Prosthetic metal implants and airport metal detectors

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ABSTRACT

INTRODUCTION Metal detectors have been present in airports and points of departure for some time. With the introduction of heightened security measures in response to fears of an increased threat of terrorism, they may become more prevalent in other public locations. The aim of this study was to ascertain which prosthetic devices activated metal detector devices used for security purposes.

METHODS A range of prosthetic devices used commonly in orthopaedic and plastic surgery procedures were passed through an arch metal detector at Birmingham Airport in the UK. Additionally, each item was passed under a wand detector. Items tested included expandable breast prostheses, plates used in wrist and hand surgery, screws, K-wires, Autosuture™ ligation clips and staples.

RESULTS No prostheses were detected by the arch detector. The expandable implants and wrist plates were the only devices detected by passing the wand directly over them. No device was detected by the wand when it was under cover of the axillary soft tissue. Screws, K-wires, Autosuture™ clips and staples were not detected under any of the study conditions.

CONCLUSIONS Although unlikely to trigger a detector, it is possible that an expandable breast prosthesis or larger plate may do so. It is therefore best to warn patients of this so they can anticipate detection and further examination.

KEYWORDS

Hand implants – Breast implants – Metal detector – Detection

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Metal detectors have been present in airports and points of departure for some time. With the introduction of heightened security measures in response to fears of an increased threat of terrorism, they may become more prevalent in other public locations.

We commonly use Autosuture™ clip applicators (Covidien, Dublin, Ireland) for ligation of the larger vessels encountered in many cosmetic and reconstructive procedures. On routine follow-up, a postoperative abdominoplasty patient mentioned that she had recently activated both the arch metal detector and, subsequently, the handheld wand. This led to a full body search and it was concluded that the clips must have been the cause. The patient therefore requested a medical letter excusing her from further investigation should she set off a security metal detector.

Previous studies have explored the activation of metal detectors by the larger orthopaedic implants such as prosthetic joints used in arthroplasty.^{1–6} However, no previous papers have commented specifically on the detection of implants used in plastic and reconstructive surgery, notably expander breast implants and those used in hand and wrist surgery. The aim of this paper was to ascertain which prosthetic devices activated metal detector devices used for security purposes.

Methods

A range of prosthetic devices used commonly in plastic surgery, orthopaedic surgery and breast procedures were selected for the study. These consisted of expandable breast prostheses, plates used in wrist and hand surgery, screws, K-wires, Autosuture™ ligation clips and staples. They were composed of several different materials, and there was a range of sizes and quantities.

It is standard practice for every passenger and flight crew member to pass through an arch metal detector at airport security. If the alarm is set off, then they proceed to a more focused wand examination. Occasionally, a random beep from the arch detector will occur, thereby necessitating a further wand examination.

The study was conducted at Birmingham Airport in the UK. The arch metal detector (CEIA® 02PN10; CEIA, Arezzo, Italy) was set at the nationally agreed threshold for detection and is a standard machine used currently in airports.² In addition, an AD10-2 (Adams, East Grinstead, UK) wand detector (similar to the ones used by Kamineni *et al*⁷ at London Stansted Airport) was passed over each device subsequently by a security officer and any activation recorded.

In an attempt to simulate the *in vivo* conditions, each item was placed sequentially in the axilla as well as be-

Table 1 Detection of implants by the arch metal detector

	Object	Manufacturer	Composition	Arch detector triggered
Breast implants	Becker breast expander (with port)	Mentor, Santa Barbara, CA, US		No
	McGhan® Style 150 breast expander	Allergan, Irvine, CA, US		No
Wrist surgery implants	2.4mm LCP® distal radius plate	Synthes, West Chester, PA, US	Commercially pure titanium	No
	2.7mm DCP, 60mm long, 7 holes	Synthes, West Chester, PA, US	Stainless steel	No
	2.7mm cortex screw, 24mm long	Synthes, West Chester, PA, US	Titanium alloy	No
Hand surgery implants	1.6mm K-wires, 150mm long (pack of 5)	Synthes, West Chester, PA, US	Stainless steel	No
	Stericut® 0.9mm K-wires, 150mm long	De Soutter Medical, Aylesbury, UK	Stainless steel	No
General	60 Autosuture™ clips (3 packs) for Premium Surgiclip™ S-9.0 and M-11.5	Covidien, Dublin, Ireland	Titanium	No
	20 Autosuture™ staple gun staples	Covidien, Dublin, Ireland	Titanium	No

LCP = locking compression plate; DCP = dynamic compression plate

tween clasped and then open hands for both the arch and wand metal detectors. The examination sequence was repeated three times for each item, using the same person to ensure body mass index consistency.

Results

Arch detector

None of the prostheses were detected by the arch detector, even when placed in open hands with no soft tissue cover. This included a variety of plates and screws, of differing composition and sizes, used in hand and wrist surgery as well as the expander breast prostheses. Even in multiple quantities, the Autosuture™ staples and K-wires failed to trigger the detector (Table 1).

Wand detector

The wand did not detect any of the implants when they were placed in the axilla. The breast expander implants and the larger stainless steel plates were detected when placed in clasped and open hands. The larger titanium plates were only detected when placed in open hands. Screws, K-wires, Autosuture™ ligation clips and staples remained undetected under all of the study conditions (Table 2).

Discussion

Airport metal detectors use electromagnetic fields to detect metals. When placed in a magnetic field, magnetic metals such as iron, nickel and cobalt produce disturbances in the electromagnetic eddy currents. These changes are detected by the metal detectors.¹ The amplitude of the electrical cur-

rent in the receiver coil should be greater in ferromagnetic metals with a high iron content than in electrically conducting diamagnetic metals such as copper, aluminium, titanium, gold or silver.⁸ The newer implants are frequently highly refined alloys such as titanium, cobalt-chromium-molybdenum and stainless steel. As such, they tend to have low iron content⁹ and are therefore less likely to be detected. Even in alloys with a significant iron content, the resulting implants are difficult to magnetise due to modern processing techniques.¹⁰ It has also been proposed that multiple different metals in combination can either have a synergistic effect or cancel each other out.⁴

Apart from implant metallurgy, other factors affecting detection include metal mass, metal detector sensitivity, transit speed and implant location.⁶ Knee prostheses are the same weight as hip prosthesis but lie more superficially, and are less shielded by cement, bone and the overlying soft tissues. Consequently, they are likely to be detected more easily.¹ The type of detector and sensitivity settings may also vary. There are, however, minimum levels of security, which should be similar among all machines. Fast or very slow transit speeds may affect detection. Security officers typically control these machines and are able to request another pass through the metal detector.⁷

All these factors tend to vary between each individual with various implants and it is therefore difficult to standardise experiments and predict detection exactly. In a previous study, a 1-inch wax shield had no effect on detectability of the underlying implant.⁷ We decided to place the prostheses under the arm at the axilla, and also between clasped and open hands. We appreciate this does not reflect real life. Nevertheless, even in a study involving patients with

Table 2 Detection of implants by the wand metal detector

	Object	Manufacturer	Composition	Detected in axilla	Detected in clasped hands	Detected in open hands
Breast implants	Becker breast expander (with port)	Mentor, Santa Barbara, CA, US		No	Yes	Yes
	McGhan® Style 150 breast expander	Allergan, Irvine, CA, US		No	Yes	Yes
Wrist surgery implants	2.4mm LCP® distal radius plate	Synthes, West Chester, PA, US	Commercially pure titanium	No	No	Yes
	2.7mm DCP, 60mm long, 7 holes	Synthes, West Chester, PA, US	Stainless steel	No	Yes	Yes
	2.7mm cortex screw, 24mm long	Synthes, West Chester, PA, US	Titanium alloy	No	No	No
Hand surgery implants	1.6mm K-wires, 150mm long (pack of 5)	Synthes, West Chester, PA, US	Stainless steel	No	No	No
	Stericut® 0.9mm K-wires, 150mm long	De Soutter Medical, Aylesbury, UK	Stainless steel	No	No	No
General	60 Autosuture™ clips (3 packs) for Premium Surgiclip™ S-9.0 and M-11.5	Covidien, Dublin, Ireland	Titanium	No	No	No
	20 Autosuture™ staple gun staples	Covidien, Dublin, Ireland	Titanium	No	No	No

LCP = locking compression plate; DCP = dynamic compression plate

implants in vivo, the effect of soft tissue coverage and body mass index remained unclear.⁷

Following activation of the arch metal detector, the individual is examined using a wand, which is more sensitive in its detection. In our study, none of the implants triggered the arch metal detector. Conversely, all plates were detected by the wand when it passed over them. It was interesting that we noticed variation among the plates when placed between clasped hands. The stainless steel dynamic compression plate with seven holes was detected but the commercially pure titanium locking compression plate (also seven holes: three in the head, four in the body) was not. None of the K-wires were detected, even when five were placed in close proximity, with the wand directly over them. No items were detected when placed in the axilla. This study examined the effect of screws commonly used in our unit, and detection may vary depending on the composition and manufacturer. A previous study showed that larger plates with more than 10 holes, used in orthopaedic surgery, may be more detectable.⁸

Breast implants incorporating metallic components to allow for expansion are in common use. Neither of the two commonly used expanders in our unit activated the arch

metal detector, nor were they detected by the wand when placed under the arm. However, both implants were detected by the wand when placed between clasped hands. In reality, these would assume a subcutaneous or submuscular position. Expandable implants are usually temporary and patients are perhaps less likely to travel as they may be having expansions during this period. Interestingly, in a study of radiological implants, the metallic subcutaneous ports were readily detected by metal detectors.²

In view of these findings, it is unlikely that the Autosuture™ ligation clips used during our patient's abdominoplasty triggered either the arch or handheld detectors. The arch metal detector's alarm is set off randomly to improve security measures, and this may be the reason for her initial detection and reason for further wand examination.

Conclusions

Although unlikely to trigger a detector, it is possible that an expandable breast prosthesis or larger plate may do so. It is therefore best to warn patients of this so they can anticipate detection and further examination, thereby avoiding potential inconvenience or embarrassment. Other authors have

recommended providing patients with certificates.¹ Nevertheless, without international recognition of these certificates they are unlikely to be accepted. Although detection settings are usually standardised throughout UK airports, the sensitivity of the metal detector may vary in times of heightened security. Newer, more sensitive machines may also be developed. This further confounds standardisation. With the introduction of wraparound scanners, concerns about such prostheses may lessen. While this may minimise patient inconvenience, these machines have raised concerns regarding patient confidentiality and data protection. The traditional detectors will therefore remain most common for some time.

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