Symptomatic sinus bradycardia following laparoscopic sleeve gastrectomy: A case series

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Introduction

Obesity creates many health challenges for patients and the physicians who care for them. While weight loss following bariatric surgery often yields improvement of comorbidities related to obesity, it also causes unanticipated changes in underlying physiology. We present the cases of 2 young patients with morbid obesity who underwent sleeve gastrectomy and postoperatively developed symptomatic sinus bradycardia. These instances emphasize the presentation, nuance, and potential complications involved in treating sinus bradycardia induced by sleeve gastrectomy in this patient population.

KEY TEACHING POINTS

- Symptomatic sinus bradycardia after sleeve gastrectomy is an immediate postoperative complication that has not been previously reported.
- The etiology of this condition is likely perturbation of the vagus nerve, but other potential mediating causes include fluctuations in leptin and ghrelin levels and manipulation of the abdominal viscera.
- Theophylline is an adenosine receptor antagonist to consider for restoration of sinus rhythm while reducing incidence of pacemaker implantation in bariatric patients.

Case report

Case 1 presentation

A 30-year-old male patient with morbid obesity, hypertension, and obstructive sleep apnea on continuous positive airway pressure therapy underwent laparoscopic sleeve gastrectomy for body mass index (BMI) greater than 70 with a preoperative weight of 674 pounds. Per a sleep study in 2020, the patient had an average heart rate of 78 beats per minute (bpm) during rapid eye movement sleep (Figure 1A). He had no significant cardiovascular history or any prior symptoms suggestive of dysautonomia. His vital signs were unremarkable on the day before surgery, with baseline heart rate of 59 bpm. He underwent uneventful laparoscopic sleeve gastrectomy anesthetized with fentanyl, ketamine, and propofol. Although the procedure itself was uneventful and without symptomatic sinus bradycardia intraoperatively, the patient developed postoperative sinus bradycardia with lightheadedness the following evening. Electrocardiography (ECG) 1 day after the surgery demonstrated sinus bradycardia to 33 bpm with intraventricular conduction delay (Figure 1B).

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The patient had appropriate but temporary response to atropine. An echocardiogram discovered decreased ejection fraction (EF) of 45%–50%, a dilated left ventricle, mild pulmonary hypertension (37 mm Hg) and elevated right atrial pressure (15 mm Hg). Baseline echocardiography 1 year prior demonstrated normal EF and undetermined right ventricular systolic pressure secondary to body habitus. He was monitored closely without spontaneous improvement and—while being considered for a pacemaker—was given a trial of oral theophylline 200 mg twice daily. This resulted in increased heart rates to 46 bpm and symptomatic relief (Figure 2A). Owing to the significant improvement on medication and the expectation of recovery in sinus node rate, pacemaker implant was deferred, and the patient was discharged with oral theophylline on postoperative day 5. A 30-day event monitor was placed, which revealed normal daytime heart rate range and only nocturnal sinus bradycardia. However, he experienced a sustained episode of atrial fibrillation with rapid ventricular response up to 192 bpm 20 days after discharge, which led to hospital readmission. It is unclear whether this was related to theophylline use or demonstrated a postoperative complication. The patient underwent direct current cardioversion with return to sinus rhythm. Theophylline was discontinued and repeat echocardiography demonstrated recovery of EF to 55%–60%. The

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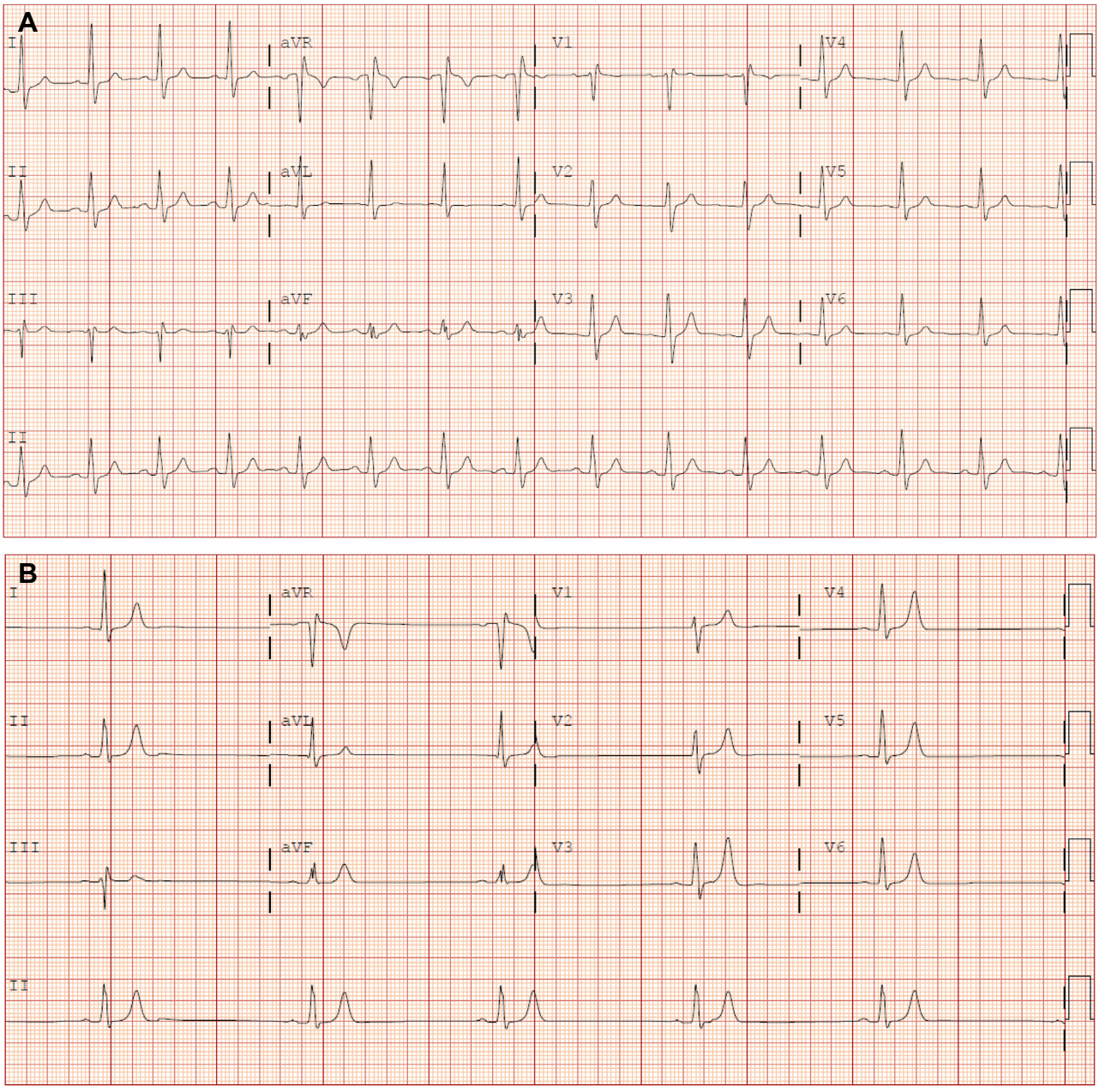

Figure 1 **A:** Preoperative electrocardiogram (ECG) of patient 1 demonstrating sinus rhythm at 90 beats/min with baseline intraventricular conduction delay. **B:** Postoperative ECG of patient 1 demonstrating sinus bradycardia to 33 beats/min and intraventricular conduction delay.

patient had an implantable loop recorder placed to evaluate burden of atrial fibrillation and bradycardia. No new atrial fibrillation events have been noted through 1 year of monitoring, although he continues to have only intermittent nocturnal sinus bradycardia and no symptomatic bradycardia episodes.

Case 2 presentation

A 25-year-old female patient with morbid obesity (BMI of 44), prior history of laparoscopic cholecystectomy 6 years ago, and Cesarean section 4 years ago underwent robotic sleeve gastrectomy for management of a preoperative weight of 307 pounds. Baseline ECG 7 months prior to surgery demonstrated normal sinus rhythm at 72 bpm (Figure 3A). She had no prior cardiovascular history but did report several episodes of near syncope, which had been related to low blood glucoses. The patient was anesthetized with midazolam, fentanyl, propofol, and hydromorphone; tolerated the procedure well; and was transitioned to the floor. The following morning, she developed heart rates in the mid 40s and symptoms of lightheadedness

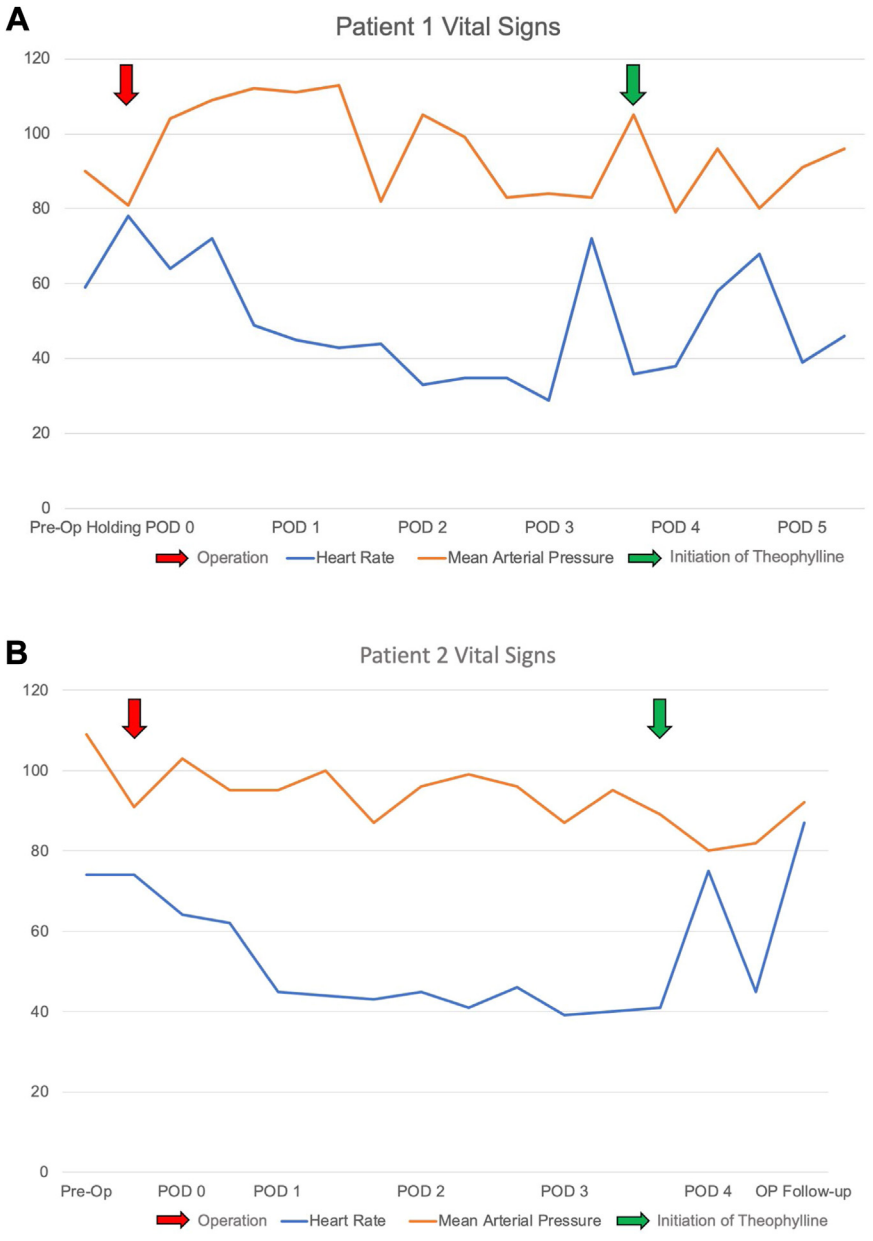

Figure 2 **A:** Graphical depiction of patient 1's heart rates and mean arterial pressures beginning in preoperative holding area and continuing from postoperative day (POD) 0 to discharge (POD 5). Heart rates were recorded at approximately 5 AM, 12 PM, and 9 PM daily. **B:** Graphical depiction of patient 2's heart rates and mean arterial pressures beginning in preoperative holding area and continuing from POD 0 through discharge (POD 4) to outpatient follow-up. Heart rates were recorded at approximately 5 AM, 12 PM, and 9 PM daily.

when ambulating (Figure 2B). An ECG demonstrated sinus bradycardia to 48 bpm without other significant changes from prior (Figure 3B). An echocardiogram was obtained, which revealed no regional wall motion abnormalities, normal left ventricular wall thickness, and normal EF (60%–65%). The patient was initiated on theophylline 200 mg twice daily with occasional improvement of heart rates to the 70s. She was discharged on postoperative day 4 with theophylline 200 mg twice daily; on outpatient follow-up 2 weeks later, she had improvement of lightheadedness with a heart rate noted of 87 bpm and symptoms of acid reflux.

Discussion

Bariatric surgery significantly improves long-term cardiovascular morbidity and mortality, including decreased incidence of myocardial infarction and stroke.[1] Improvement and resolution of other comorbid conditions are seen as well, including hypertension, hyperlipidemia, type 2 diabetes mellitus, chronic kidney disease, nonalcoholic fatty liver disease, and obstructive sleep apnea.[2] This implies the significant, multisystemic effects that bariatric surgery has on underlying physiology. However, the immediate cardiovascular impact after sleeve gastrectomy is not well reported. Our cases reveal

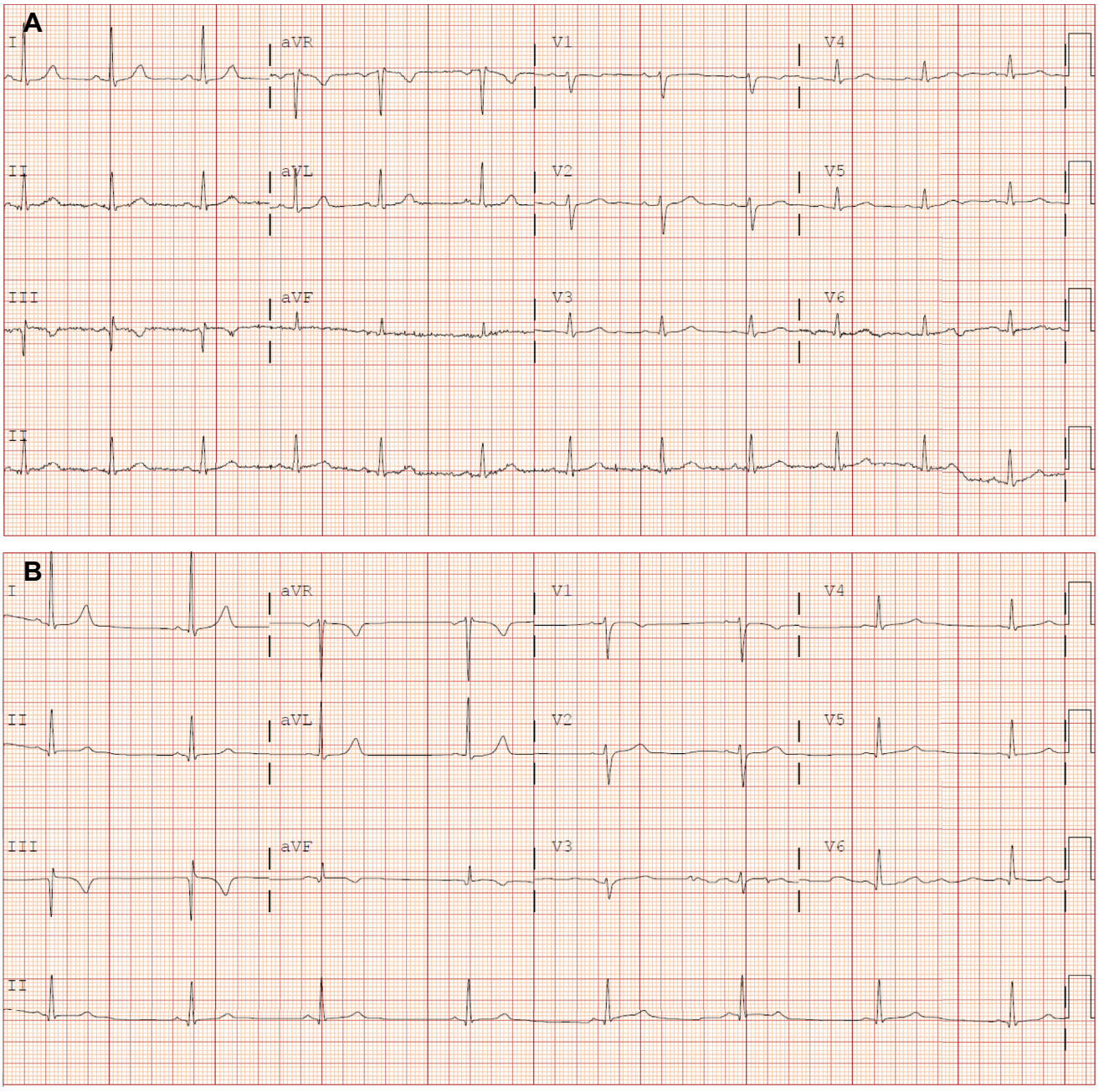

Figure 3 **A:** Preoperative electrocardiogram (ECG) of patient 2 demonstrating sinus rhythm at 72 beats/min with baseline nonspecific T-wave abnormalities in leads III, aVF, and V_6. Postoperative ECG of patient 2 demonstrating sinus bradycardia to 48 beats/min.

the occurrence of symptomatic sinus bradycardia during the immediate postoperative period after sleeve gastrectomy.

Sleeve gastrectomy is the predominant bariatric procedure in the United States, representing an estimated 61.4% of all bariatric surgeries in 2020 for more than 120,000 total procedures.[3] Studies investigating burden of cardiac arrhythmias following bariatric surgery have shown decreased incidence in sinus bradycardia, atrioventricular blocks, atrial ectopy, and ventricular ectopy.[4] Contrary to this, other studies have reported sinus bradycardia that is inversely proportional to the amount of weight lost in bariatric surgery patients.[5] The etiology has been attributed to modulation of GLP-1 as well as leptin production.[6] However, most cases in the literature describe bradyarrhythmia onset occurring between 3 and 25 months postoperatively.[5,6] Further, there was no significant change in weight in the hospitalized postoperative period for the patients presented. No acute onset of this degree of sinus bradycardia immediately after sleeve

gastrectomy has been reported, to the best of our knowledge. Although obstructive sleep apnea is a known cause of sinus bradycardia,[7] this was likely not the primary cause of these patients' symptoms, given the daytime occurrence of sinus bradycardia and no change in continuous positive airway pressure treatment postoperatively.

Autonomic dysfunction and predominance of parasympathetic component following bariatric surgery is known to occur, causing symptoms of presyncope in the immediate postoperative period after bariatric surgery.[8] Most likely, the etiology is operative perturbation of the vagus nerve resulting in increased vagally mediated cardiac parasympathetic stimulation. It is not clear if this effect is from the acute gastric volume change postprocedure, which led to profound vagal stimulation, or from direct mechanical manipulation/damage of vagal nerve endings by the sleeve gastrectomy. Other potential mediating mechanisms include disruptions of leptin and ghrelin levels, which can act as vasodilating agents.[8] Given that most sinus node disorders in adults can be attributed to increased vagal tone or acquired disease,[9] the postoperative symptomatic sinus bradycardia in our patients is likely also a result of vagal stimulation resulting from recent gastric surgery.

Bradycardia during any abdominal surgery is a fairly common occurrence related to surgical trauma and manipulation of the abdominal viscera.[10] Further, increase in parasympathetic tone can be seen in laparoscopic surgeries that use peritoneal insufflation, resulting in sinus bradycardia.[9] As this phenomenon is primarily noted intraoperatively, and neither of the patients presented experienced intraoperative bradycardia, it is unlikely to be the primary driver in these instances. Per Figure 2, heart rates were first noted to be bradycardic on postoperative day 1, suggesting a delayed hemodynamic response. However, this mechanism may also play a role postoperatively and could have been a factor in the sinus bradycardia seen in these patients. Similarly, anesthetic agents including propofol can induce intraprocedural bradycardia via sympathetic inhibition. The prolonged postoperative nature of these patients' symptomatic bradycardia and the different anesthetic agents used decreases the likelihood of these being a primarily anesthesia-driven event. Although prolonged postoperative pain can be a potential cause of cardiac perturbations, the patients' pain was noted to be well controlled. Electrolyte disturbances and pH abnormalities were ruled out in these patients' cases. Further considerations in these young patients can include a genetic component or autoimmune condition impacting their conduction systems. However, these would not be expected to manifest for the first time in the postoperative setting.

Oral theophylline 200–400 mg daily is recommended for patients who have symptomatic sinus bradycardia when sinus bradycardia may be temporary or as a trial when symptoms do not clearly correlate with sinus bradycardia.[9] Treatment with theophylline has been found to increase the sinus rate by antagonizing adenosine receptors while reducing pacemaker implantation.[11] After discontinuing theophylline, patient 1 was noted to have continued sinus bradycardia, with 60% of his daily ventricular rates less than 60 bpm. Yet, an outpatient treadmill stress test demonstrated normal chronotropic response to exercise. Appropriate sinus node reactivity implies the presence of a healthy sinus node despite resting, asymptomatic sinus bradycardia.

In the case of patient 1, his mildly reduced EF is potentially related to excessive preload owing to prolonged filling times, which resolved with treatment of his bradycardia, vs variation between echocardiographic interpretations. Other potential explanations include transient postanesthesia myocardial depression and difficult windows owing to body habitus. Further demonstrated by patient 1, there is risk of inducing atrial fibrillation with chronic use of theophylline even at therapeutic levels.[12] Whether the incidence of atrial fibrillation was caused by theophylline or the sleeve gastrectomy procedure itself remains unclear. Should patient 1 remain symptomatic from bradycardia, future management would include pacemaker implantation. Lastly, in patients with persistent symptomatic episodes of vagally mediated sinus bradycardia resistant to medical treatment, cardioneuroablation may represent a reasonable next therapeutic step.[13]

In 1 cross-sectional study, the yearly incidence of pacemaker placement in bariatric patients was 0.8%, while only 0.06% of the U.S. population underwent device insertion. Of note, 78% of bariatric surgery patients received their pacemakers between the age of 45 and 75; those who had not had prior bariatric surgery were older on average, 58% aged $\geq$75.[7] Though these results imply association between bariatric surgery and sinus node dysfunction, we cannot derive causation nor etiology from these data.

Conclusion

Bariatric surgery has benefits in individuals with BMI >40 or modifiable comorbidities. The above cases illustrate the risk for symptomatic bradycardia after sleeve gastrectomy. The occurrence of this immediate postoperative complication has not been previously reported. Treatment with theophylline can be helpful while a decision on permanent pacemaker implantation is considered based on disease evolution. Further study is necessary to encourage early recognition of these individuals, delineate the pathophysiology, and prevent future morbidity in this patient population.

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