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Electroanatomical mapping assisted conduction system pacing

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Conduction system pacing has gained significant momentum in the last few years. Chronic right ventricular (RV) pacing may lead to electrical and mechanical dyssynchrony resulting in left ventricular (LV) dysfunction, atrial arrhythmias and heart failure hospitalization [1,2]. Direct capture of His-purkinje system has been suggested as an alternative to overcome the limitations of RV pacing. His bundle pacing (HBP) involves deploying the lead in the membranous septum to capture the HB, while left bundle branch pacing (LBBP) involves positioning the lead deep inside the proximal interventricular septum to capture the broad fan of LBB fibers on the LV subendocardium [3]. Several studies have shown the feasibility, safety and efficacy of LBBP as an alternative to RV pacing in patients requiring pacing for symptomatic bradyarrhythmia [4,5]. As it can correct the bundle branch block by pacing distal to site of the block, the current interest is to evaluate the efficacy of conduction system pacing as an alternative modality for cardiac resynchronization therapy (CRT) eligible patients.

LBBP is performed by deploying the pacing lead deep inside the proximal septum 1–1.5 cm below the distal his signals along an imaginary line connecting distal HB to the RV apex. Pacing at the target site from the right side of septum will produce 'W' pattern in lead-V1, tall R-wave in lead-II along with discordant QRS complexes in lead-aVR and aVL [3]. Pacing lead can be deployed gradually with careful monitoring of paced QRS morphology and unipolar pacing impedance or by rapid rotations until a premature ventricular complex (PVC) with right bundle branch delay (RBBD) pattern (template/fixation beat) is noted [6,7]. PVC guided approach will help in safe positioning of the lead in the LBB area, reducing the fluoroscopy time and myocardial injury. Septal perforation [8] during lead deployment is considered as a major concern. Perforation can be identified by unipolar pacing impedance of <450 Ω, sudden drop in current of injury and unfiltered unipolar electrograms showing QS or RS pattern. Once identified septal perforation has to be treated immediately by repositioning the lead at a new site rather than just withdrawing it back into the septum.

Electroanatomical mapping helps in creating the geometry of the right atrium, tricuspid annulus, basal interventricular septum and identifying His bundle signals. This will help in deploying the pacing lead in the distal his bundle or in the deep septum 1–1.5 cm below the HB to capture the left bundle. Electroanatomical mapping (EAM) helps in reducing the fluoroscopy time and radiation dose in patients undergoing conduction system pacing [9]. Coluccia et al. proposed a zero-fluoroscopy approach for performing LBBP using EAM for reducing ionizing radiation in adult patients [10]. In the present study Jimenez et al. [11] demonstrated the feasibility of low-fluoroscopy approach based on electroanatomical mapping for performing conduction system pacing in pediatric populations and compared it with conventional approach. A total of 20 patients between the age-group of 8–39 years were included. Ten patients underwent minimal 3D guided conduction system pacing and 10 patients (3 of them underwent LBBP) via standard technique. Mean procedural time though longer were similar in both the groups. Fluoroscopy duration, radiation dose and DAP were significantly reduced by utilizing electroanatomical mapping. No complications were noted in either group.

Radiation exposure has been considered as the major concern in all interventional cardiology procedures and it has increased 6-fold over the last 20 years, accounting for a mean effective dose (ED) of 3.0mSV per head per year [12]. Cardiologists are responsible for 85% of the nuclear medicine exposure [13,14]. The radiation ED for VVI or DDD pacemaker implantation ranges between 1.4 and 1.7mV [15,16]. Operators are at risk of excessive scatter exposure as shielding will be difficult to achieve during device implantation than during ablation. Apart from lead aprons, lead gloves, collimation, frame-rate reduction and optimizing the projection angle, electroanatomical mapping will help in reducing the radiation exposure. A perfect geometry of the cardiac chambers along with localization of His bundle signals will ease out lead deployment procedure during conduction system pacing. In the presence of congenital heart disease, 3D mapping will help in delineating the anatomical variation and facilitate lead deployment. Intracardiac echocardiography (ICE) can also be used as a valuable tool to guide conduction system pacing [17]. Age of the study population, smaller cardiac dimension, associated structural heart disease and early part of the learning curve could explain the prolonged procedural time and fluoroscopy duration in the current study. With refinements in the technique, availability of better tools and further gain in experience, we can expect significant reduction in the radiation dose along with increase in procedural success rate. Further randomized trials are necessary to establish the cost-effectiveness and superiority of electroanatomical mapping guided conduction system pacing over standard approach in selected population.

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Declaration of competing interest

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