The Reduction of Metal Artifacts in Thorac and Neck Regions in Ct Scan

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Abstract

Introduction: CT scan is a very important image modality for examining the patient due to information we receive from it in a very short time. Receiving high quality images is challenging but the evolution of the CT scan has helped the radiology technician a lot. In this article we are going to focus on metal reduction artifacts. In polytrauma hospitals, when orthopedic, neurosurgical, and surgical clinics are mostly *with patients that have implant on them, having tools to reduce the artefacts from metals is crucial to not miss anything in regions around.*

Aims and Objectives: The aim of this article is to show the effectiveness of I-MAR as an important tool to use in patients with implant on, especially in thorax and neck regions.

Material and methods: In this article we are showing 2 study case images from 2 patients received from our CT scan in radiology department of University Trauma Hospital. Siemens CT go. Top is a 128-slice scan with two beam sources.

Conclusion: After comparing the raw dates images and images with I-MAR on, we concluded that I-MAR is a very useful algorithm to reduce artifacts. By using it we can receive more information about soft tissues around implant and the regions nearby affected by artefacts. Using this algorithm helps the technician receive a better-quality image.

Key words: *I-MAR, artefacts, implants, patient, better quality*

Introduction

The advance of technology has been a great success to archive different things in different fields benefiting humankind. Even in Medicine the impact of technology is tremendous which results in better health care service for patients. In radiology through years has been a great evolution regarding the machine we use in.

The discovery of CT scan by engineer GodFrey Hounfield has been one of the greatest evolutions that radiology ever had. Being able to receive an image from a different angle has truly changed the way a patient can be diagnosed through the image we receive. The importance of receiving a quality image has always been a goal. There are several ways to do it.

Receiving an image from CT scan is a procedure requiring putting the patient in correct position and choose the right protocol but this is not all it takes to receive a high quality image.

So, this is what's challenging for radiology technicians nowadays: processing the image to have a final high-quality image. In this article we are focusing on the importance of IMAR to reduce metal artefacts because we will have seen them a lot in images in the future.

High density and high atomic metal implants cause dark and bright streaking artefacts to lead to the loss of information.

Any loss of information can lead to missing a diagnosis. That's why is important to take high quality image. According to Do et al. 2018 there are several ways to reduce metal artifacts as follows:

1. Detector collimation and pitch should be decreased, on the other hand voltage and mAs should be increased. This "trick" might overcome photon starvation and beam hardening, but we should find a balance between the quality of the image and the dose that patient take-ALARA principle. Also increasing voltage means decreasing soft tissue contrast.
2. Anti-scatter grid that every CT scan has nowadays. Scatter grids are parallel (one-dimensional) or crossed lamellas (two-dimensional) positioned between the individual detectors to absorb the scattered photons.[4] This equipment helps in reducing artefacts.
3. Post processing is very important. The splay artifacts become worse when the reconstructed slice thickness becomes thinner. When the slice thickness is twice or greater than the width of the detector elements, the splay artifacts are decreased by thicker slice reconstruction and are essentially eliminated. If the slice thickness is 1 to 2 mm is a possible agreement between partial volume effect and artifact reduction. This thickness applies to larger anatomical regions. Increasing slice thickness is not recommended, for articular surfaces that require a high resolution like the wrist or ankle.[4]
4. Furthermore, to conventional iterative reconstruction algorithms, there are particular post-processing algorithms centered on minimizing metal artifacts like O-MAR (Philips), iMAR (Siemens) and MAR (GE), which are also known as projection-based artifact correction. Their common principle is based on a combination of corrected iterative data and raw data. The metal implant is removed from the original image by multi-threshold metal segmentation. Linear interpolation is executed on the sinogram and the in painted sinogram is combined with the original data to create the corrected image. To decrease blurring of the adjacent anatomic structures, this filtering and mixing step is performed repeatedly.

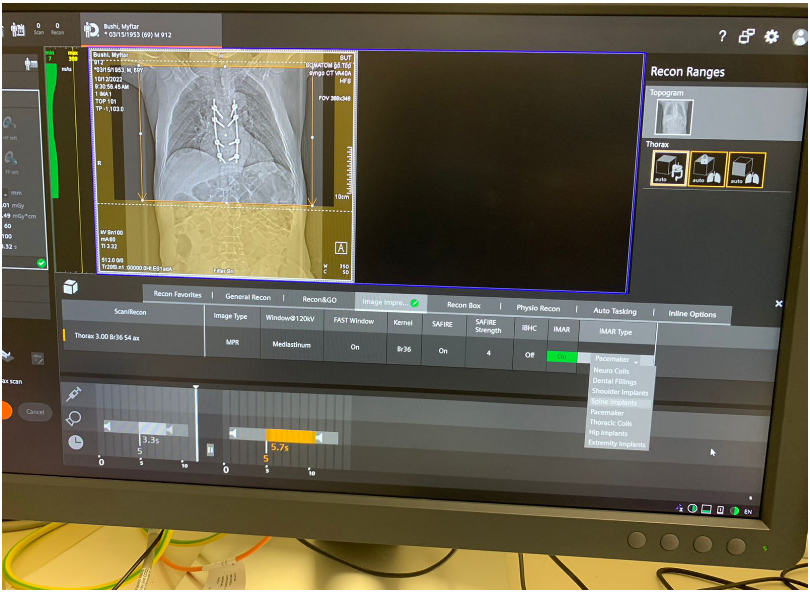
The iterative frequency split-normalized algorithm has been shown to upgrade the visibility of tissues adjacent to and distant from the implant. This algorithm is superior in comparison to conventional reconstruction with filtered back projection and metal artifact reduction with linear interpolation in hip prostheses and the spine implants.[4]

Patient 1: Thorax CT-Scan from neurosurgical clinic

Table 1: I-MAR applied thorax protocol

Protocol	Thorax– helical
Patient position	Supine head first

Area coverage	2cm superior the shoulder- upper abdominal region
Respiratory phase	Inspiration
Scan direction	Caudalcranial
Gantry angle	0
Slice thickness	5 mm
Increment	5 mm
Kv	120
Resolution	Standard
Collimation	64*0.625
Rotation time	0.75 s
FOV	512 mm
Enhancement	0.0
Recon (IRS)	Plain phase 2 mm/1 mm
Reconstruction	Axial, coronal, and sagittal
O-MAR	Selected – 5 mm thickness
Pitch	0.984
Matrix	512*512



The doctor requested a Chest CT scan for his patient. The radiology technician chose the protocol for chest and after the scanogram was taken, it noticed a spine implant. The technician activated IMAR- on-Spine implant to reduce the metal artefacts. In the image below we can compare the quality of image with and without IMAR.

FIG. A: raw data of the chest

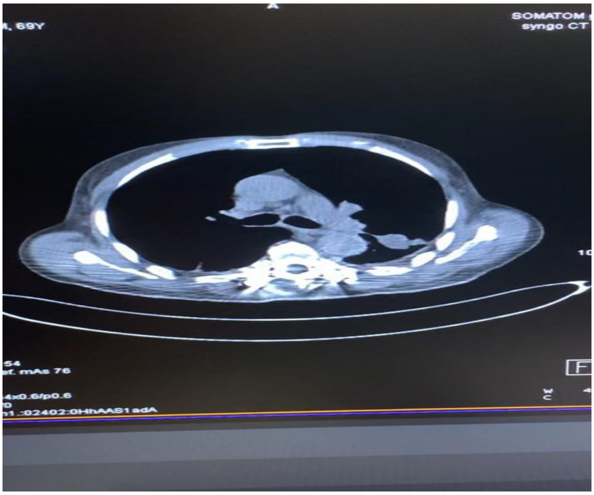


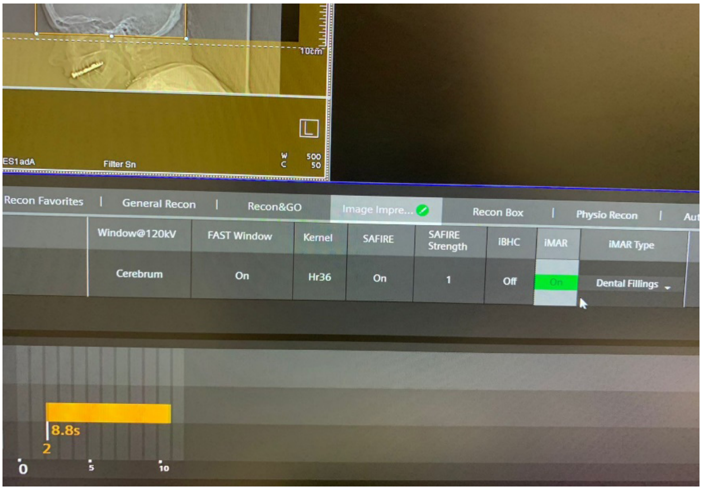
FIG. B: processed image with IMAR ON)

Patient 2. Neck CT scan

TABLE 2: i-mar applied neck protocol

Protocol	NECK– helical
Patient position	Supine head first
Area coverage	1 cm superior to skull vertex - middle T1

Scan direction	Cranial-caudal
Gantry angle	0
Slice thickness	5 mm
Increment	5 mm
Kv	120
Resolution	Standard
Collimation	64*0.625
Rotation time	0.75 s
FOV	200 mm
Enhancement	0.0
Recon (IRS)	Plain phase 2 mm/1 mm
Reconstruction	Axial, coronal, and sagittal
O-MAR	Selected – 5 mm thickness
Pitch	0.984



The doctor requested head and neck for the patient. After the scanogram, it is noticed dental filling. The radiology technician activated IMAR on, and the result of image was the reduction of dental filling artefacts especially in neck region.

FIG. A: Raw data image

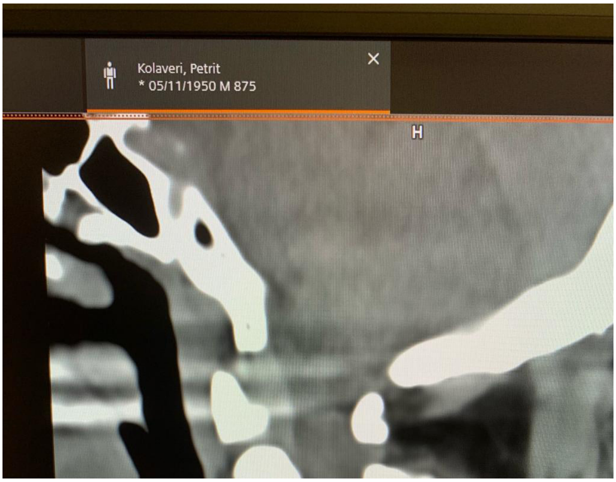
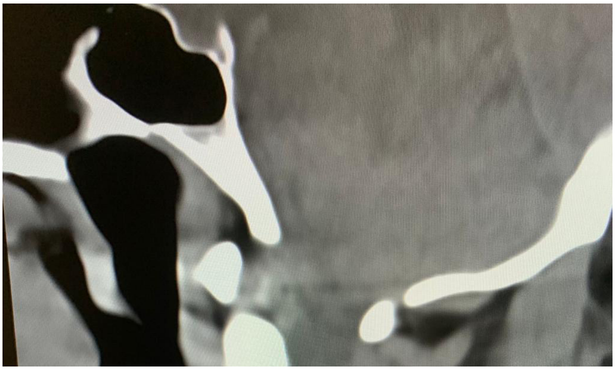


FIG. B: IMAR on images



In polytrauma patient this area is very important for any fracture of C-spine and damage of medulla spina)

As is seen in these two comparing images the reduction of dental filling is considerable due to IMAR tool.

To conclude

The advance of technology has been a great advantage for radiology to take better quality image from patients. The use of I-MAR algorithm significantly reduces the artefacts of metal. It is recommended to use it every time that radiology technician sees a metal implant in scanogram of patient.

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