Optimal P-Wave Duration for Bedside Diagnosis of Interatrial Block

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Background: Interatrial block (IAB; P wave ≥ 110 ms) is highly prevalent and associated with atrial tachyarrhythmias, left atrial electromechanical dysfunction and is a potential risk for embolism. Investigators have often used different parameters for P-wave duration to define IAB, and this causes confusion further adding to clinician ignorance of IAB. We therefore appraised the mode P-wave duration in IAB and evaluated the sensitivity and specificity of using previously used durations.

Methods: We prospectively evaluated 225 electrocardiograms (ECGs) of patients at a tertiary care general hospital for P-wave duration. Of these, 49 were excluded because of severe motion artifact, errors in lead placement, absence of adequate patient identification, and atrial flutter or fibrillation. Mean, standard error of mean (SEM), standard deviation (SD), mode P-wave duration, specificity, and sensitivity were calculated of the remaining 176 ECGs.

Results: From the sample (N = 176; ages 15–95 years; mean ± SD = 69.15 ± 16.53 years, female 50.3%), measured P-wave durations ranged from 50 ms to 230 ms (mean ± SD = 113.75 ± 30.56 ms, SEM 2.30 ms). 96 patients (54.55%) showed IAB (P wave ≥ 110 ms) with the mode P-wave duration being 120 ms. Sensitivity and specificity of using P wave ≥ 110 ms is 100% and 88.9%, respectively (accuracy 94.31%), while P wave ≥130 ms yielded 64% and 100%, respectively (accuracy 82.38%).

Conclusions: Mode P-wave duration in IAB is 120 ms, and thus, for all practical reasons, it may be used to clinically diagnose IAB using ECGs recorded at the bedside at 25 mm/s with 10 mm/mV standardization.

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interatrial block; P-wave duration; electrocardiogram

BACKGROUND

Normal P-wave duration has been defined by the World Health Organization (WHO) International Society and Federation of Cardiology Task Force[1] as <110 ms on the electrocardiogram (ECG) and denotes the normal transit time of electrical impulse generated in right atrium to conduct to left atrium (LA) resulting in atrial depolarization and its subsequent contraction.[2] Hence, P-wave prolongation (P wave ≥ 110 ms) implies interatrial conduction delay and has been so described by Bayes de Luna as interatrial block (IAB).[3,4]

IAB has been shown to be >40% prevalent among all patients in sinus rhythm in two separate general hospital populations.[5,6] It is also a strong predictor of atrial tachyarrhythmias, especially atrial fibrillation[7,8] and is associated with LA enlargement[9] and electromechanical dysfunction besides being a potential risk factor for embolism.[10] Despite this, much is yet to be studied about IAB even with regard to its fundamentals. Moreover, IAB investigators have often used different parameters for P-wave duration to define IAB. For example, Goyal and Spodick used P-wave durations of ≥120 ms[10] and Montereggi used P-wave durations

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≥130 ms[11], while others cited P wave ≥ 140 ms[12] as their criteria for definition. This along with overwhelming ignorance of its existence, forces IAB to be underappreciated and greatly overlooked.[13] Heavily contributory is also the common mistake of sole reliance on lead II rather than on all leads. We evaluated the mode duration of P waves in IAB and the specificity and sensitivity of using previously used durations.

METHODS

We prospectively evaluated 225 consecutive 12-lead ECGs at 25 mm/s with 10 mm/mV standardization in a tertiary care teaching hospital. Patients were aged 15–98 years (52.44% female) and had been admitted to the nontelemetry general medical floors for nonacute presentations. Out of these, 49 ECGs were excluded for severe motion artifact, errors in lead placement, absence of adequate patient identification, junctional rhythms, and atrial flutter or fibrillation. P waves on the remaining 176 ECGs, which were included in this study, were then measured under 10-fold calibrated magnification for the greatest duration on each lead. The onset of the P wave was defined as the junction between the T–P iso-electric line and the beginning of the P deflection and the offset as the junction between the end of the P deflection and the PR segment. Mean, standard error of mean (SEM), standard deviation (SD), mode P-wave duration, specificity, and sensitivity were calculated.

RESULTS

From the sample (N = 176), patients were of ages 15–95 years (mean age ± SD = 69.15 ± 16.53 years) with a slight predominance toward females (50.3%). Measured P-wave durations ranged from 50 ms to 230 ms (mean ± SD = 113.75 ± 30.56 ms, SEM 2.30 ms) (Fig. 1). Ninety-six ECGs (54.55%) showed IAB (P wave ≥ 110 ms) with the mode P-wave duration noted to be 120 ms (Fig. 2, Table 1).

DISCUSSION

Although IAB, or more appropriately, interatrial delay is highly prevalent[5,6] in the general hospital population and is associated with sequelae,[7–10] it is often underappreciated and often incorrectly deemed insignificant.[13] Lack of emphasis in cardiology textbooks and absence of appropriate management strategies by the American College of Cardiology/American Heart Association Task Force on Practice Guidelines, however, do not justify clinician ignorance. Moreover, lack of standardization in use of P-wave duration as its diagnostic criterion only causes further confusion and curbs our understanding of IAB. According to the WHO's standardized definition of normal P-wave duration (<110 ms),[1] our study appraised prolonged P-wave durations in IAB ranging from 110 ms to 230 ms and shows that the mode P-wave duration in IAB

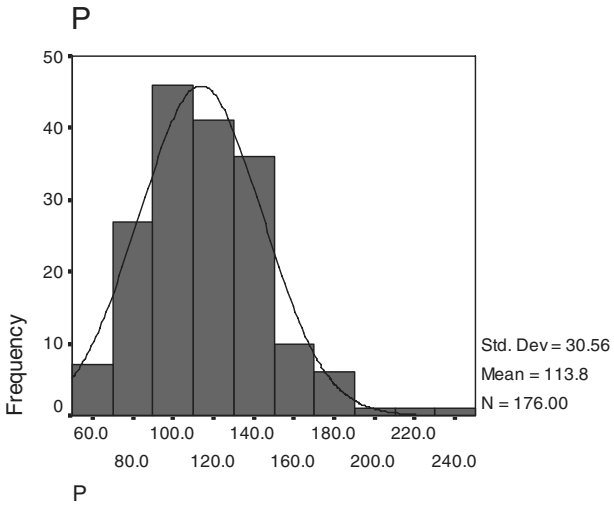

Figure 1. P-wave durations in all valid ECGs (N = 176).

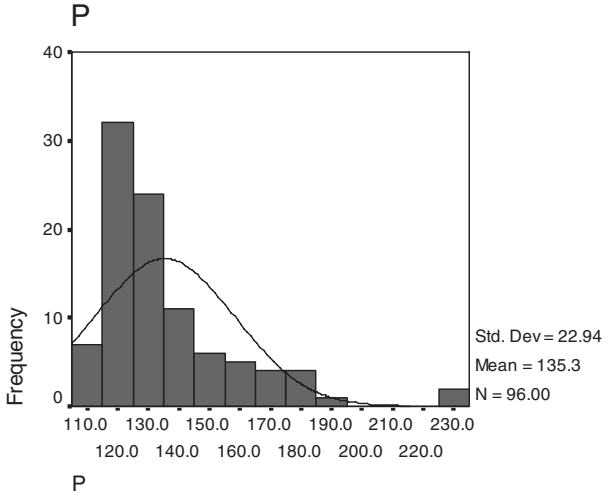

Figure 2. P-wave durations in patients with IAB (N = 96).

Table 1. Frequency Table for P-Wave Durations in Patients with IAB (N = 96)

P Wave (ms)	Frequency	Percent	Valid Percent	Cumulative Percent
110	7	7.3	7.3	7.3
115	3	3.1	3.1	10.4
120	28	29.2	29.2	39.6
123	1	1.0	1.0	40.6
125	2	2.1	2.1	42.7
130	15	15.6	15.6	58.3
133	7	7.3	7.3	65.6
136	1	1.0	1.0	66.7
140	9	9.4	9.4	76.0
142	1	1.0	1.0	77.1
147	3	3.1	3.1	80.2
150	3	3.1	3.1	83.3
155	1	1.0	1.0	84.4
160	4	4.2	4.2	88.5
165	1	1.0	1.0	89.6
167	1	1.0	1.0	90.6
170	2	2.1	2.1	92.7
180	4	4.2	4.2	96.9
191	1	1.0	1.0	97.9
227	1	1.0	1.0	99.0
230	1	1.0	1.0	100.0
Total	96	100.0	100.0	

diagnosed from bedside ECGs is indeed 120 ms (Fig. 2, Table 1).

It is, however, acknowledged that even the widest P wave taken from a tracing of a standard bedside-ECG cannot be accurately established with manual measurement. Neither the true onset nor the offset of the P wave can be so determined even under magnification. Furthermore, P-wave durations measured in this manner rarely precisely correlate with the actual total atrial activation time recorded during atrial mapping evaluations. However, the purpose of this investigation was to generate a common basis of clinically diagnosing IAB at the bedside. Altering the sweep speed or gain of the ECG in an attempt to achieve optimal results would therefore not be practical as a clinical tool and certainly not facilitate ease of diagnosis in the hands of the clinician, where IAB diagnosis probably is most important.

Table 2. Optimal P-Wave Duration for Clinical Diagnosis of IAB at the Bedside

Duration	Sensitivity	Specificity	Accuracy
P wave ≥ 110 ms	100%	88.9%	94.31%
P wave ≥ 120 ms	Mode (100%)		
P wave ≥ 130 ms	64%	100%	82.38%
P wave ≥ 140 ms	37.2%	100%	69.32%

In this study sample, 10 patients would have had the diagnosis of IAB missed if P wave ≥120 ms was used (Table 1) as a diagnostic criterion. Therefore, IAB would be diagnosed in 86 patients (48.86%) compared with 96 patients (54.54%) if the WHO's definition of P-wave ≥110 ms is utilized. While it is strictly not our purpose to challenge this guideline nor add to a diagnostic criteria, it is important to note that on most standardized ECG tracings, 10 ms on 25 mm/s recordings equals one-quarter mm. Therefore, measuring P-wave durations in 40-ms multiples (1 mm on the ECG), for example, could be more practical when P wave ≥120 ms (3 mm on the ECG) is used for IAB diagnosis at the bedside. As such, sensitivity and specificity of using P waves ≥110 ms on bedside-ECGs for IAB diagnosis is 100% and 88.9%, respectively (accuracy 94.31%), while with P waves ≥130 ms, the yield is 64% and 100%, respectively (accuracy 82.38%) (Table 2).

CONCLUSIONS

The mode P-wave duration in IAB is 120 ms (Table 1, Fig. 2). Since this duration represents 3 mm on the ECG recorded at 25 mm/s with 10 mm/mV standardization, for all practical reasons, P wave ≥120 ms can be used for optimal diagnosis of IAB. Given the high prevalence[5,6] and significant associations of IAB,[7–10] standardizing software to include P-wave durations in computer-generated ECG readings could perhaps be a useful tool in generating awareness and aiding in clinician diagnosis of IAB.

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