be considered as part of the diagnostic workup. Pacemakers are a safe and efficacious therapeutic option for all patients with that condition. In patients with associated gastrointestinal disease, specific treatment of the underlying disease has a high likelihood of resolving the swallow syncope without the need for permanent pacing.

Abbreviations
AV block: Atrioventricular block; ECG: Electrocardiogram; OGD: Oesophagogastroduodenoscopy; PPM: Permanent pacemaker

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KSSW and AL prepared the manuscript and are responsible for the overall content as guarantors. TMP and INH reviewed the manuscript. All authors read and approved the final manuscript.

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Ethics approval and consent to participate
Not applicable.

Consent for publication
Written informed consent was obtained from the patient for publication of this case report.

Competing interests
The authors declare that they have no competing interests.

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