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Factors associated with a higher number of esophageal dilations in children with a history of alkaline ingestion

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HIGHLIGHTS

- It is well-known that endoscopic classification severity is a good predictor of the risk for strictures and the need for endoscopic dilatation after alkali ingestions.
- We found that accidents with homemade products and accidents occurring outside the household environment were significantly associated with a greater number of esophageal dilatations in the long-term follow-up of children following alkali ingestion.

ABSTRACT – Background – Children who experience alkaline injury are at risk for the development of esophageal strictures and the need for esophageal dilations. **Objective –** We aimed to assess predictors for a higher number of esophageal dilatations in children following alkali ingestion. **Methods –** Single-center retrospective cohort study including children who underwent esophagogastroduodenoscopy (EGD) after alkali ingestion. Possible predictive factors for the need for esophageal dilatations were evaluated. **Results –** A total of 34 patients were included, and 19 were female (55.9%). The median age at the time of the accidents was 20.6 months (IQR 15–30.7). All alkali ingestions were accidental, in all cases involving liquid products, and most (24/34; 70%) occurred at the child's home. Homemade liquid soap was the agent in half of the cases. The most frequently reported symptom at presentation was vomiting (22/34, 64.7%). The median follow-up time was 3.2 years (IQR 1.1–7.4). On follow-up, the median number of esophageal dilatations required for these patients was 12.5 (IQR 0–34). Among demographic factors, male gender (P=0.04), ingestion of homemade products (P<0.01), and accidents happening outside of the household environment (P=0.02) were associated with a greater number of esophageal dilations on follow-up. An endoscopic classification Zargar of 2B or higher (P=0.03), the presence of stricture at the time of the second EGD (P=0.01), and gastroesophageal reflux disease (GERD) as a late complication (P=0.01) were also associated with a greater number of esophageal dilations on long term follow-up. **Conclusion –** Beyond the endoscopic classification severity – a well-known risk factor for the strictures after alkali ingestions, we found that male gender, accidents with homemade products, and accidents occurring outside the household environment were significantly associated with a greater number of esophageal dilatations in the long-term follow-up of children following alkali ingestion.

Keywords – Caustic ingestion; alkali ingestion; endoscopy, child, esophageal dilations.

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INTRODUCTION

Caustic ingestion is still a global public health issue, especially in children, representing 80% of all cases, primarily due to accidental ingestion[1]. Dishwater powder, bleach, and oven cleaners are examples of caustic products widely available in the household environment. Poisoning by household cleaning products is common in children[2]. Esophageal injuries resulting from these ingestions can cause significant morbidity, including life-threatening acute and chronic complications, such as perforation and esophageal stricture[2-4]. In our context, in Brazil, alkali ingestion is more common than the ingestion of acids, as alkaline subtstances are present in most cleaning products[5].

Esophagogastroduodenoscopy (EGD) is still considered the gold standard to classify the severity of the esophageal injury upon presentation after caustic ingestion, as symptoms and physical findings do not always correlate directly with the extent of the injury[6]. Endoscopic findings, graded with the use of standardized terminology as described by Zargar et al.[4], strongly correlate with long-term morbidity: grades 0, 1, and 2a are typically not associated with any sequelae, while grades 2b and 3 often lead to significant complications and the need for endoscopic or surgical treatment[7]. However, some authors challenge the concept that all caustic ingestion in children warrant endoscopic evaluation – arguing that endoscopy could be safely omitted in asymptomatic patients[1,6]. In this context, our study aimed to identify potential prognostic factors, other than endoscopic classification, that could predict the need for repeated esophageal dilations on follow-up of children with a history of alkali ingestion.

METHODS

A single-center retrospective cohort study was conducted, including children who presented to the emergency department after alkali ingestion between September 2001 and December 2020. Inclusion criteria were age younger than 14 years, a history of acute alkali ingestion, and having undergone at least one EGD after the ingestion. We chose not to include patients with acid ingestions because the number of accidents with acids is lower and because there is a difference in the pathophysiology of the lesion caused by these different agents.[7] All consecutive children referred to our center with the inclusion criteria were eligible. The study was approved by the local Research Ethics Board (REB) (project #92692718.0.0000.5404, approval #4.457.407).

Data were collected on history, physical examination, endoscopic findings, and characteristics of the product involved. No patients were excluded from the study. All patients were evaluated by the consult service of the division of pediatric gastroenterology upon initial admission and later followed at the pediatric gastroenterology outpatient clinic at a university-affiliated hospital (tertiary care/ referral center) in Brazil. Over the years, medical care has changed, and included the use of corticosteroids, antibiotics, or proton-pump inhibitors. Given the retrospective design of this study and the long study period (over two decades), the care provided was not standardized. EGDs were always performed under general anesthesia with pediatric endoscopes by expert endoscopists and explored the esophagus, the stomach, and the duodenum. All reports were retrospectively reviewed and the severity of esophageal injuries was graded using the Zargar endoscopic classification[4]. For patients who needed dilatation, Savary-Gilliard dilators were used. Esophageal balloon dilatation was not available. Topical mitomycin C or intralesional steroid injections were not standardized care.

Possible demographic, clinical, and endoscopic factors were tested individually for their predictive value concerning the need for intervention. The main outcome was the number of esophageal dilatations on follow-up. For the analysis, Zagar classification was further dichotomized according to the severity of the injuries: patients with grades 0 to 2a vs from grades 2b to 3b. On follow-up, we classified as having gastroesophageal reflux disease (GERD) only those patients who presented with erosive reflux esophagitis upon EGD assessment. Analyses were performed by using the Mann-Whitney test. Data were analyzed by using the SAS System for Windows Statistical Analysis System (version 9.4. SAS Institute Inc, 2002-2012, Cary, NC, USA).

RESULTS

Over the study period, we enrolled 34 patients: 19 (55.9%) were female. Overall, the median age at the time of the accidents was 20.6 months (interquartile range – IQR 15–30.7). All alkali ingestions were incidental, all involved liquid substances, and the majority (24/34; 70%) took place at the child's home. In half of the cases (17/34), the product ingested was homemade liquid soap. Three of 34 patients (8.8%) had drunk something after the accident. The most frequently reported symptom upon presentation was vomiting, in 22 of 34 (64.7%). An oral or perioral injury was observed in 20 of 34 patients (58.8%). The median follow-up time was 3.2 years (IQR 1.1–7.4). On follow-up, the median number of esophageal dilatations required for these patients was 12.5 (0–34). None of the patients included in our study had previously undergone endoscopy before presentation.

Possible predictive demographic, clinical, and endoscopic factors for the number of esophageal dilatations are presented in TABLE 1. Among demographic factors, the male gender (P=0.04), accidents with homemade products (P<0.01), and accidents occurring outside of hosehold environment (P=0.02) were associated with a greater number of esophageal dilations on follow-up. Regarding the presence of signs and symptoms on presentation – oral or perioral injury, vomiting, drooling, abdominal or retrosternal pain, fever –, even though the number of esophageal dilatations was greater when any of studied signs or symptoms were present, the differences did not reach statistical significance. As the terminology described by Zagar et al. is intended for endoscopy performed in the first few days after the caustic ingestion[4,8], Zargar classification was not used in thirteen cases because an early endoscopy was not performed in those cases. Zargar 2B or more (P=0.03), the presence of stenosis at the time of the second EGD (P=0.01), and GERD as a late complication (P=0.01) were also associated with a greater number of esophageal dilations on long term follow-up, while the presence of gastritis or duodenitis on the first EGD was not.

Among the patients included in the study, severe acute complications were reported in six patients:

TABLE 1. Possible predictive demographic, clinical and endoscopic factors for the number of esophageal dilatations.

	N	Number of esophageal dilatations	
		Median (P25–P75)	*P*-value*
Gender			
Female	19	3 (0–31)	**0.04**
Male	15	25 (9–52)	
Nature of the product			
Homemade	17	31 (16–44)	**<0.01**
Commercially available	17	2 (0–11)	
Environment of the accident			
Household	24	6 (0–28)	**0.02**
Outside the household	8	32.5 (20–36)	
Oral or perioral injury			
No	12	3 (0–25)	0.33
Yes	20	19 (1.5–32)	
Vomiting			
No	10	6.5 (0–16)	0.29
Yes	22	19 (0–35)	
Drooling			
No	16	9.5 (1–35)	0.92
Yes	16	20.5 (0–30)	
Abdominal or retrosternal pain			
No	29	11 (0–34)	0.65
Yes	3	12 (0–25)	
Fever			
No	28	11.5 (1–32)	0.75
Yes	4	15 (0–33)	
Zagar classification	**N**		
Grades 0 to 2A	16	0 (0–11)	**0.03**
Grades 2B or worse	18	30 (3–35)	
Presence of gastritis or duodenitis on first EGD			
No	30	12.5 (0–31)	0.72
Yes	4	18.5 (1–34)	
Stenosis at time of the second EGD			
No	5	0 (0–0)	**0.01**
Yes	20	30.5 (10–40)	
GERD as a late complication			
No	25	10 (0–27)	**0.03**
Yes	9	34 (25–37)	

EGD: esophagogastroduodenoscopy; GERD: gastroesophageal reflux disease.

three cases of pneumomediastinum; esophageal perforation and mediastinitis in two patients; and one case of broncho-aspiration and acute respiratory failure. Late complications were GERD in nine patients, and hiatal hernias in six. Four patients required surgical treatment (performed between 4 and 8 years after the accident): three of them underwent esophagoplasty with gastric tube placement and pyloroplasty; and one underwent gastroenterostomy and gastroenteric-anastomosis.

DISCUSSION

In our study, we found that the main factors associated with the need for repeated esophageal dilations on follow-up were male gender and factors related to circumstances of the alkali ingestion – i.e., the nature of the product (homemade, rather than commercially available cleaning products) and the environment of the accident (outside the household environment).

Earlier literature has reported male gender as having a risk for accidental caustic ingestion are younger children[9]. Interestingly, in our cohort, we report a slight female predominance, but the male gender was associated with a greater number of dilatations on follow-up, which we interpret as a proxy for more severe injuries. The most common chronic complication of caustic ingestion is esophageal stricture, with a reported incidence of up to 63%[9-11]. It has been consistently reported that a higher Zagar grade on endoscopic evaluation (grades 2b and 3) is associated with worse outcomes and a higher incidence of esophageal stricture[8]. Nevertheless, learning about demographic and clinical factors associated with worse long-term outcomes is still relevant, and this can be taken into consideration even in the decision-making process of the recommendation for prompt endoscopic evaluation in children with caustic ingestion.

Regarding the circumstances of the alkali ingestion, we hypothesize that the reason why homemade cleaning products are associated with worse outcomes relates to how these products are usually stored – usually in repurposed beverage bottles, without any type of safety caps, thus possibly related to the ingestion of greater volumes. We also found that most accidents took place in the child's own home (75%), but interestingly, the smaller percentage of accidents that took place outside the household environment was associated with a greater number of esophageal dilations on follow-up. It is possible that more severe injuries are more likely to happen in an environment unfamiliar to the child – maybe with a longer time until the accident is noticed and until an adult can intervene and stop the ingestion.

There are no internationally accepted guidelines on the management of caustic ingestion by children. In a recent review, Hoffman et al. elaborated an algorithm for the diagnosis and management of caustic ingestions that proposed that endoscopy should always be performed in cases of acid ingestion or intentional alkali ingestion, but only in selected cases of unintentional alkali ingestion[12]. According to that algorithm, patients with unintentional alkali ingestion can be discharged after observation for 4 to 6 hours if asymptomatic; while stridor alone or vomiting and drooling, would prompt immediate endoscopy; and one of the following symptoms among vomiting, drooling or inability to take food, would prompt admission, with an initial trial of NPO overnight, followed by a trial of clear liquids and then food as tolerated, and endoscopy would be recommended if the patient is unable to drink. In keeping with those recommendations, Gupta et al. found that all patients with clinically significant injury (defined as Zagar grades 2 and 3) after caustic ingestion were symptomatic at initial assessment, and that no single symptom or combination of symptoms could identify all patients with esophageal injury – concluding that asymptomatic children with alleged unintentional caustic ingestion do not necessarily have to undergo EGD[12]. Other studies have similarly supported that EGD should always be performed for symptomatic children, but not necessarily for asymptomatic children[1,6]. A recent study with analysis of 1059 diagnostic procedures performed for caustic ingestion in children concluded that other indications for EGD (beyond symptoms) were asymptomatic children who had ingested an alkaline product and asymptomatic children under the age of 6 years.

It is well-known that strictures typically develop

in the first 2 months after ingestion of caustic substances[12]. In keeping with that, we found that the presence of stenosis at the time of the second EGD, usually performed around that time frame, was associated with a greater number of EGDs on follow-up and a greater number of esophageal dilations.

Some limitations of our study included the relatively small number of patients, the retrospective design, and a possible referral bias. Another limitation of our study was the lack of evaluation of time between the dilations, which may have varied according to instuitional limitations (such as operating room availability) or compliance with treatment: a long time to perform the dilatations at appropriate intervals may have contributed to difficulties in managing these patients (greater number of dilatations or even the need for surgical corrections).

Nevertheless, our findings suggest that, at the time of the ingestion, additional epidemiologic factors, specifically, the male gender, the nature of the product (homemade) and the environment (outside of the household environment) are associated with increased morbidity in long-term follow-up – specifically with an increased need for repeated esophageal dilation, during a median follow-up time of 3.2 years.

Authors' contribution

Cardoso AJ conceptualized the manuscript and obtained REB approval, collected the data, and drafted the initial manuscript. Sandy NS supported data analysis and interpretation, supported writing of the manuscript, edited, and revised the manuscript. Gomez GS collected the data, supported data curation, edited, and revised the manuscript, provided supported supervision, reviewed and edited the manuscript. Servidoni MF and Lomazi EA supported data acquisition and curation, edited, and revised the manuscript. Bellomo-Brandao MA conceptualized the manuscript and obtained REB approval, provided supported supervision of all stages, reviewed and edited the manuscript. All authors approved the final version as submitted and agree to be accountable for all aspects of the work.

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RESUMO – Contexto – Crianças que sofrem lesões cáusticas correm alto risco de desenvolver estenose esofágica e necessidade de dilatações esofágicas. **Objetivo –** Objetivamos avaliar preditores de necessidade de maior número de dilatações esofágicas em crianças, após uma ingestão cáustica. **Métodos –** Estudo de coorte retrospectivo de centro único incluindo crianças submetidas a esofagogastroduodenoscopia (EGD) após ingestão cáustica. Foram avaliados possíveis fatores preditivos para a necessidade de dilatações esofágicas. **Resultados –** Foram incluídos 34 pacientes, 19 do sexo feminino (55,9%). A idade mediana no momento dos acidentes foi de 20,6 meses (IQR 15-30,7). Todas as ingestões cáusticas foram incidentais, de substâncias líquidas, e a maioria dos acidentes (24/34; 70%) ocorreu no domicílio da criança. Em metade dos casos, a substância ingerida foi um sabão caseiro. O sintoma mais reportado na apresentação foi vômito (22/34 -64,7%). O tempo médio de acompanhamento foi de 3,2 anos (IQR 1,1- 7,4). No seguimento, o número médio de dilatações esofágicas necessárias foi de 12,5 (IQR 0-34). Entre os fatores demográficos, o sexo masculino (P=0,04), acidentes com produtos caseiros (P=<0,01) e a localização do acidente fora do ambiente domiciliar (P=0,02) foram associados a um maior número de dilatações esofágicas no seguimento. A classificação endoscópica Zargar 2B ou mais (P=0,03), a presença de estenose na segunda EGD (P=0,01) e a DRGE como complicação tardia (P=0,01) também se associaram a maior número de dilatações esofágicas no acompanhamento a longo prazo. **Conclusão –** Além da gravidade da classificação endoscópica – fator de risco bem conhecido para as estenoses após ingestão de cáusticos, observamos que o sexo masculino, os acidentes com produtos caseiros e os acidentes ocorridos fora do ambiente doméstico foram fatores significativamente associados a um maior número de dilatações esofágicas em acompanhamento em longo prazo de crianças após ingestão de soda cáustica.

Palavras-chave – Ingestão cáustica; endoscopia, criança, dilatações esofágicas.

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