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Modified electrocardiogram using only limb leads to record V1 and V6: A simplified approach for left bundle branch area pacing follow-up

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KEYWORDS Conduction system pacing; Electrocardiogram; Follow-up; Left bundle branch area pacing; Permanent pacemakers

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Left bundle branch area pacing (LBBAP) is being increasingly adopted.[1,2] A 12-lead electrocardiogram (ECG) is necessary for evaluating conduction system capture, particularly through the assessment of R-wave peak time in V6 (V_6RWPT) and the V_6–V_1 interpeak interval[3] but is not always available and is time consuming. Two small studies totaling 30 patients reported placement of the arm electrodes in the V1 position and the leg electrodes in the V6 position using a device programmer, with recording of only pseudo-V1 and pseudo-V6,[4,5] with good agreement with V_6RWPT on standard ECG. We aimed to investigate an alternative, more intuitive ECG configuration using limb electrodes for recording modified leads I, II, III, aVF, V1, and V6 in a larger cohort of patients.

Patients and data acquisition using the modified 6-lead ECG

We studied 75 consecutive patients undergoing LBBAP implantation (age 81.2 ± 10.5 years, 42 male patients, left ventricular ejection fraction 55.7% ± 13.3%). We recorded a 12-lead ECG at 0.05–150 Hz followed by a modified (m-) intuitive 6-lead ECG (m6L) using the right arm electrode in the V1 position (recorded in aVR) and the left arm electrode in the V6 position (recorded in aVL; Figure 1). Thus, mI, mII, mIII, maVF, mV1, and mV6 were recorded. Tracings were acquired using LabsystemPRO (Boston Scientific, Marlborough, MA), with measurements performed with digital calipers during unipolar pacing at 100 mm/s. Patients gave written consent and were part of the Geneva Conduction System Registry, approved by the institutional Ethics Committee.

Data are presented as mean ± standard deviation (SD). Linear regression, paired Student *t* test and Bland–Altman analysis were used using STATA 18.0 (STATA Corp, College Station, TX). Statistical significance was $P < .05$.

Comparison of ECGs between standard and modified leads

A terminal R-wave in V1 was observed in all but 1 patient, in whom it was also absent in mV1 and in 4 additional patients, resulting in concordant findings in 71 (95%) patients. A deep S-wave in V6 (> 20% of the QRS complex[5]) was observed in 15 (20%) patients and in mV6 in 14 of these patients and in an additional 12 patients; that is, in 20% of patients previously without a deep S-wave. Findings were thus concordant in 51(68%) patients (Figure 1).

Interpretation

Our findings indicate that V1 and V6 may be approximated using only limb leads. The terminal R-wave was accurately displayed by mV1 in 95% of patients, although a deep S-wave was more often visible in V6, with a leftward shift in QRS axis using the modified ECG leads (caused by the arm electrodes being placed at an angle in the V1 and V6 positions at different intercostal spaces with clockwise rotation). The greater R-wave amplitudes in mV1 and mV6 compared with standard precordial leads can be explained by "augmented" waveforms of aVR and aVL. However, no effect on the temporal aspects of the ECG was expected, and V_6RWPT and V_6–V_1 interpeak intervals were well correlated between the standard and modified ECGs. The leftward shift in QRS axis and more frequent deep S-wave in V6 with the modified ECG leads are not ideal for LBBAP implantations; they may not truly reflect the lead position.

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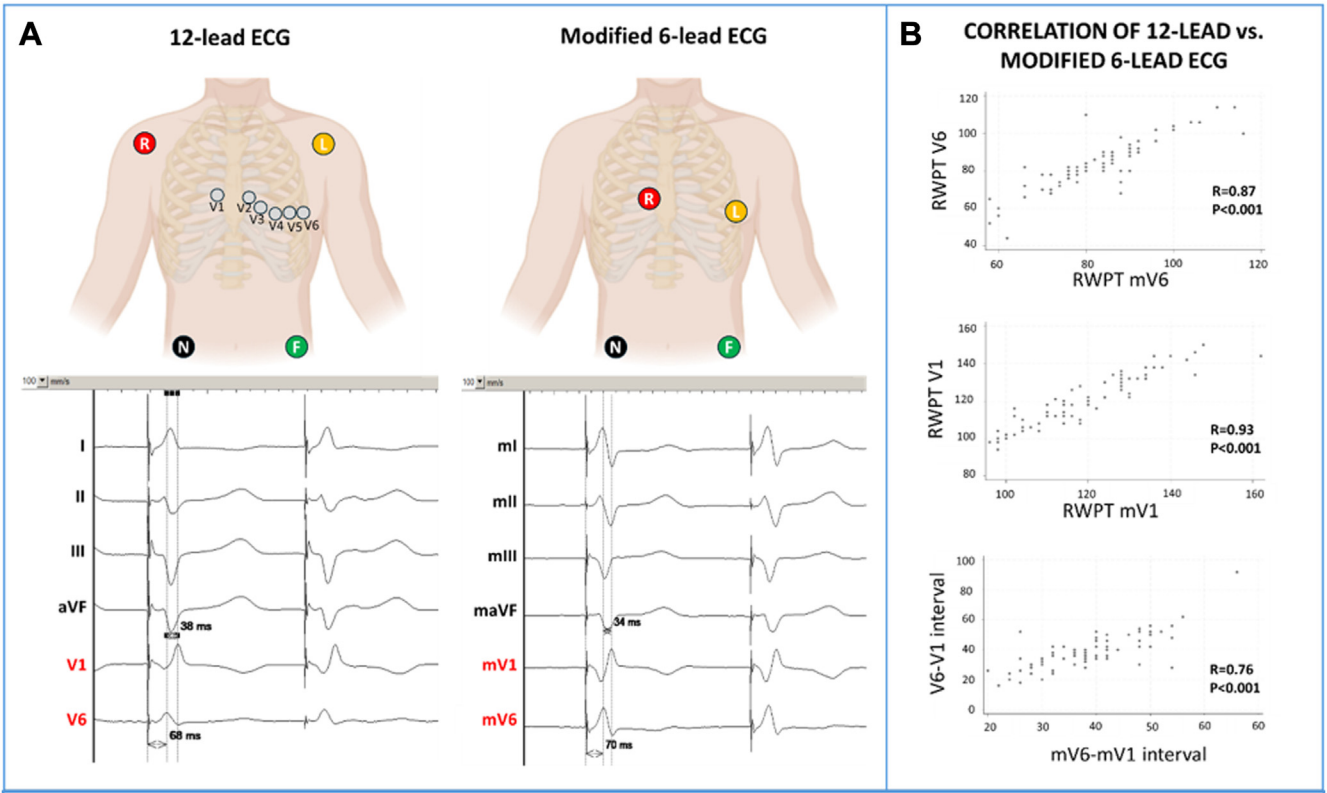

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	Standard 12-lead	Modified 6-lead	P	Correlation	Agreement*
R-wave amplitude V1 (mV)	4.1±2.6	4.8±3.2	**0.004**	0.79	0.7 (-3.1 to +4.5)
R-wave amplitude V6 (mV)	6.3±3.9	8.3±4.4	**<0.001**	0.81	2.1 (-3.0 to +7.2)
V_6RWPT (ms)	83±13	82±12	0.55	0.87	-0.5 (-13.5 to +12.6)
V_1RWPT (ms)	121±14	120±15	0.20	0.93	-0.8 (-11.4 to +9.8)
V_6V_1 interpeak interval (ms)	37±12	38±9	0.76	0.76	-0.5 (-19.2 to +18.3)
QRS axis (°)	-14±41	-50±50	**<0.001**	0.63	-36 (-121 to +49)

* Bias (95% limits of agreement)

Figure 1

A: Electrode placement for standard 12-lead and modified 6-lead ECG. In the modified configuration, the right arm electrode is positioned on V1 and the left arm electrode is positioned on V6, whereas the left and right leg electrodes remain in their standard positions. An illustrative case example is shown with 12-lead ECG *(left)* and modified 6-lead ECG (*right*), with display of RWPT measurements. **B:** Scatter plots with Pearson's correlation between the standard 12-lead and modified 6-lead ECGs. **C:** Comparison of parameters measured on standard 12-lead ECG and modified 6-lead ECG. ECG = electrocardiogram; ms = milliseconds; RWPT = R-wave peak time.

However, they may be used in lieu of a 12-lead ECG to simplify LBBAP follow-up by evaluating the presence of a terminal r/R in V1 and measuring V_6RWPT and V_6–V_1 interpeak intervals, ideally using digital calipers (available on device programmers and certain ECGs).

Limitations

Our report has certain limitations: notably, a lack of consideration for anthropometric factors and heart position. Measurements were performed at implantation using an electrophysiological recording system rather than at follow-

up with an ECG, but filter settings were set to standard values, which we believe mitigates differences.

Conclusion

The modified ECG using only limb leads to record mV1 and mV6 provides an alternative to the standard 12-lead ECG, which may be useful to streamline LBBAP follow-up in busy device clinics.

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References

1. Kircanski B, Boveda S, Prinzen F, et al. Conduction system pacing in everyday clinical practice: EHRA physician survey. Europace 2023;25:682–687.
2. Keene D, Anselme F, Burri H, et al. Conduction system pacing, a European survey: insights from clinical practice. Europace 2023;25:1–9.
3. Burri H, Jastrzebski M, Cano O, et al. EHRA clinical consensus statement on conduction system pacing implantation: endorsed by the Asia Pacific Heart Rhythm Society (APHRS), Canadian Heart Rhythm Society (CHRS), and Latin American Heart Rhythm Society (LAHRS). Europace 2023;25:1208–1236.
4. Tan ESJ, Lee J-Y, Chan SP, Boey E, Seow S-C, Kojodjojo P. Simplifying follow-up of left bundle branch pacing leads: assessment of left bundle branch capture using a programmer only. Heart Rhythm 2023;20:777–778.
5. Valappil SP, Subramanyan K, Jaiswal P, et al. A MacGyvering way to left bundle branch area pacing: using the modified V1/V6 leads connected to the pacing system analyzer. Heart Rhythm O2 2025;6:237–241.