Implementation of Whole Body Bone SPECT/CT imaging

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Introduction

Due to its ability to evaluate the entire skeleton at a relatively low-cost Whole Body Bone scintigraphy is widely used to exclude or confirm bone metastases in oncological context. This technique has been proved to have a high sensitivity in the detection of metastasis however, it presents a low specificity as any sites with increased bone turnover such as osteoarthritis, fractures or infection result in false positive scintigraphic findings that require additional radiological imaging for oncology patients. (Gates, 1998; Solomayer *et al*., 2000)

Studies have shown that complementing Whole Body Planar Imaging (WBP) with SPECT/CT (Single Photon Emission Tomography combined with Computed Tomography) improves the specificity and positive predictive value as well as diagnostic confidence of the reporter, reducing the number of equivocal reports. (Utsunomiya *et al*, 2006; Strobel *et al*, 2007; Römer, 2006; Helyar *et al.*, 2010; Palmedo *et al.*, 2014)

This work aims to show our experience, the challenges and the lessons learnt throughout the introduction of Whole body SPECT/CT imaging in the context of bone scintigraphy.

Methods

18 patients were scanned with Whole Body Planar Imaging followed by Whole Body SPECT/CT Imaging as instructed by ARSAC Certificate holder, in a single session using a hybrid gamma camera equipped with a 16 slice CT scanner (GE™ Discover 870 DR).

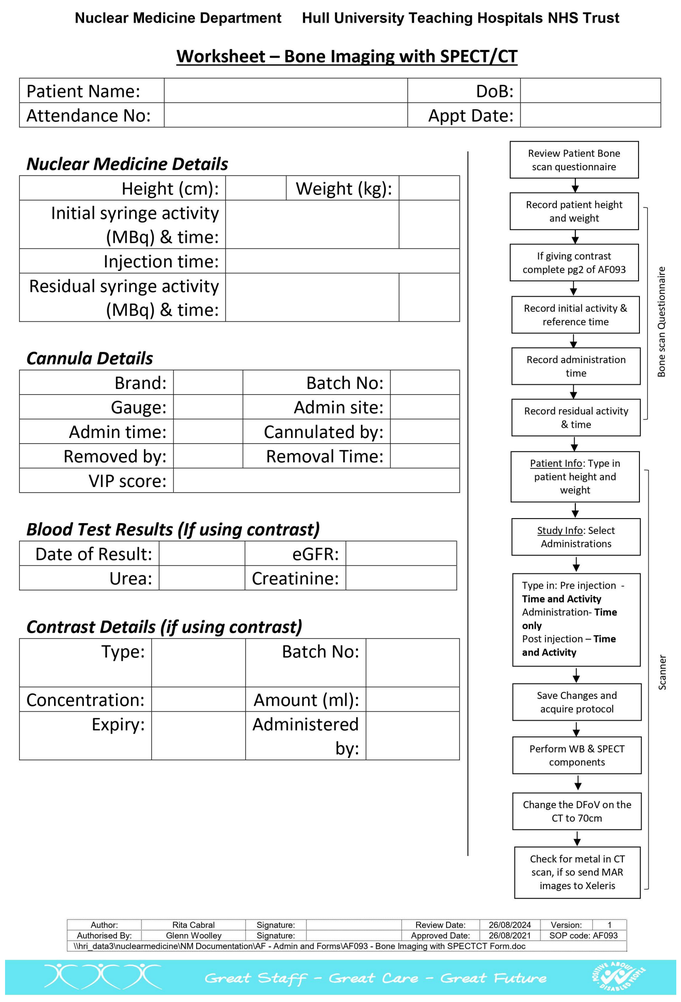
- Anterior and Posterior views covering the full skeleton, patient positioned supine, were acquired 3-5 hrs post administration of [^{99m}Tc]Tc-HDP (mean activity 776MBq) using Low Energy High Resolution Sensitivity Collimators (LEHRS), scan speed 16.6cm/min (approximate scan time 13 min);
- Planar images were reconstructed using GE™ Clarity 2D (40% blend);
- Whole Body SPECT/CT was performed without removing the patient of the bed covering 3 FoV from vertex to mid-thigh. (LEHRS collimators, 128x128 matrix, 120x10s/projection over 360° - Approximate scan time 40 min);
- Low dose CT for attenuation correction was acquired to cover SPECT length;
- Attenuation correction (AC) and resolution recovery (RR) were performed using GE Evolution for Bone™ software;
- Quantification was performed on 6 patients using GE™ Evolution for Bone package– See image 1 for details and steps required.

Table 1: CT ACQUISITION PARAMETERS

	AC	AC LOW DOSE
Type	Helical	Helical
Rotation Time	0.5	0.5
Rotation Length	Full	Full
MAR Mode	Off	Off
Rows	16	16
Thickness	2.5	2.5
Pitch	0.938:1	0.938:1
Speed (mm/rot)	9.37	9.37
Collimation	10	10
Interval (mm)	2.5	2.5
kV	120	140
SmartmA	Yes	Yes
Noise Index	50	185
MinmA	20	10
MaxmA	200	100
CTDIvol (mGy)	0.79	0.79
Anatomical Reference	NM	NM

Table 2 : CT RECONSTRUCTION PARAMETERS

Series Description	ACL 2.5mm	Bone 2.5mm	MAR ENABLED Bone 2.5mm
Interval (mm)	2.5	2.5	2.5
DFOV (cm)	50	D	D
R/L Center (mm)	R0.0	D	D
A/P Center (mm)	A0.0	D	D
Recon Type/Filter	Q.AC	Bone	Bone
Matrix	512	512	512
Recon Mode	Plus	Plus	Plus
IQEnhance	No	No	No
MAR	No	No	Yes
Window Width	400	2000	2000
Window Level	40	500	500
ASIR	SS40:Slice	SS40:Slice	SS40:Slice



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Worksheet – Bone Imaging with SPECT/CT

Patient Name:		DoB:	
Attendance No:		Appt Date:	

Nuclear Medicine Details

Height (cm):		Weight (kg):	
Initial syringe activity (MBq) & time:			
Injection time:			
Residual syringe activity (MBq) & time:			

Cannula Details

Brand:		Batch No:	
Gauge:		Admin site:	
Admin time:		Cannulated by:	
Removed by:		Removal Time:	
VIP score:			

Blood Test Results (If using contrast)

Date of Result:		eGFR:	
Urea:		Creatinine:	

Contrast Details (if using contrast)

Type:		Batch No:	
Concentration:		Amount (ml):	
Expiry:		Administered by:	

Review Patient Bone scan questionnaire
Record patient height and weight
If giving contrast complete pg2 of AF093
Record initial activity & reference time
Record administration time
Record residual activity & time
Bone scan Questionnaire
Patient Info: Type in patient height and weight
Study Info: Select Administrations
Type in: Pre injection - **Time and Activity** Administration- **Time only** Post injection – **Time and Activity**
Save Changes and acquire protocol
Perform WB & SPECT components
Change the DFoV on the CT to 70cm
Check for metal in CT scan, if so send MAR images to Xeleris
Scanner

Author:	Rita Cabral	Signature:		Review Date:	26/08/2024	Version:	1
Authorised By:	Glenn Woolley	Signature:		Approved Date:	26/08/2021	SOP code: AF093	

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Great Staff - Great Care - Great Future

Image 1. Worksheet – Bone Imaging with SPECT/CT

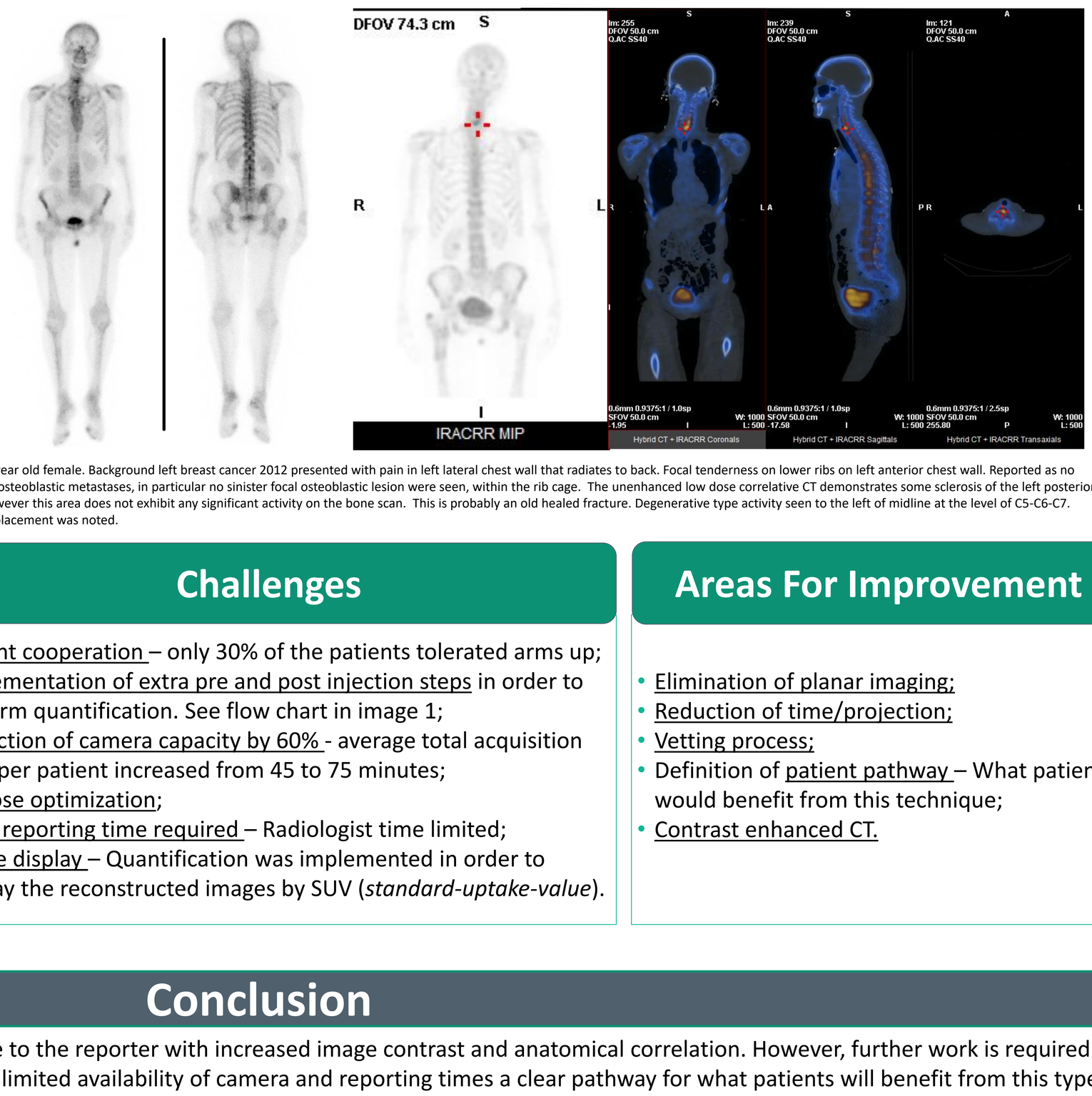


Image 2. 61year old female. Background left breast cancer 2012 presented with pain in left lateral chest wall that radiates to back. Focal tenderness on lower ribs on left anterior chest wall. Reported as no evidence of osteoblastic metastases, in particular no sinister focal osteoblastic lesion were seen, within the rib cage. The unenhanced low dose correlative CT demonstrates some sclerosis of the left posterior 11th rib, however this area does not exhibit any significant activity on the bone scan. This is probably an old healed fracture. Degenerative type activity seen to the left of midline at the level of C5-C6-C7. Right hip replacement was noted.

Challenges

- Patient cooperation – only 30% of the patients tolerated arms up;
- Implementation of extra pre and post injection steps in order to perform quantification. See flow chart in image 1;
- Reduction of camera capacity by 60% - average total acquisition time per patient increased from 45 to 75 minutes;
- CT dose optimization;
- Extra reporting time required – Radiologist time limited;
- Image display – Quantification was implemented in order to display the reconstructed images by SUV (*standard-uptake-value*).

Areas For Improvement

- Elimination of planar imaging;
- Reduction of time/projection;
- Vetting process;
- Definition of patient pathway – What patients would benefit from this technique;
- Contrast enhanced CT.

Conclusion

The introduction of WB SPECT/CT imaging added confidence to the reporter with increased image contrast and anatomical correlation. However, further work is required to optimise bone quantification and image display. Due to the limited availability of camera and reporting times a clear pathway for what patients will benefit from this type of imaging stands to be defined.

Remarkable people. Extraordinary place.

"In relation to this presentation, I declare that there are no conflicts of interest"

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