Metal detector and swallowed metal foreign bodies in children

N V Doraiswamy, H Baig, L Hallam

Abstract

***Objective*—To evaluate a metal detector to diagnose swallowed radio-opaque metal foreign bodies (MFBs) in children, and whether they can detect non-radio-opaque MFBs.**

***Methods*—In a prospective study, 231 children, who presented to the accident and emergency department with a history of swallowing MFBs, were evaluated by the metal detector as well as radiography to confirm and locate the presence or absence of MFBs.**

***Results*—A definite history of swallowing a MFB by the child was given by 186 (81%) parents. The metal detector located MFBs in 183 children and radiographs confirmed radio-opaque MFBs in 181. In the remaining 45 (19%), when swallowing was suspected and not definite, both metal detector and radiography confirmed the presence of a MFB in only four.**

***Conclusion*—A high detection rate of swallowed MFBs was observed in this study, using a metal detector. It is also of value to detect non-radio-opaque MFBs like aluminium. The detection of MFBs is high when the history of swallowing is definite.**

(*J Accid Emerg Med* 1999;16:123–125)

Keywords: metal detector; swallowed metal foreign bodies; children

Metal detectors are commonly used to screen people at most airports. It has also been used for screening patients: before magnetic resonance imaging,[1] implanted foreign bodies,[2 3] an inhaled needle in the mediastinum,[4] and detecting firearms as a safety procedure in the paediatric accident and emergency (A&E) department.[5]

Metal detectors have been used to detect swallowed metal objects.[6–14] They have also been shown to be superior to conventional radiography as aluminium rings, which are not radio-opaque,[12 13] have been detected by metal detectors.[14]

Metal detector

Adams Electronics supplied the metal detector, model AD18. This operates on the principle of linear detection technology. A continuous linear sine wave at a constant amplitude of no greater that 5 V is present at the search sensor within the circular probe. A metal object in proximity to the sensor absorbs a small proportion of the signal, which is constantly monitored and compared at a frequency of 20 000 times per second. Any difference in amplitude is detected, causing an alarm signal by means of the audiopiezo sounder and the light emitting diode. As the model AD18 works on the principle of linear detection technology it lays claim to detecting all metals: ferrous, non-ferrous, pure and alloy, at any angle or plane.

Patients and methods

A prospective study was carried out on children attending the A&E department from July 1995 to December 1996 with a history of swallowing a metal foreign body (MFB). All the children with no complications had the metal detector used and radiography. A history of swallowing a MFB, if definite or only suspected, and the type of metal swallowed, if known, were recorded.

Once the initial setting had been arranged, the metal detector was used by pressing a button and moving the sensor across. Whenever the metal was closer to the sensor there were visual signals in addition to audible alarm. The signals were positive for some distance but the intensity was high whenever the sensor was nearest to the object. The equipment was always tested using a metal, for example the examiner's watch, before its use on children, and audiovisual signals were recorded.

The process was explained and consent obtained from parents and children. In the initial period the senior author (NVD) performed the study, and when it was felt that the technique was very simple and reliable, other medical staff were encouraged to use it.

The results were recorded on an anatomical chart and the signals were documented as positive, weak positive, or negative. On radiography, if a radio-opaque foreign body was present, the site was compared with the metal detector test (MDT) record. Whenever the MDT was positive (strong or weak) and radiography did not indicate a radio-opaque foreign body, other metals in and around the child were identified and the MDT was repeated after removing them. If there were metals in the body other than the swallowed foreign body, this was recorded as a false positive, that is MDT positive and a negative radiograph.

The MDT was done from the upper part of the neck along the chest in the midline anteriorly and scanned through all the quadrants of the abdomen including the sacral area if weak signals were obtained in the lower abdomen from the presence of the foreign body in the rectum.

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Accepted 5 September 1998

Table 1 Incidence of swallowed metals

	No (%)
Coin	146 (61)
Battery	16 (7)
Ring	10 (4)
Earring	7 (3)
Screw	6 (3)
Drawing pin	6 (3)
Pin	6 (3)
Miscellaneous	34 (16)
Total	231 (100)

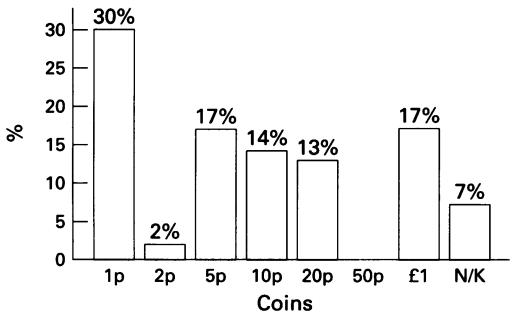

Figure 1 The incidence of different coins swallowed. Note the incidence of 50 and 2 pence coins (N/K = not known).

Results

Eighty seven and 144 children were prospectively studied over a period of six months in 1995 and 12 months in 1996, a total of 231. A definite history of swallowing a MFB was obtained in 186 (81%). Audiovisual signals were positive when the MDT was done in 183 children. However, a radio-opaque foreign body was noted on radiography in 181 children. Two parents gave a history of the child swallowing an aluminium ring pull (and therefore no radio-opaque foreign body was seen[12 13]) and the remaining three (2%) did not swallow a MFB. "He/she was playing with a metal object, it is missing and it is possible that the child may have swallowed it" was the history offered by 45 (19%) parents. Both the MDT and radiography proved negative for foreign bodies in all except four (9%) in whom both were positive.

The children had swallowed a variety of metals (table 1), the commonest being coins (61%). Figure 1 indicates the incidence of different coins swallowed. Figure 2 indicates the locations of foreign bodies as noted in both the MDT (including an aluminium ring pull in the stomach in two) and radiographs.

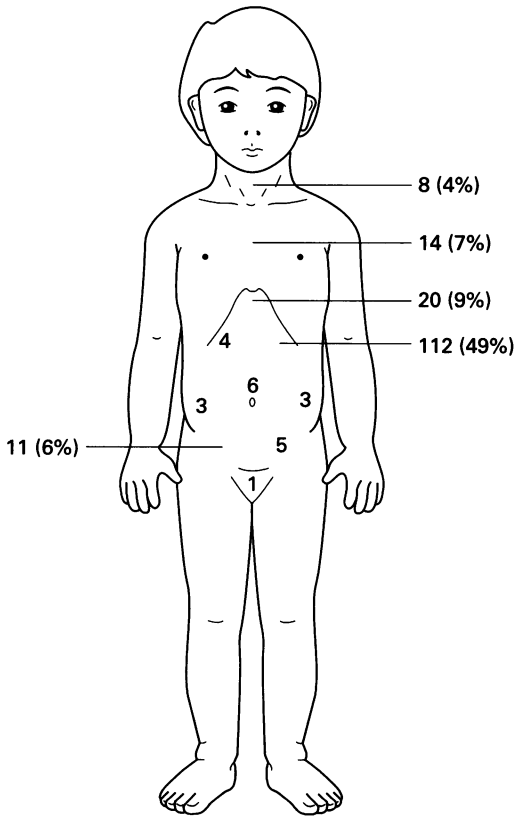

Figure 2 The locations of swallowed metal foreign bodies at presentation.

Table 2 Advantages of using the metal detector

Expenses: initial, yes; maintenance, neglible
Readily available
Non-invasive
Pain free investigation
Repeatable: instantaneous, any number
Easy to learn
No training necessary
Children happy about audiovisual signals
Mother happy: exploration of faeces not necessary

Table 3 Advantages of using the metal detector compared with conventional radiography

Radiation	Nil
Waiting time	Nil
Cost of radiography: film, processing, reporting	Nil
Saving	
Detects aluminium ring pull	

Strong audiovisual signals, as noted in three children, were confirmed as false positives, and were due to sternotomy wires in two and the mother's rings in one, when she was supporting the child from behind the chest. Weak signals but an absent radio-opaque foreign body on radiography was noted in five children—metals in the trouser zip (1), a metal button (1), a coin in the pocket (1), and a steel chair on which the children were sitting (2). Audiovisual signals were negative when the identified extraneous objects were removed.

Discussion

Although metal detectors have been noted to be useful to detect metals in the body,[1-14] only a small number of children have been studied for MFBs.[6-14] This study in children is the largest prospective study in the literature.

In the present study, a swallowed MFB was confirmed in the majority (98%) when there was a definite history of swallowing, but was not confirmed in the majority (91%) where the history of swallowing was vague or not definite.

The present study confirmed positive audiovisual signals in all 181 children in whom the radiographs proved a radio-opaque foreign body. The aluminium ring pull is non-radio-opaque[12 13] and can be diagnosed by using a metal detector.[14] The present study also confirms such findings in two children with strong audiovisual signals from the metal detector in the left hypochondrium and absence of a radio-opaque foreign body in radiographs. Coins were swallowed much more frequently (61%, table 1) than other metals. Easy availability and accessibility may be behind coins commonly being swallowed. The 2 pence coin was swallowed by 2% children and none swallowed 50 pence coins.

There are several advantages in using the metal detector (table 2) compared with radiographs (table 3). The respective costs of radiography of the neck, chest, and abdomen are £22, £26, and £30. The metal detector model AD18 was purchased at a price of £235 and required changing a standard 9 V battery (£1.80) after a year.

The MDT, just before anaesthesia, was useful to avoid endoscopy in the operating theatre, as it became negative in the chest (which was positive earlier) and positive in the abdomen. However, when complications occurred, surgeons requested radiographs so that the object could be visualised before operation. Audiovisual signals can be obtained for some distance, although the intensity increases nearer the object. Therefore, the metal detector is useful to confirm and locate the MFB but cannot localise the exact position. A metal detector cannot identify the shape of the object. Further technological innovations and research are required to clarify these problems.

Conclusion

The chance of a swallowed MFB is high when the history is definite. The metal detector is a preferable and a better alternative diagnostic tool than conventional radiography, when a child is brought in with a history of swallowing a MFB.

Our sincere thanks are due to Mr Fyfe, Surgical Director, for purchasing the metal detector, Mr Carachi, for helping to prepare the manuscript, Jean Hyslop for the illustrations, Liz Meenagh for computer assistance, and Andrea Thomson, Laura Marshall, and Claire Donati for secretarial assistance. We would like to thank all the medical and nursing staff, parents, and the children without whom this study could not have been possible.

Presented at Annual Conference of British Association of Accident and Emergency Medicine, Cardiff, 1997.

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