Turk J Gastroenterol 2010; 21 (2): 135-139

The utility of handheld metal detector in confirming metallic foreign body ingestion in the pediatric emergency department

Metalik yabancı cisim yutma şüphesi ile acil servise başvuran çocuklarda dedektör kullanımının güvenilirliği

Eylem Ulaş SAZ[1], Çiğdem ARIKAN[2], Funda ÖZGENÇ[2], Muhterem DUYU[1], Yeliz OZANANAR[1]

Departments of [1]Emergency Medicine, [2]Gastroenterology, Ege University School of Medicine, Children's Hospital, İzmir

Background/aims: *We aimed to identify the presence of ingested metallic foreign bodies with handheld metal detector in the pediatric population.* ***Methods:*** *All children (n=40) known or suspected to have ingested a MFB and who presented to the Emergency Department of the Children's Hospital of Ege University were prospectively ascertained. All patients underwent both radiographic evaluation and handheld metal detector scanning of the chest and abdomen on their presentation. In the present prospective study, we compared handheld metal detector scanning with plain radiography.* ***Results:*** *The end point of the study compared metallic foreign body findings with handheld metal detector vs radiological findings during an eight-month period. Forty subjects with possible metallic foreign body ingestion were enrolled into the study. The principle investigator scanned all subjects. Disease was defined by the presence of a foreign body in the gastrointestinal tract on radiograph. Radiographically, 35 foreign bodies were found, and handheld metal detector revealed 31 of them. The sensitivity of handheld metal detector was 88.6% (95% confidence interval [CI]: 72.1%-96.5%), specificity 100% (95% CI: 61.8%-100%), positive predictive value (PPV) 100% (95% CI: 85.8%-100%), and negative predictive value 55.5% (95% CI: 34.3%-84.6%).Handheld metal detector revealed that 2 metallic foreign bodies (1 pushpin, 1 coin) were localized to the chest, which was confirmed by radiography, and urgent removal was performed with endoscopy.* ***Conclusions:*** *Handheld metal detector scanning is an accurate, inexpensive, radiation-free screening tool and should be used for evaluation of patients suspected of ingesting metallic foreign bodies.*

Key words: Foreign body, ingestion, children

Amaç: *Metalik yabancı cisim yutan çocuklarda metal dedektör kullanımının cismi saptamadaki duyarlılığını saptamak.* ***Yöntem:*** *Çalışma periyodu içinde metalik yabancı cisim yutan ya da yutma şüphesi olan 40 çocuk, Ege Üniversitesi Tıp Fakültesi Hastanesi Çocuk Acil servisine başvurdu. Tüm hasta verileri prospektif olarak daha önceden hazırlanmış formlara işlendi. Hastalar hem grafi hem de dedektörle yabancı cisim açısından tarandı. Dedektörle göğüs kafesi, abdomen ve inguinal bölge tarandı. Sonuçlar radyolojik bulgularla karşılaştırıldı.* ***Bulgular:*** *Sekiz aylık çalışma periyodu içinde metalik yabancı cisim yutan ya da şüphesi olan toplam 40 çocuk çalışmaya alındı. Hastalık gastorintestinal sistemde radyolojik olarak yabancı cisim varlığı olarak tanımlandı. Toplamda 35 çocukta yabancı cisim radyolojik olarak saptanırken dedektör bunlardan 31 tanesini tanıyabildi. Dedektör sensitivitesi %88.6 (95% güvenlik aralığı [CI], 72.1%-96.5%), spesifisitesi %100 (95% CI, 61.8%-100%), pozitif prediktif değer 100% (95% CI, 85.8%-100%), ve negatif prediktif değer % 55.5 (95% CI, 34.3%-84.6%). Dedektör ile göğüs kafesi taramasından 1 i toplu iğne diğeri de para olmak üzere 2 yabancı cisim saptandı. Bunlar radyolojik olarak özefagusta tespit edildi ve endoskopik olarak acilen çıkartıldı.* ***Sonuç:*** *Metalik yabancı cisim yutan çocuklarda dedektör kullanımı güvenilir, ucuz ve radyasyon yaymayan bir yöntemdir. Tarama testi olarak kullanıma uygun olduğu tespit edilmiştir.*

Anahtar kelimeler: Yabancı cisim, yutma, çocuklar

INTRODUCTION

Possible foreign body ingestion is a common reason for presentation to the Emergency Department (ED) in children. Even though morbidity and mortality due to foreign body ingestion are rare in the pediatric population, the situation may cause serious anxiety for the parents.

The most commonly ingested foreign bodies among pediatric patients are coins (1-3). Generally, most ingested metallic foreign bodies (MFBs) pass spontaneously into the stomach and through the gastrointestinal (GI) tract without sequelae. However, if MFBs become impacted in the

Address for correspondence: Eylem Ulaş SAZ
Ege University Children's Hospital
Emergency medicine İzmir / Turkey
Phone: + 90 232 390 23 13
E-mail: ulas.saz@ege.edu.tr

Manuscript received: 05.11.2009 **Accepted:** 05.04.2010

doi: 10.4318/tjg.2010.0071

esophagus, they can cause some complications, including esophageal ulceration, esophageal perforation, tracheoesophageal fistula formation, and death caused by tracheal compression and aortoesophageal fistula formation (4-6).

The majority of patients undergo radiological investigation. In some patients, several radiological studies are performed. Radiological tests are time-consuming and carry the radiation risk. Although the use of a handheld metal detector (HHMD) to determine the presence of MFBs as an alternative to standard radiographs has been advocated for more than 30 years, no study has been reported in our country. There are many obvious advantages to the utilization of metal detectors in the ED; however, their use has not been widely adopted in European countries (7).

The objectives of this study were to identify the presence of suspected or ingested MFBs using a HHMD in the pediatric population and to determine the accuracy of MFBs with respect to localization in the GI tract.

MATERIALS AND METHODS

From January 1, 2009 through September 30, 2009, all children who presented with MFB ingestion to the ED of the Children's Hospital of Ege University were enrolled. The data form was prepared by the principle investigator and included age, gender, time of ingestion, time of admission, and time of endoscopic or spontaneous removal of the MFB. First, the initial history was taken and physical examination was performed. All patients underwent HHMD scanning, and anteroposterior, lateral neck and chest radiographs including the gastric bubble were obtained (Figure 1). The patients were undressed and all metallic jewelry, eyeglasses, and clothing with metallic elements were removed before scanning. With the child standing or held upright away from metal interferences, an HHMD (Garrett Super Scanner; Garrett Security Systems, Garland, TX) was passed over the child's body in a "zigzag" fashion from the cervical esophagus to the spina iliaca anteriorly and posteriorly (Figure 2).

Figure 1.


Figure 2.

A positive scan was defined as a strong audio signal and a positive visual indication on the HHMD. All patients underwent radiographic evaluation. Patients presenting to the ED with a previously obtained X- ray were enrolled and scanned by two separate investigators blinded to the radiographic findings.

Disease was defined as a MFB visualized in the GI tract on plain radiograph. X-rays demonstrating no foreign body were considered negative for disease. The HHMD scan results indicating a MFB on either chest or abdomen were considered posi-

tive tests. Negative tests were those HHMD scans indicating no foreign body. Cross tab analysis was used for statistical calculations. HHMD scanning compared with radiographic evaluation determined sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and proportion correct with calculated confidence intervals (CIs).

Ethics approval was deemed unnecessary as this was an observational study and no identifiable patient characteristics were used.

RESULTS

A total of 40 patients (25 girls and 15 boys) were enrolled, with a mean age of 110 months (range: 3 months-173 months). The time of presentation ranged from 20 minutes to 8 days after ingestion; 31 patients (79.5%) presented less than 24 hours after ingestion and the mean time to presentation was 23.7 hours.

The ingested foreign bodies were coins (n=14), button batteries (n=13) and pin/safety pin (n=8), respectively. Five patients were suspected of having ingested other MFBs.

Table 1 compares HHMD scan findings with radiographic results in the study group. In 35 of 40 patients, radiographs demonstrated a radiopaque foreign body in the GI tract. In 24 patients, MFB was determined below the umbilicus, in 9 patients below the xiphisternum, and in 2 patients, MFB was demonstrated at the sternal notch. No MFB was determined by X-rays in 5 patients who presented with suspected ingestion. In 2 out of 5 patients, parents had suspected coin ingestion, 1 family stated that their child ingested a piece of his name bracelet, 1 patient had been taken for an X-ray to an outside facility without removing his metal charm and was referred to our ED with suspected charm ingestion. Upon admission, the charm was removed, X-ray performed and no MFB was determined. The remaining case presented to the ED because of ingestion of her metallic dental prosthesis. On her X-ray, no ingested MFB was found.

The sensitivity, specificity, PPV and NPV are summarized in Table 2. Although in 31 out of 40 patients, HHMD was positive, in the remaining 9 patients, HHMD was negative for MFB (Table 1). Interobserver agreement with Cohen's kappa coefficient was calculated as 0.660 (95% CI: 0.343 to 0.976).

Among the study group, 5 were also negative on radiographs and the principle investigator reported 4 false-negative scans. Three of these 4 patients had ingested a safety pin, and the remaining case had ingested a pushpin. They were aged 15 months, 20 months, 13 years and 2.5 years, respectively.

The sensitivity and specificity of HHMD were 100% for all coin or coin-like MFBs such as button battery, coat button and magnet (27/27). However, HHMD was positive in only half of the patients who ingested sharp objects (4/8) (safety pin, pin, pushpin, etc.). This group was reanalyzed to explain the associated factors. We determined that the mean presentation time was significantly longer in the HHMD-positive group (1105 vs 120 minute) (p=0.01). Although the mean age in HHMD-positive group was younger, there was no statistical difference between the positive and negative groups (4.3 ± 6.4 vs 6.0 ± 6.7) (p=0.8).

In terms of localization, HHMD was positive in 2 patients with localization in the chest and in 29 with localization in the abdomen (9 below the xiphisternum, 20 below the umbilicus). Thirty-one patients were consulted to the pediatric gastroenterology department. Totally 11 endoscopies were performed uneventfully, and 10 MFBs were removed: 2 from the esophagus and 8 from the stomach; 1 removal was unsuccessful. A total of 25 patients had no intervention and were followed conservatively.

DISCUSSION

Metallic foreign body ingestion is still a problem in developing countries. The majority of patients are younger than two years and for that reason, investigators have been warranted to develop noninva-

Table 1. Handheld metal detector (HHMD) scan vs radiographic findings

	Foreign Body in GI tract by X-Rays		
HHMD (n=40)	**Positive**	**Negative**	**Total**
Positive	31	0	31
Negative	4	5	9
Total	35	5	40

Table 2. Handheld metal detector (HHMD)

	% (95% CI)
Sensitivity	88.6 (72.1-96.5)
Specificity	100 (61.8-100)
Positive predictive value	100 (85.8-100)
Negative predictive value	55.5 (34.3-84.6)

sive and safe tools. In several studies, sensitivities and specificities of HHMD on MFB ingestion have been reported as 95–100% and 82–93%, respectively (1, 2, 8-12). The majority of those reports have used techniques of vertically scanning the chest from chin to xiphoid, horizontally across the abdomen and horizontally down the back. In the present study, HHMD was passed over the child's body in a "zigzag" fashion from the cervical esophagus to the iliac spine anteriorly and posteriorly.

Various MFBs were ingested in our series, including coins, button batteries, and safety/turban pin. The blue beads/safety pin and turban pin were the third most commonly ingested MFBs (22%) in our center. However, previously published reports showed that rate as 2-6% (2, 13). This difference can be explained by cultural factors, such as the common use of a turban pin in this country.

Schalamon et al. (13) reported that an HHMD correctly identified all 32 coins ingested by children, but 8 of 15 non-coin MFBs were not identified, including two button batteries and a needle. In another study reported by Bassett et al. (8), HHMD correctly identified 53 of 54 coins but missed one esophageal coin. Similar to the published data, in our group, the HHMD also correctly identified all coins (n=12) and coin-like MFBs (n=13) ingested by the children.

The sensitivity concerning other MFBs depends on the size and shape of the swallowed object. Our results revealed that 8 non-coin MFB ingestions (safety pin/pin) were determined and 4 of them were detected by HHMD. The mean age of the detected patients was younger and the presentation time was significantly earlier than in the others, which may reflect that objects in the upper GI can be detected more easily. To our knowledge, this is the first study demonstrating that HHMD may identify the ingested sharp objects when the patient presents early. HHMDs may not be reliable at excluding the presence of MFBs other than coins. In some published studies, similar difficulties have been shown (9, 12). Since dangerous objects may cause mucosal necrosis and ulceration, an X-ray and endoscopy should be considered in these children.

A HHMD is useful to confirm and locate the MFB, but cannot localize the exact position. If ingested coins are located at the level of the xiphisternum, they should have confirmatory radiographs to exclude impaction at the gastroesophageal junction. Children with coins localized below the xiphisternum can forego radiographic evaluation. Since some cases can be managed conservatively, accurate coin localization to the abdomen is important. In our series, the majority of MFBs (82%) were determined by HHMD in the abdomen, and 71.5% were managed conservatively.

This study demonstrates that the HHMD can be used safely and reliably in children suspected of having ingested coins or coin-like MFBs. HHMD is also an effective tool for searching the location in the GI tract. There are several advantages in using the HHMD: it is easy, inexpensive and radiation-free. However, very small MFBs cannot be detected reliably by HHMD. We conclude that if a nonhazardous MFB is clearly identified with a HHMD in the stomach or lower GI tract in an asymptomatic child, additional radiological confirmation is not required. However, if past medical history is consistent with MFB ingestion and if HHMD scanning is negative, an X-ray should be obtained.

REFERENCES

1. Doraiswamy N, Baig H, Hallam L. Metal detector and swallowed metal foreign bodies in children. J Accid Emerg Med 1999; 16: 123–5.
2. Seikel K, Primm PA, Elizondo BJ, et al. Handheld metal detector localization of ingested metallic foreign bodies. Accurate in any hands? Arch Pediatr Adolesc Med 1999; 153: 853–7.
3. Lemberg PS, Darrow DH, Holinger LD. Aerodigestive tract foreign bodies in the older child and adolescent. Ann Otol Rhinol Laryngol 1996; 105: 267–71.
4. Obiako MN. Tracheoesophageal fistula: a complication of foreign body. Ann Otol Rhinol Laryngol 1982; 91: 325-7.
5. Pasquariello PS, Kean H. Cyanosis from a foreign body in the esophagus: respiratory difficulties three months after swallowing a coin. Clin Pediatr (Phila) 1975; 14: 223-5.
6. Tucker JG, Kim HH, Lucas GW. Esophageal perforation caused by coin ingestion. South Med J 1994; 87: 269-72.
7. Wolter JR, Wolter KH. A simple and inexpensive metal detector for magnetic and nonmagnetic metallic foreign bodies. Trans Am Ophthalmol Soc 1974; 72: 363–7.
8. Bassett KE, Schunk JE, Logan L. Localizing ingested coins with a metal detector. Am J Emerg Med 1999; 17: 338–41.
9. Muensterer OJ, Joppich I. Identification and topographic localization of metallic foreign bodies by metal detector. J Pediatr Surg 2004; 39: 1245–8.
10. Biehler JL, Tuggle D, Stacy T. Use of transmitter-receiver metal detector in the evaluation of pediatric coin ingestions. Pediatr Emerg Care 1993; 9: 208-10.
11. Ros SP, Cetta F. Successful use of a metal detector in locating coins ingested by children. J Pediatr 1992; 120: 752-3.

12. Sacchetti A, Carraccio C, Lichenstein R. Hand-held metal detector identification of ingested foreign bodies. Pediatr Emerg Care 1994; 10: 204-7.
13. Schalamon JHE, Haxhija EQ, Ainoedhofer H, et al. The use of a hand-held metal detector for localisation of ingested metallic foreign bodies – a critical investigation. Eur J Pediatr 2004; 163: 257–9.
14. Bassett KE, Schunk JE, Logan L. Localizing ingested coins with a metal detector. Am J Emerg Med 1999; 17: 338–41.