JOURNAL OF MULTIDISCIPLINARY SCIENCES AND INNOVATIONS
VOLUME 04, ISSUE 10
MOPNTHLY JOURNALS
ISSN NUMBER: 2751-4390
IMPACT FACTOR: 9,08

MODELING THE ELECTRICAL ACTIVITY OF THE HEART (Biophysics of the ECG Signal)

Tashkent State Medical University
Qurbonov Jamjid Muyiddinovich
Odinaboboyev Navruz Abdunabi ugli

Abstract:This article examines the theor etical and practical aspects of modeling the electrical activity of the heart muscle. Electrocardiography(ECG) is one of the main methods for studying cardiac electrical activity, widely used to measure the electrical signals generated during myocardial excitation and for diagnostic analysis.

Keywords: Heart muscle modeling of electrical activity, ECG, propagation of electrical signals, diagnostic analysis, biophysics, myocardium, heart rhythm, electrical conductivity.

Аннотация: В данной статье рассматриваются теоретические и практические аспекты моделирования электрической активности сердечной мышцы. Электрокардиография (ЭКГ) является одним из основных методов исследования электрической активности сердца, широко используемым для измерения электрических сигналов, возникающих во время возбуждения миокарда, и для диагностического анализа.

Ключевые слова: Сердечная мышца, моделирование электрической активности, ЭКГ, распространение электрических сигналов, диагностический анализ, биофизика, миокард, сердечный ритм, электрическая проводимость

Annotatsiya: Ushbu maqolada yurak mushaklarining elektr faolligini modellashtirish bo'yicha nazariy va amaliy jihatlar ko'rib chiqiladi . Elektrokardiografiya (EKG) yurak elektr faolyatini tadqiq etuvchi asosiy usullardan biri bo'lib , u miyokard qo'zg'alish jarayonida hosil bo'lgan elektr signallarni o'lchashda va diagnostik tahlil qilishda keng qo'llaniladi .

Kalit so'zlar: Yurak mushaklari, elektr faolligini modellashtirsh, EKG, elektr signallari tarqalishi, diagnostik tahlil, biofizika, miyokard, yurak ritmi, elektr o'tkazuvchanlik.

Introduction

The electrical activity of the heart muscle is a set of electrical impulses generated by ion currents occurring in cardiac cells. By measuring and modeling the heart's electrical activity using electrocardiography (ECG), it becomes possible to detect cardiac abnormalities earlier. Every year, millions of people suffer from cardiovascular diseases.

Main Part

The electrical activity of the heart refers to the changes in electrical signals that enable the cardiac muscles to contract and help circulate blood. Every heartbeat begins with a very small electric current generated by the movement of ions inside heart cells. Due to the movement of sodium, potassium, and calcium ions across the membranes of myocardial cells, a difference in electrical potential is produced. This process is called depolarization, during which the heart muscles begin to contract. Afterwards, the muscles return to their resting state, a phase known as repolarization.

These electrical processes regulate the rhythmic contractions of the heart. Each small impulse coordinates with the next one, creating the overall distinctive rhythm of the heart. Reproducing these processes on a computer and showing their changes over time is known as modeling electrical activity.

Importance of Modeling the Heart's Electrical Activity:

- Helps detect where and how rhythm disturbances originate.

- Allows safe experimentation with conditions not testable on real patients.

- Helps evaluate the effects of medications influencing heart ion channels.

- Improves interpretation of ECG signals and detection of abnormalities.

Electrocardiography (ECG)

Electrocardiography, or ECG, is a modern method for recording the electrical activity of the heart. ECG is a diagnostic tool that tracks each heartbeat and records the heart's electrical activity. Using special electrodes, these signals can be captured on the body's surface and recorded.

The electrode data are transmitted to a device that displays the heart's electrical activity graphically. This graph helps identify how each part of the heart functions. In a healthy person, ECG patterns vary depending on age, body structure, and individual characteristics. However, normal ECG always includes distinguishable waves and intervals reflecting sequential excitation of the heart muscle. In diseases, the duration, size, and direction of the waves change significantly. ECG is essential for diagnosing rhythm disorders, ischemic heart disease, and myocardial infarction.

Conclusion

The biophysics of the ECG is based on measuring the electrical signals generated on the body surface during contraction and relaxation of heart muscle cells. Modeling the electrical activity of the heart using biophysical equations allows computer simulation of impulse propagation. These methods are crucial for clinical diagnostics, early disease detection, and understanding arrhythmias.

References

- Guyton A.C., Hall J.E. Medical Physiology. — Philadelphia: Elsevier, 2021
- Berne R.M., Levy M.N. Cardiovascular Physiology. — Mosby, 2018.
- Malik M., Camm A.J. Dynamic Electrocardiography. — Blackwell Publishing, 2004.
- Plonsey R., Barr R. Bioelectricity: A Quantitative Approach. — Springer, 2010.
- Webster J.G. Medical Instrumentation: Application and Design. — John Wiley & Sons, 2014