The Use of Metal Detectors as a Tool for Diagnosing Ingested Metal Foreign Bodies- A Review

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The Use of Metal Detectors as a Tool for Diagnosing Ingested Metal Foreign Bodies- A Review

Author(s): Siddiqui M

Abstract

Coins are frequently ingested by young children in the UK. X-Radiographs have been considered as the gold standard of detecting any swallowed metal foreign bodies in order to ascertain subsequent management. The cost of radiographs, high proportion of normal radiographs and potential long term hazards of ionising radiation has led some investigators to look for alternative first line diagnostic tests.

A hand held metal detector is an obvious alternative both potentially cheap and effective without the hazard of radiation. This review looks at the relevant literature in order to determine whether or not a metal detector is a suitable alternative with a good specificity and sensitivity.

Introduction

Coins are frequently ingested by young children in the UK. X-Radiographs have been considered as the gold standard of detecting any swallowed metal foreign bodies in order to ascertain subsequent management. The cost of radiographs, high proportion of normal radiographs and potential long term hazards of ionising radiation has led some investigators to look for alternative first line diagnostic tests.

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Methods

Search Strategy

The following databases on WebSPIRS from SilverPlatter Information N.V were searched: Medline (1990-2002), Embase (1988-2002), PsycInfo (1990-2002), Serfile (2002), ASSIA for Health (1987-2002), AMED (1995-2002), CINAHL (1982-2002), HMIC, BNI Plus. The Cochrane Database of reviews was accessed via the University of Liverpool website. To obtain journals, I checked the library catalogues at the Royal Liverpool Hospital, the University of Liverpool Harold Cohen Library, Liverpool John Moores library, Alder Hey Hospital, the Liverpool Medical Institute and the British Library in London.

My aim was to identify any relevant RCTs, prospective studies, meta-analyses or reviews which focused on metal detectors and ingested foreign bodies. Non-specific titles were initially included i.e. if the title referred to metal detectors in general. Free-text terms and MeSH terms chosen from the index of aditus were used. Terms were subsequently crossed with each other. Other limits included the English language.

The articles that were found were mainly from Medline1 as the other databases were either irrelevant or repeat citations from Medline. The titles and abstracts were closely looked at and determined whether or not they were truly relevant to the dissertation. I discarded any trials not relating to ingested foreign bodies. I also looked at the references of papers and obtained any which were relevant.

Guidelines from NICE3 were sought but not found. The website for best evidence in Accident and emergency was also looked at but there were no relevant articles.

From the searches 7 papers were found. Of which 6 were relevant. Further papers were identified from the references and ordered. 5 prospective studies were identified, 1 controlled trial using a model and 7 case studies. No reviews were found.

Review

Initially concentrating on the five prospective studies found, an assessment was carried out based upon adapted published quality criteria-4-7. The assessment of papers can be seen in table 2.

Discussion

The vast majority of ingested foreign bodies will follow a benign course with no significant complications;
there have been cases of problems with retained objects in the oesophagus including perforation, airway obstruction and fistulae16-19. Children may be unreliable historians and many reporters suggest a radiograph to be done on every child with a history of foreign body ingestion20. Radiographs offer the Gold standard of diagnostic tests in this area and are highly specific, very available and offer immediate feedback. The disadvantages include the use of ionising radiation (which although realistically is negligible9,11 remains a cause of concern to mothers and fathers, we also do not know any long term effects), the logistics, the time to complete the test and the overall cost. This however may be unnecessary especially with the combined fact of the high specificity and sensitivity a hand held metal detector offers and the relatively uncomplicated course of ingested FBs. The device uses the potential risk of radiation, it is also small, convenient and easy to use. Its cheapness is also a key issue; the cost of the entire equipment for a whole year can be recovered with the saving of one or two roentographs9. A flow diagram of when to use the metal detector must therefore be drawn up, taking into account the issue of location, and the issue of any subsequent follow up. Combining suggestions from the papers13,10 and the algorithm in another15 a proposed flow chart is shown in fig 1.

One of the few problems that exist with the metal detector is that there is difficulty detecting metal objects less than 1 cm. The localisation can also be ambiguous at times meaning that coins identified in the epigastrium via metal detector must be classified as being in the chest as opposed to the abdomen. The other issue arises if the child swallows a non-radio-opaque metal for example aluminium? In this scenario the metal detector acts as safety net. From the literature it seems that hand held metal detectors are viable alternatives to an X-Radiograph. If the history of a metal object ingestion is definite then a metal detector may even supercede the gold standard of X-Rays. If a patient is asymptomatic and a metal foreign body is detected below the oesophagus then the child should be discharged with the possibility of a follow up appointment in 1 week or if complications such as abdominal pain, vomiting, diarrhoea, blood in stool or pyrexia develop. If symptomatic then X-Radiograph should be done immediately with a view to subsequent invasive management. Even though a large number of databases were searched, the specificity hoped for was not achieved. Ingested foreign coins could be expressed in various ways and a complete search would have taken more time. A possible hand search of relevant articles and databases with grey literature would have enhanced the search results. The authors of key papers could also have been approached via email along with inclusion of perhaps any unpublished data. Limits inflicted upon the size of this project may have led to a reduced number of articles appraised.

Conclusions

Further technological advances may lead to metal detectors being able to localise the exact position of the foreign body. This will require their subsequent investigation in similar methods to referenced studies.

References

1) www.aditus.nhs.uk
2) www.liv.ac.uk
3) www.nice.org.uk
12) Sacchetti A. Carraccio C. Lichenstein R. Hand held metal detector identification of ingested foreign
Illustrations

Illustration 1

Figure 1

Hx of Ingestion

Metal

Non Metal

Potent hzrd / < 1 cm / symptomatic (choking / dysphagia )

Non Hzrd / > 1cm / asymptomatic

MD -ve

MD +ve

MD -ve

MD +ve

X-Radgrph

Abdo

Chest

Discharge

Abdo

Chest

Discharge

X-Radgrph

F/up 1 week or return if abdo pain, vomiting, diarrhoea, blood in stool or a pyrexia

Don’t use Metal detector. Radiograph indicated to localise it. Further Mx depends

F/up 1 week or return if abdo pain, vomiting, diarrhoea, blood in stool or a pyrexia
Illustration 2

Table 1

<table>
<thead>
<tr>
<th>MeSH terms used for metal detectors</th>
<th>MeSH terms used for foreign bodies</th>
<th>Free text terms used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metal</td>
<td>Foreign bodies</td>
<td>Eaten coins</td>
</tr>
<tr>
<td>Detectors</td>
<td>Ingested coins</td>
<td></td>
</tr>
<tr>
<td>Metal detectors</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Illustration 3

Table 2

<table>
<thead>
<tr>
<th>Quality criteria used to assess articles for inclusion in to the review</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality Criteria</td>
<td>8 9 10 11 12 13</td>
</tr>
<tr>
<td>Was the study important?</td>
<td>2 2 2 2 2 2</td>
</tr>
<tr>
<td>Compared with Gold Standard?</td>
<td>2 2 0 2 2</td>
</tr>
<tr>
<td>Broad Patient Spectrum</td>
<td>1 1 1 2 1</td>
</tr>
<tr>
<td>Was each patient given both sets of tests?</td>
<td>2 2 2 2 2</td>
</tr>
<tr>
<td>Were the results of one test known before the other was performed?</td>
<td>0 2 0 0 0 0</td>
</tr>
<tr>
<td>Is the test reproducible?</td>
<td>0 0 0 1 0</td>
</tr>
<tr>
<td>Is the Sensitivity and Specificity &gt;75%?</td>
<td>2 2 2 2 2</td>
</tr>
<tr>
<td>Have Confidence intervals been given?</td>
<td>0 0 0 0 2</td>
</tr>
<tr>
<td>Is this test placed within a context?</td>
<td>1 2 2 2 2</td>
</tr>
<tr>
<td>Total Max. 18</td>
<td>10 13 11 7 13 13</td>
</tr>
</tbody>
</table>

Yes = 2  
Unclear/ Possibly = 1  
No/Not mentioned = 0

All the papers fell down in areas such as giving the confidence intervals. They also failed to mention whether the study was blinded i.e. whether the examiners knew the results of the first test before they carried out the other. And only one paper mentioned the possibility of the results being reproducible. The papers were taken into consideration if they scored 10 and above.
Results of each paper

<table>
<thead>
<tr>
<th>Reference</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>12</th>
<th>13</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. Of children</td>
<td>1430</td>
<td>20</td>
<td>231</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>Detections by metal detector</td>
<td>+10</td>
<td>27</td>
<td>13</td>
<td>187</td>
<td>15</td>
</tr>
<tr>
<td>Detections by X-Rayograph (Gold Standard)</td>
<td>+11</td>
<td>27</td>
<td>13</td>
<td>185</td>
<td>16</td>
</tr>
<tr>
<td>Totals</td>
<td>3</td>
<td>3</td>
<td>7</td>
<td>46</td>
<td>7</td>
</tr>
<tr>
<td>True Positives</td>
<td>1027</td>
<td>13</td>
<td>182</td>
<td>15</td>
<td>250</td>
</tr>
<tr>
<td>True negatives</td>
<td>3</td>
<td>3</td>
<td>7</td>
<td>44</td>
<td>7</td>
</tr>
<tr>
<td>False Positives</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>False negatives</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

From the results above we can see that a combined sensitivity of 250/252 = 99.2% and specificity of 66/68 = 97.1% is achieved. A positive predictive factor of 250/252 = 99.2% and negative predictive factor of 66/68 = 97.1%.
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