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Reader confidence in lesion detection and lesion characterization with xSPECT Bone

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INTRODUCTION

The recently introduced xSPECT Bone* (xB) incorporates tissue boundary delineation from a CT for bone SPECT imaging with Tc99m Di-phosphates. In this work we compare confidence in image interpretation between Flash 3D (F3D, OSEM3D) and a representative prototype of xB. Other aspects of the research are underway.

METHODS

- ❑ 9 physicians read 76 anonymized scans
- ❑ Reconstructed with either F3D with clinically used parameters or xB with optimized parameters, displayed as either F3D, xB, F3D/CT, xB/CT in fully randomized sessions
- ❑ The readers evaluated image quality (noise, resolution, artifacts, overall acceptance) using a 5-point scale
- ❑ The readers assessed 3 VOIs placed on 3 bones for each patient. The VOIs were selected by a physician, who was not part of the reader group, and included normal bones, as well as bones with malignant or benign lesions.
- ❑ For each VOI, readers answered two questions with a five-point scale rating:
  - ❑ Question 1: Is a lesion present?
  - ❑ Question 2: Is the lesion benign or malignant?
- ❑ Analysis method:
  - ❑ Global image quality: mean difference of ratings
  - ❑ Correlation: Pearson's chi square with Yates correction χ^2_{Yates}
  - ❑ Confidence likelihood ratio $R_C = (H_{xB}/L_{xB})/(H_{F3D}/L_{F3D})$

    H, when the lesion was clearly positive or negative (2,-2)

    L, when the lesion was equivocal (-1,0,1)

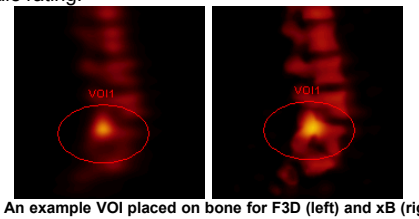

Fig 1. An example VOI placed on bone for F3D (left) and xB (right). Data courtesy of Johns Hopkins University, Baltimore, Maryland, USA.

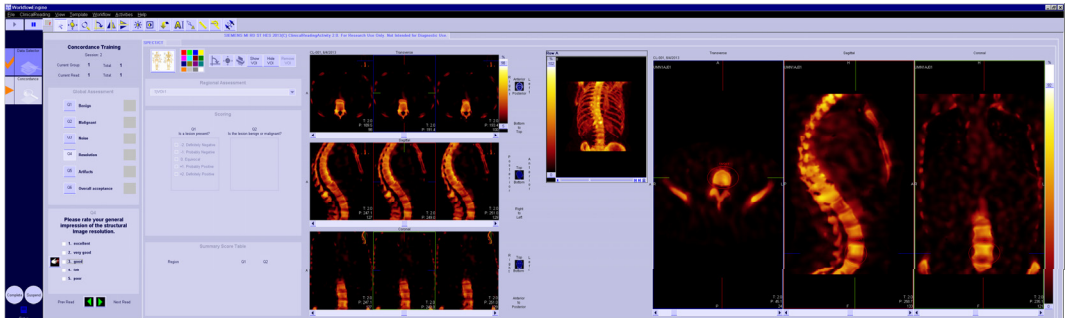

Fig 2. The user interface of clinical evaluation software. Data courtesy of University of Minnesota, Minneapolis, Minnesota, USA.

RESULTS AND ANALYSIS

Ratings of global image quality. Smaller score value meaning better results.

	F3D	xB	xB-F3D	Std. Error	F3D/CT	xB/CT	xB/CT-F3D/CT	Std. Error	Conclusion
Background noise	2.220	1.936	-0.285	0.045	2.042	1.797	-0.246	0.0464	xB better, p < 0.001
Structure resolution	3.488	1.718	-1.771	0.049	3.181	1.502	-1.680	0.0517	xB better, p < 0.001
Artifacts severity	2.466	2.105	-0.358	0.057	2.107	1.878	-0.230	0.0531	xB better, p < 0.001
Overall acceptance	2.630	1.725	-0.905	0.054	2.408	1.538	-0.870	0.0533	xB better, p < 0.001

Lesion-based correlation analysis and confidence likelihood ratio

Q1 Lesion Detection	without CT			with CT		
	xB high	xB low	total	xB high	xB low	total
F3D High	1103	141	1244	1290	135	1425
F3D Low	303	505	808	215	412	627
Total	1406	646	2052	1505	547	2052

Q2 Lesion Classification	without CT			with CT		
	xB high	xB low	total	xB high	xB low	total
F3D High	156	79	235	706	157	863
F3D Low	392	963	1355	270	509	779
Total	548	1042	1590	976	666	1642

Statistical analysis	CT	Q1 Lesion Detection			Q2 Lesion Classification		
		value	p value	Conclusion	value	p value	Conclusion
Correlation: χ^2_{Yates}	w/o CT	594.5	p < 0.001	Correlation high	124.4	p < 0.001	Correlation high
	w/ CT	704.3	p < 0.001	Correlation high	377.5	p < 0.001	Correlation high
Confidence likelihood ratio R_C	w/o CT	1.41x	p < 0.001	Confidence increased 41%	3.03x	p < 0.001	Confidence increased three folds
	w/ CT	1.21x	p < 0.01	Confidence increased 21%	1.32x	p < 0.001	Confidence increased 32%
Note	$\chi^2_{Yates}(0.001, 1) = 10.83$, Calculation of R_C example (548/1042) / (235/1355) = 3.03x						

CONCLUSION

Based on five-point scale image quality ratings, the xSPECT Bone (xB) resolution is improved by almost two points and overall acceptance is improved by one point compared to F3D (Table 1). The confidence level to characterize the lesion is significantly higher (3.03x w/o CT, 1.32x w/CT) with xB than with F3D (Table 2). In lesion detection and classification, there is high correlation between xB and F3D scores, but lesion detection confidence is increased by 41% w/o CT, and 21% w/ CT when using xB as compared to F3D (Table 3).

REFERENCES

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3. J. Ma, A. H. Vija, M. Bhattacharya and D. Spence, "A reconstruction parameter optimization scheme based on human observations", SNM Annual Meeting Abstracts 2013 54:2057

* xSPECT Bone is not commercially available in all countries. Due to regulatory reasons its future availability cannot be guaranteed. Please contact your local Siemens organization for further details.