Identification manual for foreign bodies by using the chest phantom and the dual energy subtraction radiography

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There are no conflicts of interest with respect to presenting these research results.
Dual energy subtraction (DES) radiography

- DES is an imaging technique that takes advantage of differences in the degree to which objects attenuate low- and high-energy photons.
- DES produces two separate images: a soft tissue image and a bone image.
Potential of DES radiography

• Even objects with low attenuation values are clearly visualized on DES radiographs if the differences are large.
• Thus, it is possible to detect foreign bodies with DES radiographs that are difficult to detect on conventional radiographs.
### Foreign bodies of the chest

#### Common items
- Batteries
- Coins
- Magnets
- Toys
- Balls
- Pieces of plastic
- Safety pins
- Balloons
- Pen caps
- Buttons
- Pieces of jewelry
- Nails/screws
- Bones (fish and chicken)
- Food bolus
- Press-through packages (PTPs)

#### Medical items
- Gauzes
- Catheters
- Surgical gauzes
- Endoscopic clips
- Drainage tubes
- Surgical clips

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Each foreign body was placed in a chest phantom (N1 Lungman, Kyoto Kagaku, Japan) and evaluated by DES radiography.
Case 1: Toy made of PVC

Toys made of PVC are detected more easily on bone images than on conventional radiographs.
Case 2: Toy made of ABS

Toys made of ABS are not detected on either conventional radiographs or bone images.
Case 3: PTP

PTPs are not detected on either conventional radiographs or bone images.
Case 4: Fish bone

Fish bones are not detected on either conventional radiographs or bone images.
Toys made of wood are not detected on either conventional radiographs or bone images.
Case 6: Coin made of Cu and Ni

Coins made of metals are easily detected on both conventional radiographs and bone images.
Case 7: Safety pin and a clip

Safety pins and clips made of metals are easily detected on both conventional radiographs and bone images.
Case 8: Button battery

Button batteries are easily detected on both conventional radiographs and bone images.
Toys made of glass are detected on both conventional radiographs and bone images.
Case 10: Toy made of TPE

Toys made of TPE are barely detected on conventional and DES radiographs.
Case 11: Toy made of ABS with a semiconductor substrate

Toys made of ABS with a semiconductor substrate are more easily detected on bone images than on conventional radiographs.
Toys made of PP are not detected on either conventional radiographs or bone images.

Case 12: Toy made of PP

Conventional radiograph

Bone image

Magnification of bone image
Case 13: Toy made of PS

Toys made of PS are barely detected on conventional and DES radiographs.
Surgical staples are detected more easily on bone images than on conventional radiographs.
Endoscopic clips are detected more easily on bone images than on conventional radiographs.
Case 16: NaI-123 capsule

NaI-123 capsules are barely detected on conventional radiographs, and are not detected on bone images.
Case 16: NaI-123 capsule

NaI-123 capsules are barely detected on soft tissue images.
Case 17: Catheter

Catheters inside the aorta are detected more easily on bone images than on conventional radiographs.
Drainage tubes in the pleural cavity are easily detected on both conventional radiographs and bone images.
Surgical gauzes are easily detected on both conventional radiographs and bone images.
Clinical case 1: Surgical clip

Surgical clips are detected more easily on bone images than on conventional radiographs.
Clinical case 2: Gallstone

Gallstones are detected more easily on bone images than on conventional radiographs.
Foreign bodies in DES radiograph

**Bone image**

Because the mediastinal intensity is low, it can be detected if foreign bodies are visualized even at a low intensity.

However, most foreign bodies visualized on conventional radiographs are also visualized on bone images, and most foreign bodies not visualized on conventional radiographs are also not visualized on bone images.

**Soft tissue image**

The intensity of foreign bodies is often lower on soft tissue images than on conventional radiographs. On the other hand, because the mediastinal intensity is high, it is more difficult to detect foreign bodies on DES radiographs than on conventional radiographs.
Foreign bodies visualized on bone images -common items-

- Foreign bodies with PVC, which is a common resin, are barely visualized on conventional radiographs, but are clearly visualized on bone images.
- Also, foreign bodies with small and thin metals, such as semiconductors, can be detected more clearly on bone images.
Foreign bodies not visualized on either conventional or DES radiographs

- common items -

- PTPs, woods, fish bones
- Foreign bodies made of ABS (most of LEGOs) or PP even if they are large
- Small items made of resins (except for PVC)

Wood   PTP

conventional radiograph

soft tissue image

PP   ABS

bone image
Foreign bodies on bone images -medical items-

- Clips or staples, which are made of small metals, can be detected more clearly on bone images.
- Catheters, tubes or surgical gauzes overlapping with the mediastinum can be detected more clearly on bone images.
- Normal gauzes are not detected on either conventional radiographs or bone images.
Conclusion

DES radiography can add beneficial information regarding detection of foreign bodies.
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