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LETTER TO THE EDITORS

Visualization and ablation of the autonomic nervous system corresponding to ganglionated plexi guided by D-SPECT ^{123}I-*m*IBG imaging in patient with paroxysmal atrial fibrillation

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Sirs:

A 56-year-old woman with a history of documented, drug-resistant, paroxysmal atrial fibrillation (AF) was referred for radiofrequency catheter ablation. She reported palpitations, fatigue and dyspnea, beginning 7 years previously. Despite treatment with propafenone and amiodarone, the AF episodes became more frequent. On admission to our center, an electrocardiogram showed normal sinus rhythm with heart rate of 72 bpm. Echocardiography revealed a moderately enlarged left atrium (5.1 cm) with normal left ventricular ejection fraction. The TEE and cardiac catheterization were normal. After signing informed consent the patient underwent D-SPECT^{TM} SUMO image acquisition at 4 h after injection of ^{123}I-*m*IBG.

Hybrid images were generated by combining a previously acquired multi-slice computed tomography (CT) and the D-SPECT^{TM} SUMO raw data to generate a parametric representation of the cardiac chambers. D-SPECT^{TM} data were reconstructed with 2.46 mm pixels and processed by defining the endocardial contours using an edge detection algorithm and an approximated minimal error linear model.

The epicardial tissue was defined arbitrarily as the virtual space surrounding the epicardial contour of each cardiac chamber with a thickness of 20 mm from the end-diastolic relevant epicardial contour. SUMO processing applied a spatial search algorithm to seek epicardially located discrete uptake areas (DUA) in the left atrium (LA). Specific activity (corrected for volume) from each DUA was measured, as well as the mediastinal specific activity (corrected for volume), to describe the ratio between DUA and the mediastinum.

The patient had four DUA located in the LA and one in the left ventricle (Fig. 1a, c), with the estimated distance to the LA epicardial boarder ranging from 0 to 3.7 mm. The DUA activity ranged from 722 to 1545 photons/s/ml with a mean DUA to mediastinum ratio of 2.97 (range 2.1–4.6).

3D reconstruction of the LA was performed using an electroanatomical mapping system (CARTO^{TM}, Biosense Webster, Diamond Bar, CA, USA) and merged with the SUMO image, providing a reference of increased sympathetic activity on the CARTO map. High frequency stimulation (HFS) was applied to the SUMO identified DUA locations and the response to HFS was documented prior to ablation. Ablation was only performed at DUA sites where there was a positive HFS response (previously demonstrated to correspond to GP locations) [1, 2]. During radiofrequency energy delivery to these locations target sites a positive vagal response was seen. Up to five lesions were applied in each DUA area at 42 °C, 35 W, 17 ml/min for 40 s (Stockert, Biosense Webster) [2] (Fig. 1b, d). Following ablation there was no response to HFS at these sites. No pulmonary vein isolation was performed. At the end of the procedure a cardiac monitor (ICM) for continuous rhythm assessment was implanted.

The patient underwent repeat SUMO ^{123}I-*m*IBG imaging at 6 days and 6 months after the ablation procedure. The follow-up SUMO images demonstrated no DUA in the left atrium; with one DUA visualized in left ventricle as on the previous baseline images (Fig. 2). The patient has stable sinus rhythm based on 6 month follow-up ICM data with no antiarrhythmic drug therapy. The AF burden was 0 %.

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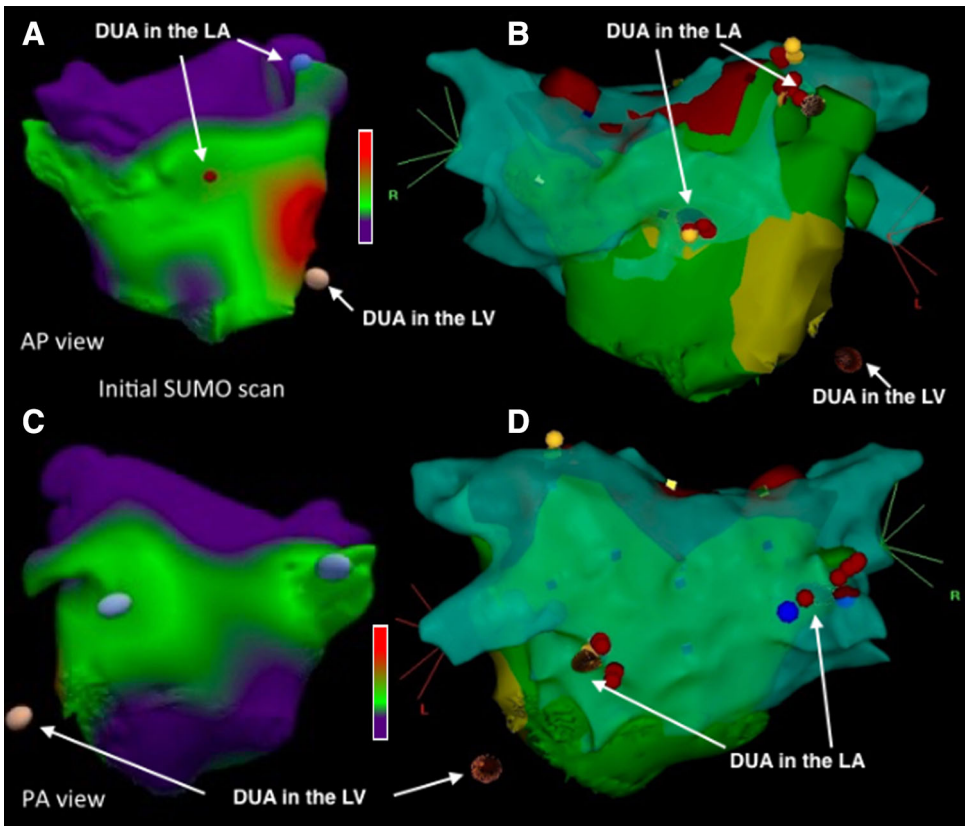

Fig. 1 Baseline SUMO scans with 3D reconstruction of the left atrium during ablation procedure. **a**, **c** SUMO scan with DUA in the left atrium and left ventricle; **b**, **d** 3D reconstruction of the LA and merging with SUMO scans. *Brown dots* DUA, *red dots* ablation points, *yellow* and *blue dots* positive HFS response; **a**, **b** anterior wall of the LA; **c**, **d** posterior wall of the LA

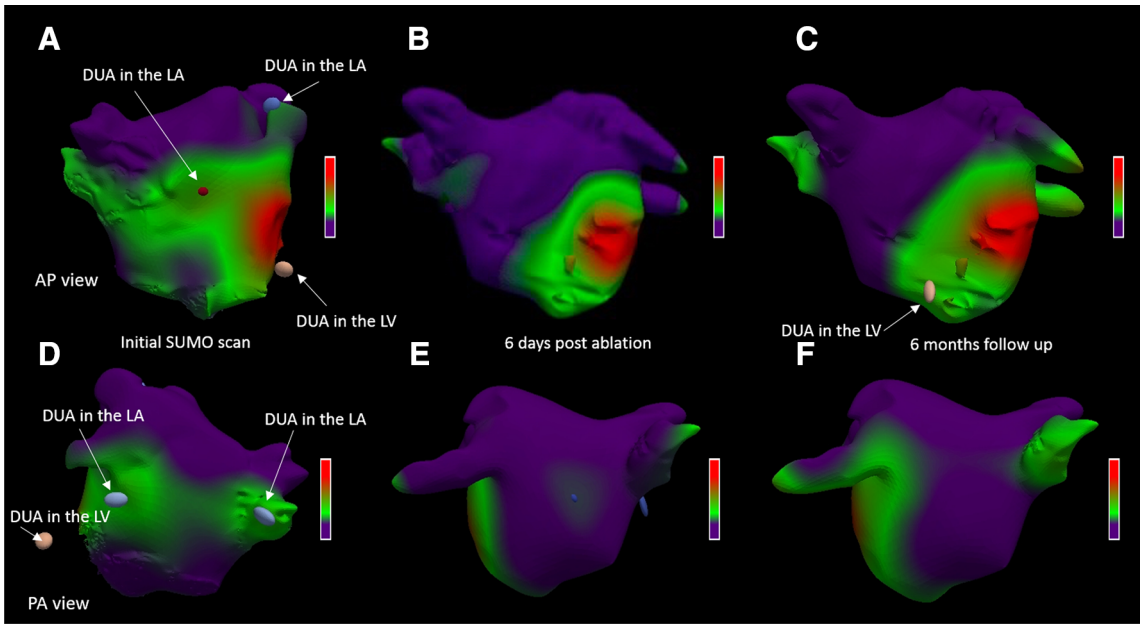

Fig. 2 The baseline, 6 days and 6 month follow-up SUMO images. **a**, **d** Baseline SUMO scans; **b**, **e** 6 days SUMO scans; **c**, **f** 6 month FU scans; **a–c** anterior wall of the LA; **d–f** posterior wall of the LA

A novel non-invasive image processing technique, referred to as SUMO, has been developed which uses the D-SPECT^{TM} (Spectrum Dynamics Medical Ltd., Caesarea, Israel) CZT cardiac SPECT imaging system and utilizes the radiopharmaceutical Iodine-123 *Meta*-iodobenzylguanidine (^{123}I-*m*IBG, an analogon for

norepinephrine) to provide anatomical quantification of autonomic nervous system structures that previously have not been able to be visualized [3]. Processed SUMO data can be imported to a 3D cardiac electroanatomical mapping system where the images of atrial cardiac innervation may be used to guide catheter ablation procedures through identification of target sites. The autonomic nervous system (ANS) plays an important role in initiation and maintenance of AF [1, 4–6]. Existing ablation techniques for ANS modulation have several disadvantages. One of them is the difficulty in precisely locating the ANS structures which correspond to ganglionated plexi in a particular patient. The targeted ablation of DUA, imaged using D-SPECT^{TM} SUMO and ^{123}I-*m*IBG and verified by a positive response to HFS (as an indication of GP locations), may potentially increase the efficacy of the ablation procedure without touching the viable myocardium. This current case demonstrates a novel technique based on D-SPECT^{TM} SUMO technology for the localization of DUA of ^{123}I-*m*IBG in the left atrium, thought to correspond to GP, in a patient with paroxysmal AF. The DUA locations in the left atrium were confirmed by HFS and successfully ablated. No left atrial DUA were detected at 6 month follow-up and the patient was in sinus rhythm verified by ICM data.

Compliance with ethical standards

Conflict of interest Christopher Breault is an employee of Spectrum Dynamics. Other authors: no conflict of interest.

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