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ORIGINAL ARTICLE

Glucagon Is a Safe and Inexpensive Initial Strategy in Esophageal Food Bolus Impaction

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Abstract
Background Controversy exists about the utility of pharmacologic agents and endoscopic technique used for esophageal food bolus impaction.
Aim To evaluate the utility of glucagon and the technique used for endoscopic removal, including the rate of success and the adverse events of the techniques.
Methods The database of the largest healthcare provider in southeastern Wisconsin was retrospectively reviewed for patients presenting with esophageal food bolus impaction. Data extracted included glucagon administration and its success rate, outcome of radiographic studies, and the endoscopic method of removal and adverse events associated with it, including 30-day mortality.
Results A total of 750 patients were identified with food bolus impaction from 2007 to 2012. Glucagon was administered in 440 patients and was successful in 174 (39.5 %). Endoscopic removal was performed in 470 patients and was successful in 469 (99.8 %). The push technique was utilized in 209 patients, reduction in the bolus size by piecemeal removal followed by the push technique was utilized in 97 patients, and the pull technique was utilized in 107 patients. There were no perforations with endoscopic removal. Only 4.5 % of the X-rays performed reported a possible foreign body within the esophagus. Glucagon was a significantly less-expensive strategy than endoscopic therapy ($p < 0.0001$).
Conclusion Glucagon is low cost, is moderately effective, and may be considered as an initial strategy. Endoscopic removal regardless of technique is safe and effective. The yield of radiography is poor in the setting of food bolus impaction.

Keywords Endoscopy · Glucagon · Food bolus impaction · Dysphagia · Foreign body

Introduction

Esophageal food bolus impaction is a common problem in clinical practice. Glucagon has been shown to decrease pressure in the lower esophageal sphincter in normal subjects [1]. The role of glucagon in patient management is uncertain, and differences in outcome between techniques of extraction remain unclear. Given the difficulties of conducting randomized trials in emergency settings, only one small placebo-controlled trial of glucagon has been performed [2] and the use of glucagon remains controversial in clinical practice. The role of radiography in the management of uncomplicated patients has not been defined. While radiography can be helpful in identifying perforation when it is suspected, the utility of radiography remains questionable. The aim of this study was to retrospectively evaluate the utility of glucagon, the rate of

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successful removal and the adverse events of endoscopic therapy, and the yield of radiology in patients presenting with an esophageal food bolus impaction.

Methods

Data Extraction

Aurora Health Care is the largest healthcare provider in southeastern Wisconsin. This was a retrospective analysis of the electronic database of patients presenting with esophageal foreign body impaction from January 1, 2007, to December 31, 2012. This healthcare system serves 90 Wisconsin communities and has 15 hospitals (urban, suburban, and rural), 185 clinics, and 7.8 million patient encounters annually. Patients were identified using the specific ICD 9 billing code (935.1) for esophageal foreign body impaction.

Inclusion/Exclusion Criteria

We limited our study to food material and medications and did not consider metallic or plastic foreign bodies. Patients were excluded if data were missing.

We evaluated age, sex, race, time of presentation, the duration of time between ingestion and presentation, radiologic imaging performed and findings, whether glucagon was administered as monotherapy or in conjunction with a benzodiazepine and/or nitroglycerine, the dose of glucagon, the route of administrations [intravenous (IV) or intramuscular (IM)], and the success of glucagon therapy. Since this was a retrospective study, we could not control for dose and route of administration or co-administration of other medications with glucagon. These decisions were made by the performing provider at the time of presentation. Unfortunately, this was not homogenous between providers. Other data collected included the need for endoscopy, method of removal, type of bolus removed, whether biopsy or dilation was done on initial endoscopy, cause of impaction, and adverse events following endoscopic intervention, including perforation and 30-day mortality.

Cost Calculations

The cost of glucagon in Milwaukee averages $256 for one ampoule. The price of endoscopy ranges from a low of $600 in private endoscopy center to $1900 in hospital settings. We compared the cost of glucagon therapy to low-cost endoscopy and high-cost endoscopy.

Statistics

Categorical variables were compared using a Chi-square test or Fisher's exact test. Means were compared using a two-tailed t test for independent groups. Significance was assumed if $p < 0.05$.

Definitions

Glucagon was considered successful if, after administration, the patient was able to tolerate their own secretions, had a subjective feeling of bolus passage, and had the ability to drink liquids freely. Glucagon was also deemed successful if the bolus was found to have already passed into the stomach at endoscopy. X-ray findings were reported as positive if there were characteristics of possible esophageal pathology. Other pulmonary or cardiac findings were not deemed relevant to esophageal foreign body impactions and were recorded as no findings. Eosinophilic esophagitis (EoE) was defined as mid- or proximal esophageal biopsies with >15 eosinophils per high-power field (hpf) or if a distal esophageal biopsy revealed >20 eosinophils per hpf with endoscopic characteristics of EoE. The institutional review board of Aurora Health Care approved the study protocol. All patients undergoing endoscopy gave written informed consent for the procedure and interventions (biopsy and/or dilation).

Results

A total of 844 charts were reviewed with 750 patients meeting the inclusions criteria. There were 486 males and 264 females with a mean age of 56.7 years (SD 21.7 years). The majority of patients were Caucasian (94 %), with 2.5 % African-American, 3 % Hispanic, and <0.5 % other. The mean duration between food bolus impaction and presentation was 6.4 h (SD 10.4 h). There were 126 (30.1 %) patients who presented with a food bolus impaction that spontaneously passed the bolus without glucagon or endoscopic intervention.

Glucagon was administered in a total of 440 and was successful in 174 patients, giving an overall success rate of 39.5 %. Glucagon was given as monotherapy in 365 patients and was successful in 143 (39.2 %) patients. Glucagon was co-administrated with a benzodiazepine in 44 patients, four patients also received nitroglycerine, and was successful in 20 (45.5 %; $p = 0.42$ compared with glucagon alone, Chi-square test) patients. Glucagon was administered with nitroglycerine in 35 patients, four patients also received a benzodiazepine and was successful in 14 (40 %) patients, respectively ($p = 0.9$ compared with glucagon alone, Chi-square test) (Fig. 1). Three of the four

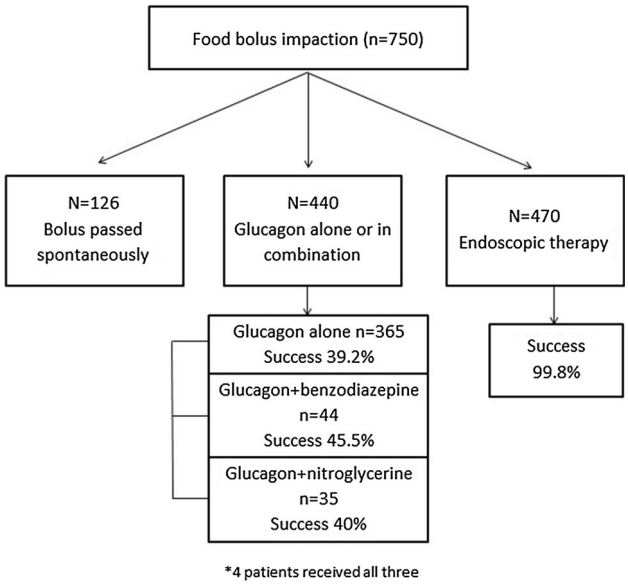

Fig. 1 Flow chart of study

patients receiving glucagon, benzodiazepine, and nitroglycerine cleared the bolus. Glucagon was administrated as a 1 mg IV bolus in 376 patients and was successful in 144 (38.3 %) patients. Of the 18 patients given a 2 mg IV bolus, 11 (61.1 %) successfully passed the bolus. Twenty-six patients were given successive doses of glucagon after the initial dose failed; starting at 1 mg IV followed by another 1, 2, or 3 mg IV and was successful in nine (34.6 %) patients. Twenty patients received 1 mg IM glucagon with 11 (55 %) successfully clearing the food bolus. Medication impaction was present in 18 patients and resolved with glucagon in 14 (78 %). All the others were food bolus impactions.

Chest X-ray with or without a soft tissue X-ray of the neck was performed in 243 patients presenting with a presumed food bolus impaction of the esophagus. Only 11 (4.5 %) of the X-rays performed reported a possible foreign body within the esophagus. No perforation or pneumomediastinum was identified.

Upper endoscopy was performed in 470 patients. Endoscopic removal was successful in 469 (99.8 %). One patient required rigid endoscopy and removal of a large food bolus impacted in the upper esophageal sphincter. The push technique was utilized in 209 patients, reduction in the bolus size by piecemeal removal followed by the push technique was utilized in 97 patients, and the pull technique (including Roth net and snares) was utilized in 107 patients. The technique used for removal was not reported in 21 patients. The bolus had spontaneously passed into the stomach in 36 patients, 23 of whom were given glucagon prior to endoscopy. Glucagon was deemed to have been successful in these 23 patients. Biopsies of the esophagus were obtained at the initial endoscopy in 111 patients, and dilation of the esophagus was performed in 65 patients.

Of the 470 patients who underwent endoscopy, a distal esophageal ring, stricture, web, or narrowing without signs of esophagitis accounted for the largest proportion: 145 (31 %), followed by erosive esophagitis with a stricture 130 (27 %). Eosinophilic esophagitis accounted for 11 % of the food impactions. Other less common causes included achalasia, esophageal adenocarcinoma, candida esophagitis, diverticulum, dysmotility, presbyesophagus, radiation damage, esophageal squamous cell carcinoma, lung cancer, and Zenker's diverticulum (Fig. 2).

Impaction of meat occurred in 552 (73.6 %). Beef/steak impactions represented 48 %, chicken or turkey 29 %, pork 21 %, and fish 2 %. Non-meat food material accounted for 161 (22.4 %) of the impactions. There were 37 (5 %) impactions caused by medications. In the glucagon group, 18 of 440 patients had an impaction with a medication, and the remaining 422 were due to food bolus impactions.

Of the 440 patients that received glucagon, there were only 11 reported cases of nausea with emesis following administration. Eight of these cases occurred following 1 mg and two following 2 mg. There were no other reported side effects with glucagon administration. There were no perforations following endoscopic intervention regardless of mode of removal or whether biopsy or dilation was done. One patient was admitted for aspiration pneumonia the day following endoscopy. There were two deaths within 30 days of endoscopy. An elderly male was found dead of unknown cause in his bed at the nursing home 24 h after removal of the food bolus, and an elderly female died from a severe case of preexisting *Clostridium difficile* colitis.

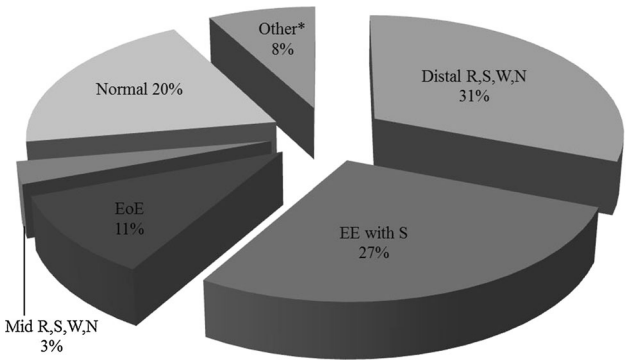

Fig. 2 Cause of food bolus impaction. *R* Ring, *S* stricture, *W* web, *N* narrowing, *EE* erosive esophagitis, *EoE* eosinophilic esophagitis, *Mid* mid-esophagus, *Distal* distal esophagus. *Asterisk* Achalasia, adenocarcinoma, candida, diverticulum, dysmotility, presbyesophagus, radiation, squamous cell carcinoma, lung cancer, Zenker diverticulum

Cost Analysis

The average cost of an ampoule of glucagon in Milwaukee is $256. The cost for endoscopy in Wisconsin ranges from $575 to $1900. The total cost of the glucagon strategy was $19,356. This includes the cost of glucagon administered to patients who did not have a response. The total estimated cost of the endoscopic strategy using a low-price estimate ($575) was significantly higher at $270,250 ($p < 0.0001$) compared with an initial glucagon strategy. Using a cost value of $1900 for upper endoscopy, the total costs of endoscopy was also significantly higher than glucagon alone ($893,000; $p < 0.0001$).

Discussion

The results of this study suggest that glucagon is effective in approximately one-third of patients with food bolus impactions. Glucagon has been shown to decrease lower esophageal sphincter pressure. High-quality evidence comparing glucagon to placebo is lacking. In a small study of 43 patients that lacked adequate statistical power, nine of 24 patients that were randomized to pharmacological therapy with glucagon and valium passed the food bolus while 6 of 19 patients that were randomized to placebo passed the bolus, but the effect took several hours in both groups [2]. Other studies have suggested low efficacy rates. In a retrospective review, glucagon was effective in 9.4 % of cases [3]. A systematic review of glucagon therapy suggested that the usefulness of glucagon was a myth [4]. More recent studies have suggested efficacy rates similar to the data reported in our study. Thimmapuran et al. [5] found that glucagon was effective in 33 % of 125 cases. A smaller study found that glucagon and an effervescent drink were effective in 69 % of cases [6]. Our study suggests that the cost of a glucagon strategy is significantly lower than an initial endoscopy strategy.

Randomized controlled trials comparing glucagon and endoscopic therapy are desirable but are difficult to perform. A major problem is obtaining informed consent in a patient who is uncomfortable with a food bolus impaction. This makes it particularly difficult to conduct a placebo-controlled trial in the emergent setting and to obtain high-level evidence of efficacy. Our data support the ASGE guidelines, which state that glucagon is relatively safe and is an acceptable option [7].

In this study, individual endoscopists used a number of techniques to deal with food bolus impaction. There were no perforations with any of the techniques. Concerns have been expressed about the push technique. As this study illustrates, there were no perforations and no deaths related to the push technique. In our study, eosinophilic esophagitis accounted for 11 % of the food bolus impactions while a narrowing in the distal esophagus without esophagitis was seen in the largest proportion of patients. A small study of 31 patients suggested that eosinophilic esophagitis was the cause of 50 % of food bolus impactions in a gastroenterology practice [8]. Our study suggests that reflux esophagitis, rings, and chronic fibrotic strictures remain the most common causes of food bolus impactions. Our data also suggest that biopsies may be obtained safely and that dilation may also be performed safely at the initial endoscopy.

Sugawa et al. [9] have suggested in their review that plain radiographs may demonstrate the foreign body in patients with food bolus impactions. Radiographs are commonly ordered when patients present with esophageal food bolus. The yield is poor, and radiographs were often obtained in patients in whom perforation was not a consideration. Radiographs were not helpful in visualizing the foreign body or in determining its location within the esophagus. Routine use of radiographs should probably be abandoned except when perforation is a concern.

The strength of our study is that it examines consecutive patients treated in an entire region comprising urban and rural hospitals and therefore provides a measure of the efficacy of different techniques in routine clinical practice. Another strength is the number of subjects evaluated which makes it one of the largest studies performed in the era of modern endoscopic practice. The limitations of our study are that it is not prospective in design, that the dose, route of admission, and use of other medication with glucagon were uncontrolled, and that there was no placebo-controlled data on glucagon.

In conclusion, glucagon is a low-cost strategy and should be considered as an initial strategy for esophageal food bolus impactions. Rings and strictures are the most common cause of food bolus impactions with eosinophilic esophagitis accounting for a small, but significant proportion of cases. Endoscopic removal regardless of technique appears to be safe and effective. The yield of radiography is poor in the setting of food bolus impaction.

Compliance with ethical standards

Conflict of interest None.

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