CONDUCTION SYSTEM PACING USING INTRACARDIAC ECHOCARDIOGRAPHY GUIDANCE – A CASE REPORT

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Abstract.

Conduction system pacing (CSP) is a pacing technique involving the implantation of permanent pacing leads at different sites along the cardiac conduction system and includes His bundle pacing (HBP) and left bundle branch area pacing (LBBAP). Intracardiac echocardiography (ICE) might facilitate the implantation of the permanent pacing lead in the left bundle branch (LBB) area of the interventricular septum. We report a case of an 83-year-old patient presenting with right bundle branch block (RBBB), left anterior fascicular block (LAFB), and dizzy spells during episodes of 2:1 atrioventricular (AV) block who underwent CSP with ICE guidance at our center. Apart from standard fluoroscopic guidance and monitoring of intracardiac signals, ICE was also used to monitor lead advancement in the septum during the implantation. The
Conduction system pacing (CSP) is a technique of pacing that involves the implantation of permanent pacing leads along different sites of the cardiac conduction system by pacing at the level of His bundle or its major branches or their further ramifications including distal Purkinje fibers. Recently left bundle branch area pacing (LBBAP) was introduced and accepted widely as it provides more stable pacing parameters. Mafi-Rad et al. demonstrated the feasibility of permanent left ventricular septal pacing (LVSP) via the ventricular transseptal approach in a first-in-human study [1]. Huang et al. modified this technique and demonstrated that direct pacing of the proximal part of the left bundle branch can be acquired and accomplished using the transseptal route [2]. Conventional stylet-driven and lumenless leads could be used as CSP lead and stylet-driven leads offer higher LBBAP lead implantation success rates while shortening implant duration [3]. Regardless of the type of permanent lead that is used for CSP, multiple screw-in attempts under fluoroscopy are often needed to place the pacing lead tip near or at the left bundle branch (LBB) [4]. Because of that, intracardiac echography (ICE) guidance could be helpful for better lead placement [5, 6]. One of the most valuable advantages of ICE is the ability to assess the proximity of lead helix to the LV endocardium and detect septal perforation early.

**Case Description**

We report the case of an 83-year-old male patient with 2:1 AV block, right bundle branch block (RBBB), and left anterior fascicular block (LAFB) (Figure 1) presenting with shortness of breath and dizziness without syncope dating back two weeks prior to hospi-
The recording system setup used at our center included 12-lead ECG and intracardiac electrograms recorded at 100 mm/s sweep speed during LBBAP implantation, representing unipolar recording from the lead tip filtered 30-500 Hz and also unfiltered unipolar signal from this pole. Following the standard routine at our center, we used the axillary vein for the implantation and the right femoral vein for ICE sheath placement (10 Fr, 25cm sheath). We used a stylet-driven lead and an introducer system (Selectra 3D delivery sheath 65-39 cm, Biotronik, Germany) that was advanced into the right ventricle over a guidewire under ICE guidance. The landing zone for the delivery system was identified using contrast injection through the delivery sheath and verified using ICE (Figure 2). The stylet-driven lead (Solia S 60, Biotronik Germany) was advanced to the interventricular septum, in particular at the right ventricular (RV) side of the septum through the sheath, and an initial pacing attempt was performed for QRS morphology verification. Pace-mapping of the RV septum showed QRS characterized by notches in lateral leads and “W” morphology in lead V1 (Figure 3 panel A). Further advancement of the lead in the septum resulted in deep septal paced QRS which is narrower and without notch in lateral leads while the notch in V1 moved towards the terminal portion of the QRS. R-wave peak time in lead V6 (V6RWPT) was below 120 milliseconds (ms) but still exceeding the accepted value of 75 ms. These findings, as well as the position of the lead into the mid-septum verified with the ICE can be seen in Figure 3 panel B. Further penetration of the lead into the left ventricular (LV) septum close to the proximal left bundle was monitored on fluoroscopy and ICE. At some point, a subendocardial “tenting” of the lead could be visualized by ICE (Figure 3, panel C). Pacing at that position revealed V6RWPT of 71 ms and interpeak distance (IPD) – the time
Discussion

In patients with RBBB, RV contracts asynchronously with mostly normal LV activation [8]. Routine RV pacing leads to local RV myocardium pre-excitation but more pronounced LV activation delay, thus taking the risks of pacing-induced cardiomyopathy for patients expected to receive a high per-

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Fig. 1. Twelve-lead ECG of the patient before the implantation demonstrating 2:1 AV block, right bundle branch block (RBBB) left anterior fascicular block. Sweep speed 25 mm/s
Fig. 2. Panel A. Fluoroscopy in the right anterior oblique (RAO) position shows the delivery system across the tricuspid valve. Contrast was injected through the sheath to visualize surrounding structures. His bundle area (arrowhead) is located at the angle between the tricuspid valve and the projection of the aortic valve as delineated by the orange line. The temporary pacemaker near the right ventricle’s apex could be seen. The delivery system is positioned just over the “landing zone” which in fact is the area where the lead could start penetrating the septum. Panel B. The “home view” on the intracardiac echocardiography shows the septum below the aorta where the landing zone is located. The introducer sheath tip can be visualized lying against the landing zone (arrowhead). The distance from the tricuspid annulus to the point of penetration in this case was measured 27 mm.

Ao – aorta, RVOT – right ventricular outflow tract, TV – tricuspid valve, DS – delivery system, TPM lead – temporary pacemaker lead.

Fig. 3. Intracardiac echocardiography and twelve-channel ECG, accompanied by filtered and unfiltered electrogram from the lead tip at different depths during lead penetration. Panel A. The tip (arrowhead) of the pacing lead is attached to the RV septum. The paced QRS was narrower, without the notches in lateral leads and the notch in V1 has moved towards the terminal part of the QRS. R-wave peak time in lead V6 (V6RWPT) was 82 ms and the interpeak distance (from RWV6 to RWV1) in V6RWPT time was short – just 24 ms as expected with deep septal pacing. Panel C. The lead tip was positioned just below the endocardium on the left ventricular (LV) septum, demonstrating non-selective left bundle branch block capture. L Bip – filtered EGM from the lead tip; L Uni – unfiltered EGM from the lead tip. Sweep speed 100 mm/s.

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Fig. 4. Twelve-lead surface ECG along with filtered and unfiltered electrogram from the lead tip. Panel A. Transition from non-selective (the first beat) to selective (the subsequent beats) during threshold testing. Please note the change in morphology in V1 from qR to RsR' and the occurrence of deep S waves in V6. A discrete electrogram following the pacing spike is also visible (arrowhead). Selective left bundle capture occurred at the third beat. Panel B. Fascicular potential and the current of injury at the final position of the lead. The interval from the fascicular EGM to R-wave in V6 is 65 ms approximating the V6RWPT during pacing, shown to be 72 ms in Figure 3, Panel C. The abbreviations as in Figure 3. Sweep speed 100 mm/s.

камерна стимуляция [9]. От друга страна, когато BiV стимуляция се прилага на пациента със запазена активация по лявото бедро, това води до ятрогенно удължаване на времето за активиране на лявата камера спрямо нативния ритъм. Моделът на RBBB, създаващ се при LBBAP, е отражение на относителното забавяне на активирането сред останалата проводна система в сравнение с лявото бедро. Общата левокамерна електрическа синхронност се запазва, тъй като импулсът се разпространява бързо през интактното LBB [9]. Следователно по този път се постига начин на стимуляция, близък до физиологичния, за разлика от BiV стимуляцията, която по същество също е нефизиологичен начин на стимуляция. Запазената синхронност на LV при нашия пациент беше демонстрирана чрез използване на автоматичен strain rate със speckle tracking след процедурата (фиг. 5), като не очакваме влошаване на LV функцията при този пациент въпреки високия процент камерна стимуляция.

percentage of ventricular pacing [9]. BiV pacing, when delivered to patients with preserved activation via the left bundle, results in iatrogenic prolongation of LV activation time relative to the intrinsic rhythm. However, the RBBB pattern created in LBBAP is a reflection of the relative delay of the activation among the rest conduction system in comparison with LBB. The general LV electrical synchrony is preserved because the impulse propagates rapidly through intact LBB [9]. Because of that, we strongly believe that there is no better pacing manner than the physiological one, since even BiV pacing, in essence, is a non-physiological pacing manner. The preserved LV synchrony in our patient was demonstrated by using an automated strain rate protocol with speckle tracking after the procedure (Figure 5) and we do not expect deterioration of LV function in this patient despite of high percentage of ventricular pacing.
On the other hand, in patients with large right heart chambers, positionally rotated hearts, or even prosthetic valves, manipulating the delivery system as well as the determination of the "landing zone" for LBBAP and the degree of lead penetration into the septum could be difficult to estimate using X-Ray alone. In their randomized study Kuang et al. demonstrated that ICE guidance during LBBAP was associated with shorter procedure duration and fluoroscopy time and is more likely to achieve LBB trunk pacing and LBBAP more frequently and with fewer implantation attempts [4]. Data from The MELOS registry showed that the majority of the LBBAP lead complications (8,7%) were attributed to acute perforation to LV (3,7%) and lead dislodgement (1,5%) [10]. The most common sign of septal perforation during LBBAP implantation is the drop of the COI [7]. But when the COI drops, the septal perforation has already occurred. Often the moment just before the perforation could be detected on ICE and it can be prevented by monitoring the "tenting" of the LV endocardium by the tip of the pacing lead (Figure 3, Panel C). Therefore, the use of ICE during LBBAP implantation could reduce these complications significantly due to the ability for better visualization of the lead penetration into the septum.
ването на електрода в септума. Трябва също така да се оценят фактове, че колкото повече се увеличава опитът на оператора при имплантиране на LBBAP под контрола на ICE, разполагането на позицията на електрода в септума само чрез използване на електрограми и ЕКГ става по-лесно. Доколкото ни е известно, това е първият опит с имплантиране на LBBAP под контрола на ICE в нашата страна. По-широко използване на този подход може да подобри работния процес при имплантиране на LBBAP и да минимизира усложненията на имплантацията.

Изводи

Използването на ICE по време на имплантацията на LBBAP е приложимо и се свързва с възможност за намаляване на честотата на усложненията и повишаване на успеха на процедурата поради възможността за визуализация на проникването на електрода през септума в реално време по време на имплантацията. Необходими са допълнителни проучвания, които да покажат приложимостта на този подход в ежедневната клинична практика.

Библиография / References


CONCLUSION

The use of ICE to guide LBBAP implantation is feasible and shows promise to reduce complications and improve procedure success due to the ability for real-time visualization of the lead penetration into the septum during the implantation. Further studies are needed to establish the value of this approach for routine clinical practice.

No conflict of interest was declared.