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A paradigm shift in ECG interpretation method - Application of cardiac vector theory

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COVID-19 can cause heart and vascular damage and affect overall cardiovascular health. Coronary heart disease likely to remain number one killer disease of the world indefinitely due to long-term COVID-19 impact. Electrocardiogram (ECG) is one of the oldest and most important diagnostic tool for diagnosis of coronary artery disease in medicine yet its interpretation remains an arduous task. A lot of advancements had come in the ECG machine, yet the basic physics principle of ECG is not clearly understood. The concept of Einthoven triangle and the cardiac vector describing the electrical activity of the heart was first described by Einthoven even before a century but he never published a complete detailed description of the same. After many decades, the complete Heart-Lead vector relationship and Einthoven's equilateral triangle hypotheses was published by the current author in previous research articles. Cardiac vector hypothesis states that voltage (scalar quantity measured in volt) recorded in a particular lead is the result of dot product between cardiac vector (electrical field vector of dimension volt/metre) and lead vector (measured in metre). The lead vector denotes the orientation of the electrode position. The magnitude and orientation of heart vector with lead vector will cause deflections in the ECG voltage in the vertical axis resulting in the formation of ECG waves. The velocity of Cardiac Vector is related with time in the horizontal axis of ECG.

In the hex-axial reference system of ECG, plot the net voltages of bipolar limb leads and connect them. Similarly, plot the net voltages of unipolar limb leads and connect them. Each forms equilateral triangles. The voltage recorded by the electrodes (Lead I, II, III, aVR, aVL and aVF denoting right arm, left arm and left leg) are the vertices of an electrical equilateral triangle. The equilateral triangle can be converted into a circle. Each circle has same origin, same orientation, but different radii because bipolar and unipolar limb leads have different resistance. Multiply each unipolar limb lead voltages by correction factor 1.154 and then plot. The two equilateral triangles are on the same circle. Thus heart is situated in the center of the electric field which it generates. The two upper limbs and the left lower limb are the extensions of its electrical field. Each cardiac wave (P, QRS, T) can be represented in the form of circles. All circles (see the diameter) should be formed in the left lower quadrant except QRS which can go up to -30 degree. When the angle between the 'QRS' and 'T' circles widens it usually denotes ischemia. Larger the size of a circle, higher will be the voltage. No circle should be formed during ST-segment since it is an iso-electric period. Formation of circle and its magnitude during the ST-segment indicate the amount of myocardial injury. Thus by observing the size and location of the circles in the hex-axial reference system, interpretation can be done easily. The present study summarizes the clinical applications of cardiac vector theory to be applied at the bed side for ECG interpretation. The better understanding of vector physics principle and its application in each ECG tracing helps to overcome the arduous task of pattern memorization method of ECG interpretation. The combination of the 12-lead ECG with this Novel Perspective ECG translation (resultant cardiac vector represented by circle in the hex-axial reference system) provides the optimum approach to ECG interpretation. The early diagnosis can reduce the morbidity and mortality so quicker and proper interpretation of ECG report will result in saving millions of cardiac patients.

Recent Publications:

1. Rajini Samuel T What to the world Einthoven talking about? Journal Of Pharmaceutical And Biomedical Sciences JPBS, 2012, 23 (17)
2. Rajini Samuel Formulation And Clinical Application Of Cardiac Vector Hypotheses In ECG Interpretation Using Vector Physics Principle EJPMR, 2018,5(11),523-536

3. Rajini Samuel. Application of Cardiac Vector Theory In ECG Interpretation, PARIPEX - Indian Journal of Research. 2021;10(10): 1-3.
4. Rajini Samuel T, BalajiRajagopalan, Uma Maheshwari. A novel contemporary perspective teaching method for interpretation of various acid base disorders citing with examples. International Journal of Contemporary Medical Research 2019;6(3):C10-C14.
5. Rajini Samuel T "Revised Graphical Tool for ABG Interpretation using Modified Bicarbonate/Standard Bicarbonate Ratio". International Journal of Clinical Chemistry and Laboratory Medicine (IJCCLM), 2019 5(3) : 19-29

Biography

T Rajini Samuel is presently working as an Associate Professor of Biochemistry in Shri Sathya Sai Medical College and Research Institute, Chennai, India. His academic qualifications are MBBS (2004–2010) at Chengalpattu Government Medical College located at Chengalpattu, Tamil Nadu, India and M.D in Biochemistry (2012-2015) at Sree Balaji Medical College and Hospitals, Chennai. He had proposed Cardiac Vector Hypothesis and developed a Novel Perspective ECG Interpretation Method. He then focused his research on Arterial Blood Gas (ABG) analysis. He had developed a Novel ABG Interpretation method and constructed a Novel Four Quadrant Graphical Tool for ABG interpretation. He then focussed his research during COVID times on Ventilator Graphics Interpretation. He had derived Novel Equations of Motion for mechanical ventilation and published 3 research articles on Ventilator Graphics Interpretation in 2021. He had published 36 research articles, 3 books and one chapter. He received High Flyers 50 Global Achievers Awards 2022 for the Best Medical Science Researcher, Atmanirbhar Bharath Award 2022 and Indian Achievers Award 2021 for Excellence in Innovation awarded by the Indian Achievers Forum.

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