IOCH 2026 Conference

The 1st International Online Conference on Healthcare

25–26 March 2026 | Online

MDPI

Automatic Identification of First-Degree Atrioventricular Blocks

Manuel Sandoval Martínez, Claudia Morales Barrón, Luz Elba Castillo Izquierdo, Ramón Izquierdo Córdova
Instituto Tecnológico Superior de Comalcalco. Tabasco, México.
Manuel.Sandoval@comalcalco.tecnm.mx

INTRODUCTION & AIM

PR Interval

The PR interval is measured from the beginning of the P wave to the beginning of the QRS complex (Figure 1).

First-degree AV block is defined by a **prolonged PR** interval greater than 200ms on the electrocardiogram, with every atrial impulse conducted to the ventricles (figure 2).

Figure 1. Normal PR (120-200ms)

Figure 2. PR Prolonged (320ms): First degree AVB

The quadrant method

Identifying axis orientation requires measuring the net deflection (the "height" of the R wave minus the "depth" of the S wave) in leads **I** and **aVF** (Figure 3).

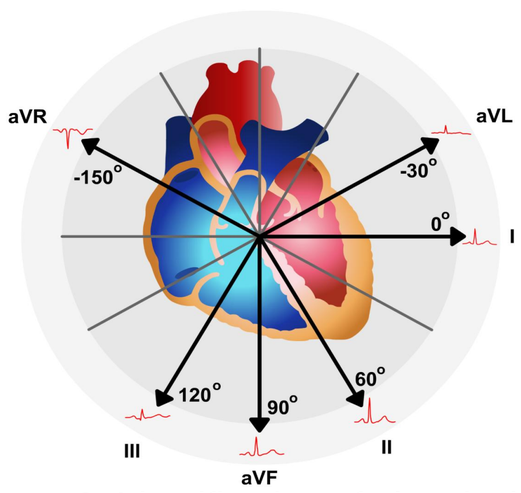

Figure 3. Identification of electrical axis

Lead I	Lead aVF	Axis Interpretation
Positive (+)	Positive (+)	Normal Axis
Positive (+)	Negative (-)	Left Axis Deviation (LAD)
Negative (-)	Positive (+)	Right Axis Deviation (RAD)
Negative (-)	Negative (-)	Extreme Axis

METHOD

- *A large scale 12-lead electrocardiogram database for arrhythmia study, published on Physionet* (115 ECG), all known to exhibit AVB1, was used.
- We developed a tool using Neurokit2, Scipy, pandas, numpy and matplotlib to analize each ECG.
- Our code classifies heart rate, the electrical axis, and identifies first-degree atrioventricular block (AVB1).
- Our tool considers both, PR interval and electrical axis, to deliver a pre-diagnosis of the ECG

RESULTS & DISCUSSION

The table shows a subset of results obtained from the automated analysis of 115 ECGs using our tool. The PR values observed in the table range approximately from 190 ms to 397 ms (values between 216–301ms suggest atrioventricular conduction delay), with one case where no PR interval was detected (suggests that the algorithm did not clearly detect the P wave). The electrical axis deviation is classified into three categories: Normal axis; Right axis; Left axis.

The algorithm proposes several physiological interpretations based on the measured parameters: Advanced AV nodal delay / Nodal delay, Interatrial block (suggested when PR prolongation occurs together with axis deviation), Structural failure (indicating potential structural cardiac abnormalities), Outlier (identifying extreme values that could be due to measurement errors or uncommon clinical conditions), No PR / No BAV (cases where the PR interval cannot be detected or no atrioventricular block is identified). The diagnostic suggestions derived from the analysis include, ECG monitoring (when PR prolongation matches first degree AVB, Overload (indicating possible cardiac overload), Suspected cardiomyopathy (in cases with axis deviation and structural abnormalities) and Repeat ECG (when the data appears atypical or incomplete).

Edge	Sex	BPM	PR	Axis	Possible cause	Pre-diagnostic
52	Famale	56.7	272	Normal	Advanced AV nodal dalay	ECG monitoring
86	Male	107	245	Normal	Nodal dalay	ECG monitoring
54	Male	50	268	Rigth	Interatrial Block	Evaluate IV septum
29	Famale	113	216	Rigth	Structural failure	Overload
81	Male	56	301	Left	Advanced structural failure	Suspected cardiomyopathy
61	Famale	75	264	Left	Advanced structural failure	Suspected cardiomyopathy
66	Male	113	335	Normal	Advanced AV nodal dalay	ECG monitoring
84	Male	113	397	Normal	Outlier	Repit ECG
32	Male	144	0	Normal	No PR	Repit ECG
20	Male	100	190	Normal	No BAV	No BAV

In the table below, 83.13% of the ECGs present a normal electrical axis, 14.46% show left axis deviation (suspected cardiomyopathy), 2.41% right axis deviation (structural abnormalities). Our method not only successfully identified all cases of first-degree AV block present in the dataset, but also extracted additional clinically relevant information, such as the electrical axis deviation.

Axis	Percentage	Possible cause	Pre-diagnostic
Normal	83.133	System conduction	ECG monitoring
Left	14.458	Structural	Suspected cardiomyopathy
Rigth	2.4096	Structural	Evaluate IV septum

CONCLUSION

- The tool demonstrated an **effectiveness of 95%** in 1AVB detection.
- The time spend by the code, analizing all the ECG was less than 3min.
- Additionally, the program was able to produce the following:
  Measurements: Electrical Axis: 83% Normal, 15% Left Axis Deviation, and 3% Right Axis Deviation
  Heart Rate: 50% Bradycardias (30% Mild, 10% Moderate, 10% Severe), 25% Tachycardias, and 25% Normal Rates.

FUTURE WORK / REFERENCES

We are expanding our code to enable the detection of both **anterior and posterior hemiblocks**; this will allow us to more effectively monitor conduction system issues

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