ABSTRACT

Objectives. To describe variation in the initial management of children presenting to Emergency Departments (ED) with coins lodged in the oesophagus. To determine the usage of Hand Held Metal Detectors (HHMD) in EDs, including their role in clinical decision making, and training in their use.

Methods. Online multicentre cross-sectional survey of EDs in the UK and Ireland, with results described using descriptive statistics.

Results. 55/61 (90%) sites responded. The two main strategies described for lodged oesophageal coins were endoscopic removal or observation with reassessment, dependent on location. For coins in the proximal third of the oesophagus 43/55 (78.2%) referred for endoscopic removal, 6/55 (10.9%) observed; in the distal third 19/55 (34.5%) referred for endoscopic removal; 20/55 (36.4%) observed. 30/55 (55%) used HHMDs, 21/30 (70%) had guidelines for their use, and 3/30 (10%) provided formal training. 20/30 (67%) used the xiphisternum as the anatomical cut-off for assuming safe passage of metallic foreign bodies (FB) beyond the lower oesophageal sphincter.

Conclusion. There is considerable variation in the management of oesophageal coins in children, though two dominant strategies were identified. As endoscopy is significantly more invasive that observation, future research should aim to determine whether either is more effective and safer in children. There is a clear division in departmental adoption of HHMDs, which may be due to regulatory or scientific issues. However, in those sites using HHMDs there was little formal training in their use, and there are large variations in techniques and their role in clinical decision making.

Key messages

What is known on this subject?

- Ingestion of a metallic foreign body is a common reason for children to present to ED.
- Swallowed coins lodged in the oesophagus can cause significant complications, and international guidelines on their management vary
- Hand held metal detectors are reported to be sensitive in the detection of some ingested metallic foreign bodies, but they are not regulated as medical devices

What this paper adds:

- Variation exists across emergency departments in their management strategies for lodged oesophageal coins
- There is a 50:50 split between emergency departments in usage of HHMDs, and in those where it is used there is variation in training, techniques, and role in clinical decision making
- Further research should focus on determining the most effective, safe, and acceptable method of managing lodged oesophageal coins, and determine what role if any there is for regulation of HHMDs in routine clinical care

INTRODUCTION

Metallic objects are the foreign bodies (FB) most frequently ingested by children, and are a common reason for attending Emergency Departments (ED). Up to 4% of children swallow a coin at some point, with the most common age for ED attendance being 6 months - 5 years[1]. Most ingested metallic FBs are inert and pass through the gastrointestinal tract with no complications, but a minority cause internal injury either due to their size or shape (such as large coins or pins), or their contents (notably button batteries). Complications include oesophageal stricture[2], perforation[3], acute upper airway obstruction, and even death[4].

The greatest risk of injury with inert FBs is from lodgment in areas of anatomical narrowing, especially the oesophagus, where the most common site is the thoracic inlet[5]. International guidance recommends endoscopic retrieval of oesophageal coins, with European guidance recommending removal within 24 hours if asymptomatic, or 2 hours if symptomatic[6]. Other management strategies described include bougienage[7], Foley catheter removal (under fluoroscopic guidance[8] or 'blind'[9]), and a 'watch-and-wait' approach[10]. This latter is underpinned by reports of spontaneous passage, with success rates between 22% and 89% depending on initial location[10,11]. It is therefore likely that management practices vary between EDs and clinicians, with consequent potential for differences in outcomes, despite the existence of published guidelines.

Excluding aluminium FBs (which are often radio-lucent[12]), the traditional gold standard for locating metallic FBs is a plain radiograph. A potential alternative is a hand held metal detector (HHMD). This was first described 40 years ago[13], and studies have reported it to be a sensitive, non-invasive test [14]. Potential benefits include reduction of radiation burden, improved ED patient flow, and cost savings for healthcare systems[15]. However, they have not been shown to be 100% sensitive for the detection of ingested button batteries[16], and the consequences of failing to identify these may be catastrophic. In addition, HHMDs are not registered medical devices, and uncertainty over regulation and diagnostic accuracy may limit clinicians' willingness to trust and use them. Finally, there are no published guidelines or training packages to optimise safety and accuracy in novice hands. It is unclear how widespread their use is in EDs, how they are used (and in which clinical situations), and how clinicians are trained in their use.

We therefore aimed to (i) describe current practice and variation in the initial management of children with oesophageal coins and (ii) determine the proportion of EDs using HHMDs, and explore variation in their investigative processes and training packages.

METHODS

Study design

This multi-centre cross-sectional survey was delivered using Online Surveys (www.onlinesurveys.ac.uk) between 19th March and 3rd May 2018. This closed survey was distributed to Paediatric Emergency Research in the United Kingdom & Ireland (PERUKI) sites, a research collaborative which includes mixed (adult/paediatric) and paediatric EDs from urban and rural settings; one response was sought on behalf of each site[17]. This survey study was performed in line with the CHERRIES statement[18].

The survey was developed iteratively by the study team based on existing literature and feedback from pilot testing. The final survey consisted of 21 questions (Appendix 1), with adaptive questioning used to ensure that respondents answered relevant questions only, and that all relevant questions were answered. Participants could review their responses at any stage prior to final submission.

Questions related to departmental practice for ingested metallic foreign bodies, including initial management of oesophageal coins (early removal, ‘watch and wait’, or other strategies), observation practice where relevant, and use of HHMDs (including make/model, training, body areas scanned, and use in clinical decision making where relevant).

Response types included single answer and multiple selection, as well as the option to provide free-text. Results are presented using descriptive statistics.

This survey accessed clinicians via a research collaborative to assess departmental practice, and did not include any patient data; formal ethics review was not required according to the Framework for Health and Social Care Research (UK)[19]. No incentives were provided. Consent was implied by participation.

Patient and public involvement

As this was a survey of practice there was no patient or public involvement.

RESULTS

In total 55/61 (90%) sites responded.

There was a mix of tertiary paediatric and district general hospitals as well as stand-alone children's EDs and mixed EDs. Initial management of oesophageal coins varied by lodgement level, in general being progressively more conservative the more distal the location (Table 1).

In those managed with a "watch and wait" approach, most had a maximum observation period of 12 hours; no patients were observed for more than 24 hours (Table 2).

A small number of sites allowed patients home for the observation period. This was more likely if the coin was in the lower third of the oesophagus (7 sites) than if it was in the middle or proximal third (4 and 3 sites respectively). Most sites using this strategy allowed patients to eat and drink throughout. One department reported Foley catheter removal under fluoroscopic guidance for coins in the proximal two thirds; another site reported blind Foley catheter removal at the discretion of the treating clinician for coins in the proximal third.

For sites where initial management was at the discretion of the treating clinician (up to 11 sites depending on location) the most common strategies were referral to surgical team, feeding and re-assessing, and giving cola +/- food. One site used glucagon and one used a nasogastric tube to try to advance the coin into the stomach.

Thirty (55%) departments used HHMDs to identify ingested metallic FBs. Of the remaining 25, most (22; 88%) used x-ray only, two used x-ray and ultrasound, and one site used fluoroscopy. Thirteen different models of HHMD were in use (seven brands). Guidelines for HHMD use were available in 21/30 (70%) sites, and 3 (10%) provided formal training. In 17/30 (57%) sites, HHMD use was restricted based on patient characteristics, most commonly excluding obese and older patients. Other reasons for not using a HHMD included presence of indwelling metallic prostheses, piercings, or thoracotomy clips. In addition to identification of swallowed FBs, two sites (7%) used HHMDs for alternative reasons; in one this was for identification of soft tissue FBs, and in the other it was to identify concealed weapons.

The most common combination of anatomical regions scanned was “anterior & posterior neck, chest, abdomen, pelvis – midline & lateral” (16/30, 53%), and the most common anatomical cut-off for assuming safe FB passage past the lower oesophageal sphincter was the xiphisternum (20/30, 67%). Other anatomical cut-offs used for safe passage past the lower oesophageal sphincter included: below the diaphragm (4/30, 13%) and umbilicus (2/30, 7%).

Where a metallic FB was identified above a stated anatomical cut-off, all sites performed an x-ray to confirm position. In 27/30 (90%) EDs children were discharged if the HHMD identified a non-hazardous FB below the “safe” anatomical cut-off; the other sites performed confirmatory x-rays. In cases where non-hazardous metallic FBs were not identified by HHMD, 21/30 (70%) EDs allowed immediate discharge; five of the other nine routinely performed an x-ray to confirm absence, and four made this decision on an individual patient basis. One site allowed discharge if potentially hazardous FBs (e.g. button batteries) were not detected by HHMD. Of 18 sites using HHMDs in triage, nine (50%) allowed immediate discharge if a non-hazardous metallic FB was not detected, or was identified below their “safe” anatomical landmark; no site allowed discharge from triage if a HHMD failed to detect a potentially hazardous FB.

DISCUSSION

This survey has identified variation in the identification and management of ingested metallic foreign bodies in children presenting to Emergency Departments, and in doing so has highlighted areas worthy of further investigation to facilitate standardisation and improve outcomes. This variation existed in the urgency and indications for intervention in oesophageal lodgement, and in opinions on the utility of hand held metal detectors. This latter was emphasised by variation in approach and decision making in departments where they were in use.

International guidelines[6] recommend endoscopic coin removal up to 24 hours after ingestion for asymptomatic patients due to increasing risk of complications beyond this[20]. Most sites reported practice in line with this guidance, albeit with some variation based on foreign body location. Observation prior to removal, the second most frequently reported strategy, was increasingly common the more distal the foreign body. This watch and wait approach is likely to be popular with children and carers as it may obviate an invasive procedure and general anaesthetic, and appears clinically sensible. Whilst guidance is based largely on two retrospective case series consisting mostly of adults who commonly ingested fish bones, evidence suggests that a large proportion of coins swallowed by children pass spontaneously[10,11].

Other possible techniques for attempting dislodgement were much less frequently reported in our survey, including push (bougienage), pull (Foley catheter), or medication (glucagon). Bougienage (in which a bougie dilator is used to push the FB into the stomach) has been demonstrated in some reviews to be a quick, safe, and cheap alternative to endoscopy that can be delivered in the ED[7]. Foley catheter removal (in which a Foley catheter is inserted past the FB before inflation and removal) has also been shown to be effective and cost-efficient in retrospective case series[8,9]. This is most often done under fluoroscopic guidance, though one large case series not using fluoroscopy reported a success rate of 94% with no major complications[21]. However, these techniques are likely not in wide use due to the specialised nature of the equipment, and the training required for the technique. Other concerns which have previously been raised on their use include a lack of airway protection during removal, and the inability to directly visualise the oesophageal mucosa for complications or contributory pathology. Glucagon is no longer recommended for routine use. One small, underpowered, randomised controlled trial showed no benefit in the management of oesophageal coins in children[22], and a systematic review and meta-analysis for all for oesophageal foreign bodies also showed no benefit, but with a greater risk of adverse events[23].

It is likely that several factors contribute to the divide in opinion over the utility of HHMDs in EDs, and to variations in training, usage, and clinical decision making. HHMDs are not registered medical devices – identification of ingested metallic FBs is not their stated use, and there are no instructions from manufacturers on training, techniques, or patient selection. However, their embedded use across multiple sites suggests that perceived clinical utility outweighs regulatory issues for many clinicians. One offsetting factor may be the perceived benefit of reducing x-ray exposure and associated costs, if the diagnostic accuracy is satisfactory. When used as a rule out test for non-hazardous metallic FBs, one study reported that only 3.7% of asymptomatic patients would require an x-ray[15]. When used as a rule-in test for hazardous FBs such as button batteries, providing a general location may reduce the number of body areas x-rayed.

Evidence of their diagnostic accuracy is somewhat mixed, though the largest systematic review[14] reported a sensitivity for coin detection of 99.4% (95% CI 98.0-99.9%), and accuracy of localisation at 99.8% (95% CI 98.5-100.0). This included 11 studies of variable size and quality, though all used x-rays as the reference standard test. A subsequent single-centre case series[15] comprising 422 episodes of HHMD use reported no adverse events, though the reported sensitivity was lower at 78% for all metallic FBs, and 88.9% for coin-like objects. Importantly, HHMDs may fail to identify swallowed button batteries[16], with potentially catastrophic outcomes. X-ray should therefore remain the gold standard test in suspected cases of button battery ingestion, as was the case in the majority of sites in this study.

Whilst there is some variation in our survey responses and the literature [15,24], the xiphisternum is the most commonly described anatomical safety level for HHMD use in both. This makes pragmatic sense, as the xiphoid process and the gastro-oesophageal junction lie at the level of the 10th thoracic vertebra[25]. There is currently no unified guidance on what constitutes a safe scanning technique, again reflected in variation between sites. Some (but not all) published studies describe their technique, with no standardised or validated approach. However, as in our survey, most describe scanning from neck to pelvis anteriorly and posteriorly, in an effort to cover all areas in which an FB may have become lodged, and this approach is likely to be strengthened somewhat by dividing the trunk into areas through which the operator can progress.

Clinicians rarely use equipment without training, yet in our study this was the case in 90% of sites using HHMDs. There is limited evidence to determine whether this is actually necessary, with one case series reporting no significant difference between experienced and untrained practitioners in their ability to localise metallic FBs[24]. However, as most sites make clinical decisions based on HHMD results, this lack of training may represent an unnecessary risk, especially when coupled with the practice variation we have described. Where sites choose to use HHMDs, basic training on their use should include patient selection, preparation and positioning, HHMD familiarity, causes of false positives and false negatives, anatomical areas to be scanned, and anatomical cut-off.

A limitation of our study of our study is that we asked each respondent to answer on behalf of their whole department and there may be some user bias present in our results. In addition, our results are based on reported and not measured practice. However, responses tallied with the submitted guidelines where available. In addition, we had an excellent response rate so our survey is likely to be an accurate representation of current practice.

While it was beyond the scope of our survey to measure outcomes for the various diagnostic and management strategies. However, the heterogeneity in practice we have described makes it essential that research exploring these outcomes is done to underpin best practice. In regards oesophageal coins, paediatric-specific evidence of this type of lodgement would better inform practice than current evidence, which mainly includes adult patients. We suggest several domains of HHMD use are worthy of further study, including whether there is any difference in diagnostic accuracy between (type of) device, determining the optimum scanning technique, and identification of patients in whom this may be more of less accurate in order to clarify whether this is a sensitive and clinically useful approach. If found to be of potential benefit, that evidence can then be used to underpin standardised guidelines for training and practice.

Conclusions

There is significant variation in the Emergency Department investigation and management of patients who have ingested metallic foreign bodies. For coins lodged in the oesophagus, the two predominant management strategies are endoscopic removal, and “watch and wait”, dependent on the position in the oesophagus. Approximately half of Emergency Departments use hand held metal detectors to identify swallowed metallic foreign bodies in children, though with little standardisation in machine, technique, training, or processes. Future research should focus on outcomes and patient/family preferences in order to provide evidence to underpin practice in this area.

Competing interests

The authors have no competing interests to declare

Patient consent

None required

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Tables

Table 1. Management of coin by location

	% of departments		
	Proximal third	**Middle third**	**Distal third**
Refer for endoscopic removal	43 (78.2%)	33 (60%)	19 (34.5%)
Observe & reassess	6 (10.9%)	11 (20%)	20 (36.4%)
Clinician's discretion	2 (3.6%)	6 (10.9%)	11 (20%)
Feed & Reassess	-	2 (3.6%)	3 (5.5%)
Refer for surgical opinion	3 (5.5%)	2 (3.6%)	2 (3.6%)
Foley catheter & Fluoroscopy	1 (1.8%)	1 (1.8%)	-

Table 2 – management of patients who were observed

		Proximal 1/3	Mid 1/3	Distal 1/3
Departments who observe as 1st line management*		6 (11%)	11(20%)	20 (36%)
Departments allowing home for observation*		3 (5%)%	4 (7%)	7 (13%)
Maximum period of observation**	**0-4h**	3 (50%)	8 (73%)	13 (65%)
	4-8h	2 (33%)	1 (9%)	2 (10%)
	8-12h	0 (0%)	0 (0%)	0 (0%)
	>12h	1 (17)%	2 (18%)	5 (25%)

*Percentage of all departments; ** % only of departments who observe