A puzzling electrocardiographic phenomenon following transcatheter aortic valve replacement

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Clinical vignette
A 76-year-old male with severe aortic incompetence underwent transcatheter aortic valve replacement (TAVR) with a balloon-expandable valve. His pre-TAVR electrocardiogram (ECG) showed sinus rhythm with a normal QRS duration of approximately 100 ms and paroxysmal episodes of non-sustained atrial tachycardia. A temporary pacemaker was routinely implanted post-TAVR. The patient reported no obvious discomfort except intermittent palpitations. Telemetry monitoring day 1 post-TAVR revealed beat-to-beat change in QRS morphology, which exhibited a positive correlation between the QRS durations and the preceding R-R intervals: i.e. that the longer the preceding R-R interval was, the wider the QRS duration became.

The laboratory tests including serum electrolytes and cardiac enzymes were normal.

What is the explanation for this puzzling electrocardiographic phenomenon?

Multiple-choice questions and explanations

Question 1
Judging by the multiple changes in QRS morphology, what is the most likely diagnosis?
A. Non-uniform ECG recording speed
B. Intermittent ventricular preexcitation
C. Varying degrees of left bundle branch block (LBBB)
D. Ventricular ectopic beats and fusion beats
E. Ventricular pacing and fusion beats

The correct answer is C.

Non-uniform ECG recording speed due to malfunction of ECG machine may result in different QRS widths, while P waves should also be affected as well, which is apparently not the case. The absence of delta wave and short PR interval make intermittent ventricular preexcitation unlikely. Relatively fixed PR intervals without pacing artifacts do not support right-ventricular paced QRS complexes and fusion beats. Beat-to-beat change in QRS complexes with fixed PR intervals in response to different rates indicates an atrioventricular conduction relationship. Thus varying degrees of LBBB is the diagnosis.

Question 2
What mechanism best explains the beat-to-beat change in QRS morphology that exhibits the positive correlation between the QRS duration and the preceding R-R interval?
A. Phase 3 block in left bundle branch (LBB)
B. Phase 4 block in LBB
C. Inverse decremental conduction in LBB
D. Supernormal conduction
E. Gap conduction

The correct answer is C.

LBBB is the most frequent complication post-TAVR. Complete LBBB occurs after preceding R-R intervals > 513 ms, whereas incomplete LBBB occurs after relatively short intervals ranging from 450 to 513 ms. The QRS complexes normalize after preceding R-R intervals < 450 ms. This special conduction accords with the inverse decremental conduction, also known as Yan conduction, in LBB, which was first described by Yan in 2021. In Yan conduction, the conduction velocity inversely correlates with the upstream stimulation interval and exhibits a continuing change presumably via a mechanism of continue diastolic depolarization. Whereas in phase 4 block, the impulse either conducts at its baseline speed or ceases at the site of the block resulting from the pause-dependent source-to-sink mismatch that may be independent of phase 4 depolarization. Gap conduction may explain the QRS normalization after a shorter PP coupling interval during which conduction delay in atrioventricular node facilitates conduction in His-Purkinje system. However, no significantly prolonged PR intervals in atrial premature beats do not support it.

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Question 3
What would you do next?
A. Permanent pacemaker implantation
B. Outpatient Mobile Cardiac Telemetry (MCOT) for 1–2 weeks
C. AV bypass ablation
D. Coronary angiogram
E. Take a new 12 lead ECG immediately

The correct answer is B.

Yan conduction in the His-Purkinje system may be a transitional pathological state shortly post-TAVR insults or other diseases that can evolve into two consequences: (i). gradually recovering from the injury and resuming its all-or-none conduction or (ii) developing into advanced or complete AV block. There is no indication for permanent pacemaker implantation at this point. Outpatient MCOT for 1–2 weeks for closely monitoring possible high degree of AV block is an appropriate next step. Of note, Yan conduction in LBB with preexisting RBBB, manifests as varying PR interval changes of which clinical significance may be easily ignored, which may herald the development of complete AV block and asystole under this situation.2

Consent: The authors confirm that written consent for submission and publication of this case report including images and associated text has been obtained from the patient in line with COPE guidance.

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