RAD

Development of Smart DSI™ for Detecting Retained Surgical Objects

Medical Systems Division, Shimadzu Corporation
Naomasa Hosomi

1. Introduction

Surgical items such as gauze, suture needles, or forceps are sometimes accidentally left inside the patient's body during invasive procedures. These types of medical incidents are an infrequent but serious problem not only due to the physical risk they pose to the patient, but also the resulting degradation of trust in medical services and the economic damage invited by the medical facility. Medical institutions seek to prevent these incidents by taking counts of surgical items before and after surgery and checking radiographs of the patient taken after surgery. Despite these measures, patients are still at risk of objects being left inside the body due to miscounting of surgical items, objects being overlooked on postoperative radiographs, and a variety of other reasons. Thus, Shimadzu has developed Smart DSI (Detection Support with Image processing), an AI-based software that aids the detection of retained surgical items in postoperative radiographs. This article presents an overview of Smart DSI.

2. Retained Objects

The 15th Report of the Japan Council for Quality Health Care[1)] analyzed surgical incidents involving retained objects and found that, among surgical items such as gauze, suture needles, and forceps, gauze was the most common item left inside patients. The 54th Report of the Japan Council for Quality Health Care[2)] examined medical incidents involving only gauze left inside the body and noted 57 reported incidents between January 2016 and March 2019. Radiography was performed after surgery in 43 of these 57 incidents, and in 24 of these 57 incidents, the gauze count was correct before wound closure and no gauze was discovered in postoperative radiographs. The Japan Council for Quality Health Care has identified five primary reasons why gauze was not identified in these postoperative radiographs: (1) the gauze overlapped with bone, (2) the images were small making the radiographs difficult to examine, (3) the gauze was outside the field of view of the radiographs, (4) attention had been drawn to the drainage tube in

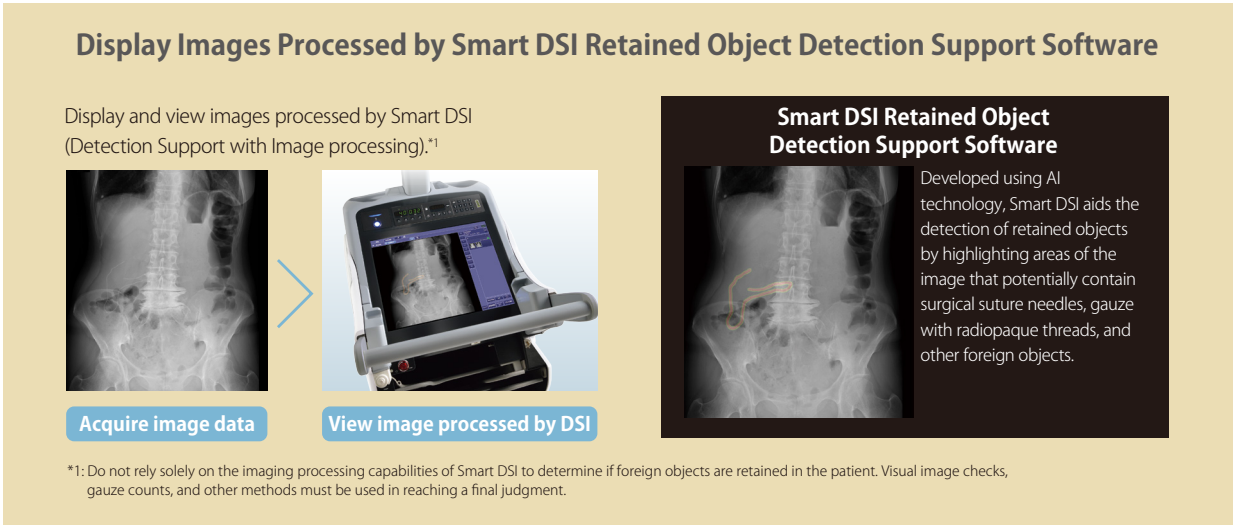

Fig.1 Fig. 1 Smart DSI Retained Object Detection Support Software

the radiograph, and (5) a number of gauze counted was the same as the expected number, leading to radiographs being checked under the assumption no gauze was present. Surgical items left inside the patient may be missed on postoperative radiographs for any of these reasons.
Smart DSI is designed to help prevent retained objects from being missed by highlighting potential surgical items in postoperative radiographs.

3. Smart DSI Retained Object Detection Support Software

Smart DSI is an image processing feature available for the MobileDaRt Evolution MX8 Version c type digital radiographic mobile X-ray system that highlights areas of radiographs that may show surgical items retained in the body.
Smart DSI performs this image processing on the mobile X-ray system and can display highlighted areas on an image around 15 seconds after acquisition of the postoperative radiograph. **Fig. 2** shows the operating screen of the mobile X-ray system. Once the mobile X-ray system has acquired a postoperative radiograph, Smart DSI processes the image and displays highlighted areas in the image on the screen of the mobile X-ray system. Users can inspect images for highlighted areas on the mobile X-ray system screen and even switch between the original radiograph and the processed image. Image processing can also be performed by selecting the Smart DSI image processing button on the operating screen. Whether the postoperative radiograph is automatically sent to Smart DSI or processing must be applied manually depends on the acquisition protocol used by the mobile X-ray system.

4. Smart DSI Features

Smart DSI uses a deep learning model developed with deep neural networks. The deep learning model takes an input image, extracts features from the image that differ from anatomical structures seen in training data, and outputs the extracted information as highlighted areas that potentially correspond with retained objects. The data used to train the model was also enriched through augmentation to better account for variability in patient thickness and the different exposure conditions used by the mobile X-ray system.
Fig. 3 and **Fig. 4** show radiographs processed by Smart DSI with highlighted areas indicating potential retained objects. **Fig. 3** shows a frontal chest radiograph acquired by the mobile X-ray system and the processed image with a highlighted area. **Fig. 4** shows a frontal abdominal radiograph acquired by

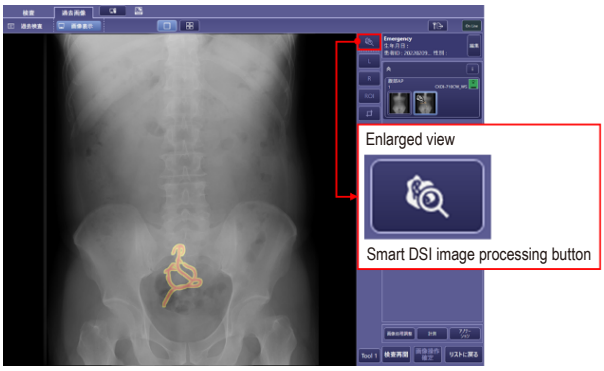

Fig.2 Mobile X-Ray System Operating Screen

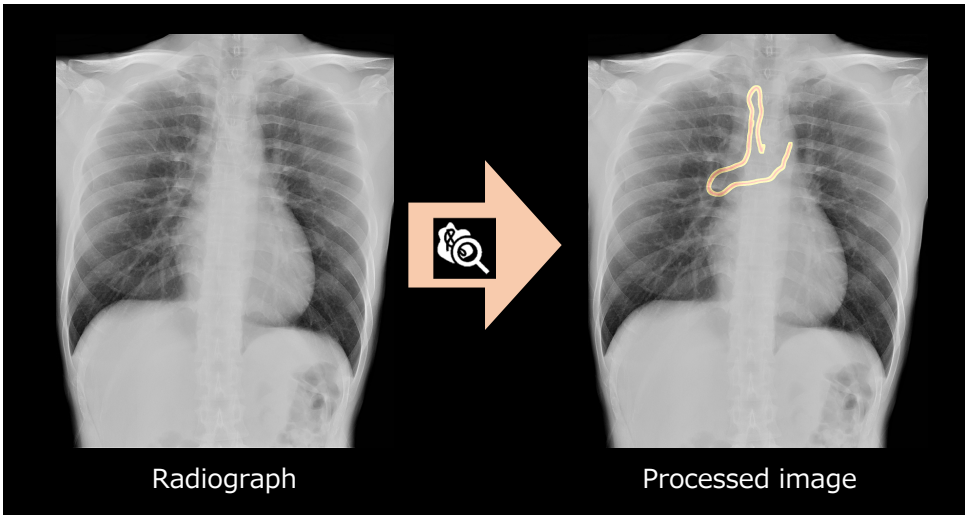

Fig.3 Chest Radiograph and Image Processed by Smart DSI

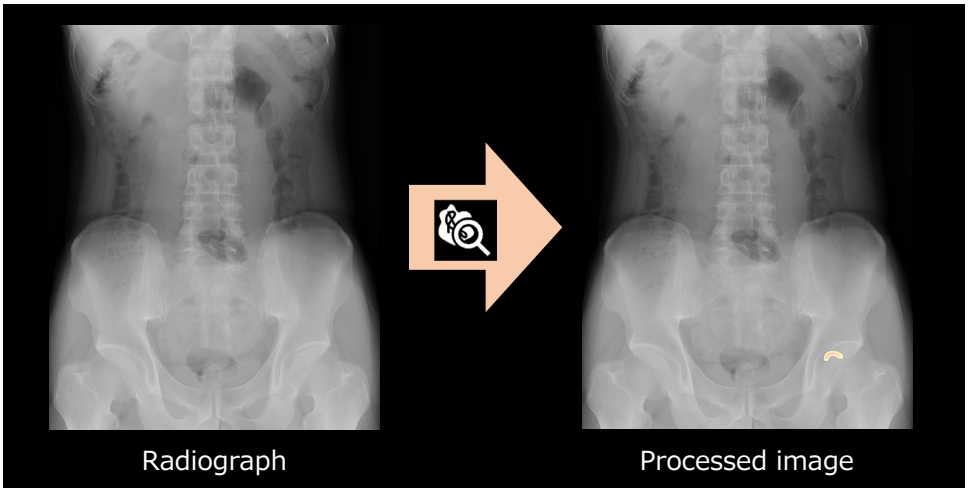

Fig.4 Abdominal Radiograph and Image Processed by Smart DSI

the mobile X-ray system and the processed image with a highlighted area. Thus, Smart DSI aids in the postoperative visual check for retained surgical items by highlighting parts of the radiograph that potentially show a retained object.

5. Conclusion

This article presents Smart DSI, an AI solution that uses deep learning to aid the identification of retained objects in the body, which is now available for the MobileDaRt Evolution MX8 Version c type digital radiographic mobile X-ray system. Shimadzu will continue to develop applications that add value to diagnostic imaging and integrate with mobile X-ray systems. Shimadzu would also like to strive to integrate customer feedback into product development for improved medical safety and more efficient workflows.

References

1) Project to Collect Medical Near-miss/Adverse Event Information—15th Report (December 9, 2008). Division of Adverse Event Prevention, Japan Council for Quality Health Care, https://www.med-safe.jp/pdf/report_15.pdf (Accessed on June 6, 2022)
2) Project to Collect Medical Near-miss/Adverse Event Information—54th Report (October 2018), Division of Adverse Event Prevention, Japan Council for Quality Health Care, https://www.med-safe.jp/pdf/report_54.pdf (Accessed on June 6, 2022)

Note: The AI (artificial intelligence) technology used in Smart DSI is not a self-guided iterative learning-type AI.