




Influence of Ectopic Beats on the Average, Maximum, and Minimum Heart Rates

Asmaa A Ajwad  (PhD)¹, Muayad Kadhim Rashid (BSc, HD)², Ibrahim Tariq Ibrahim  (MSc)³, Mustafa Abdulkareem Salman  (MSc)⁴, Ali Mousa Jaafar(PhD)⁵
^{1,2,3,4,5} College of Medicine, University of Diyala ,Diyala, Iraq

Abstract

OPEN ACCESS

Correspondence Address: Asmaa A Ajwad
College of Medicine, University of Diyala,
Diyala, Iraq

Email: asmaamedeng@gmail.com

Copyright: ©Authors, 2023, College of
Medicine, University of Diyala. This is an
open access article under the **CC BY 4.0**
license

(<http://creativecommons.org/licenses/by/4.0/>)

Website:

<https://djm.uodiyala.edu.iq/index.php/djm>

Received: 29 October 2023

Accepted: 21 November 2023

Published: 25 December 2023

Background: Heart rate metrics including the average heart rate, maximum heart rate, and minimum heart rate reflect the physiological condition of the heart. Clinically, determining the impact of ventricular and atrial ectopic beats on those three metrics is important because they indicate how hard the heart is working.

Objective: To investigate the changes in heart rates of ventricular and atrial ectopic patients.

Patients and Methods: In this study, data from 90 persons (30 with ventricular ectopic beats, 30 with atrial ectopic beats, and 30 healthy people) were gathered and analyzed to see what changes in heart rate metrics may occur in patients with ectopic beats.

Results: According to our results, the three heart rate metrics in almost all three groups are statistically insignificant (p -value > 0.05). The average heart rate was significantly higher ($p < 0.05$) in ventricular ectopic patients than in atrial ectopic patients. The effect of age and gender on heart rate metrics were statistically assessed.

Conclusion: Despite the fact that no significant differences were found in all groups, there were certain differences that require further examination. One of the long-term objectives is to expand this study to incorporate electrocardiography (ECG) analysis in order to complete the comparison between the three groups.

Keywords: Ventricular ectopic beats, Atrial ectopic beats, Heart rate

Introduction

In order to force the heart muscle to contract and pump blood through the body's circulatory system, the cardiac conduction system relays the signals produced by the heart's pacemaker, the sinoatrial node. The signal passes through the right atrium, the atrioventricular node, the bundle of His, and the bundle branches, ultimately arriving at the Purkinje fibers located in the ventricle walls. Ectopic beats are caused by a

disruption in the electrical conduction pathway, which causes the heart to skip a beat or add an extra beat. Ectopic heartbeats are prevalent in otherwise healthy people of all ages. Based on their origin, ectopic beats are classified into ventricular ectopic beats when they originate in the heart ventricles and atrial ectopic beats when they originate in atria of the heart [1]–[6]. Both types can be

detected using an electrocardiogram (ECG) or a Holter monitoring device [1], [6–9].

A solitary or recurring cardiac pattern is seen in patients with ventricular ectopic beats. The isolated pattern consists of a normal heartbeat, a premature beat (ectopic rhythm), a pause, and a regular heart rate that is commonly distinguished by its high strength when compared to other regular beats. This enormous strength is supposed to come from the extra blood that enters the heart during the pause. Bigeminy, which defines a pattern in which ventricular beats alternate with a normal beat, and trigeminy, which describes a pattern in which a ventricular beat occurs after every two regular beats, are the two forms of repeated rhythms. Two or three recurring ventricular ectopic beats are referred to as doublets and triplets, respectively [2, 10]. Atrial ectopic beats, also known as premature atrial contractions (PACs), occur when electrical impulses are generated inside a region of the heart's atria before the heart's regular pacemaker (sinoatrial node) receives a signal [7,11]. While ventricular ectopic beats can be identified and observed on a 24-hour holter monitor in around 40% to 75% of healthy persons, atrial ectopic beats can be seen in about 60% of healthy people [7,12].

Despite the fact that ventricular and atrial ectopic beats are thought to be harmless and pose no pathological risk, research has shown that they are clinically important and can have underlying clinical implications for heart diseases [1], [12-15]. In this study, we looked at some measurements that characterize some heart features, such as heart rate and variability that may explain some of the cardiac characteristics in patients

with ventricular and atrial ectopic beats. Furthermore, a statistical investigation of the possible differences in those measurements between ventricular and ectopic individuals was performed. The aim of this study was to see if the heart rates of ventricular and atrial ectopic individuals differed.

Patients and Methods

Patients and Data Collection

Data from 60 patients (30 with ventricular ectopic beats and 30 with atrial ectopic beats) was collected and compiled in a private medical cardiac facility in Diyala province in Iraq from January 2019 to January 2020. In addition, data from 30 healthy participants were gathered to serve as comparative controls. Medical history, physical examination, blood pressure, weight, height, and drug history were all included in the clinical evaluation of each patient. The ethical criteria developed by the scientific committee of the institute of medicine faculty/ university of Diyala/Iraq were followed throughout the investigation.

Each subject was required to wear a Holter monitor for the whole 24 hours of the recording. The data was recorded and collected using a Contec TLC6000 Holter monitoring device which was implanted under the participant's chest for 24 hours following the methods outlined in the manufacturer's user manual. The participants were advised to continue with their usual routines while additionally doing some exercises according to their ability. After 24-hours of recording, the Holter was removed from the individual and the data was retrieved and archived for analysis.

The data was classified into three groups: controls, ventricular ectopic beats (VEBs),

and atrial ectopic beats (AEBs). Each category contains 30 sample. In each of the three categories, the data was then subdivided into subgroups based on the age and gender characteristics. The distribution of data in each group is depicted in Figures (1) and (2). In both control and atrial ectopic groups, female percentage was remarkably higher than male %. The gender distribution in the ventricular group was not very different.

Statistical Analysis

Heart rate parameters of the controls, ventricular ectopic patients, and atrial ectopic

patients were compared using Wilcoxon signed-rank test. Wilcoxon rank-sum test (Mann–Whitney test) was used to assess the effect of age and gender on heart rate metrics (average heart rate, maximum heart rate, and minimum heart rate) in controls, ventricular ectopic patients, and atrial ectopic patients. Statistical significance was defined as a p-value of less than 0.05.

Results

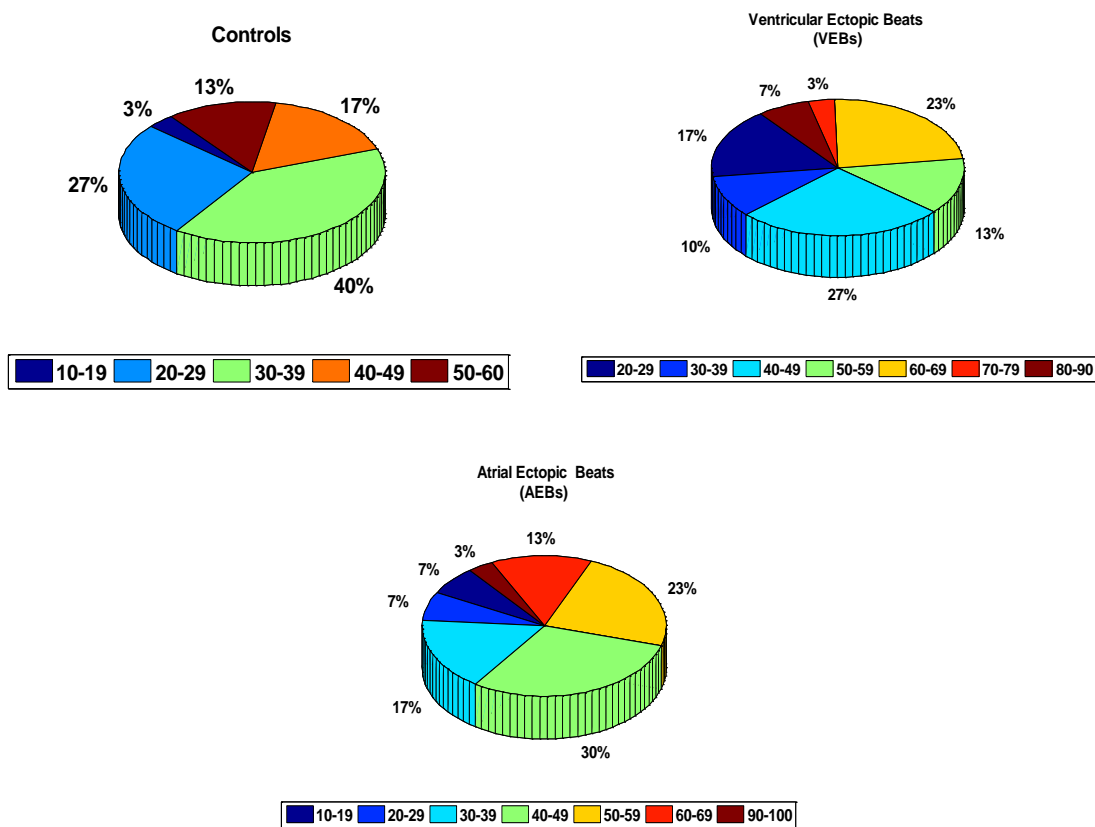


Figure (1): Age distribution of the control, ventricular ectopic (VEBs), and atrial ectopic (AEBs) groups. Each group had a decent mix of ages

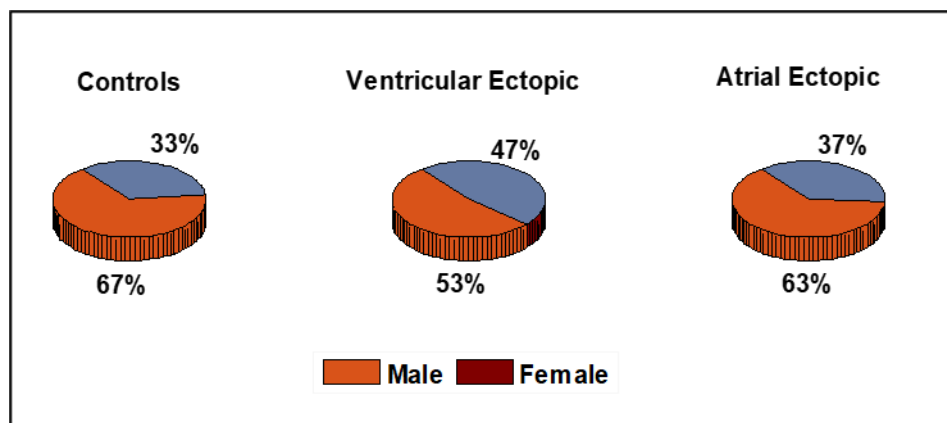


Figure (2): Distribution of the data according to gender factor

Heart Rate Changes between Control, Ventricular Ectopic, and Atrial Ectopic Groups

The difference in average heart rate between the three groups was statistically evaluated using the signed rank Wilcoxon test. Our results revealed that ventricular ectopic patients have a greater average heart rate than controls and atrial ectopic patients, albeit the difference was only significant between ventricular and atrial ectopic patients, Figure (3). While ventricular ectopic patients had a greater average heart rate than controls ($p=0.29$), atrial ectopic patients had a lower

average heart rate ($p=0.27$). The average heart rate in the atrial ectopic group was significantly lower ($p=0.05$) than that of the ventricular ectopic patients. While there was almost a significant difference in maximal heart rate between controls and ventricular ectopic patients ($p=0.0584$), there was no differences between controls and atrial ectopic patients or between atrial ectopic and ventricular ectopic patients ($p > 0.05$). The minimum heart rate decreased steadily from control to ventricular to atrial group, however the decrease was not significant ($p > 0.05$).

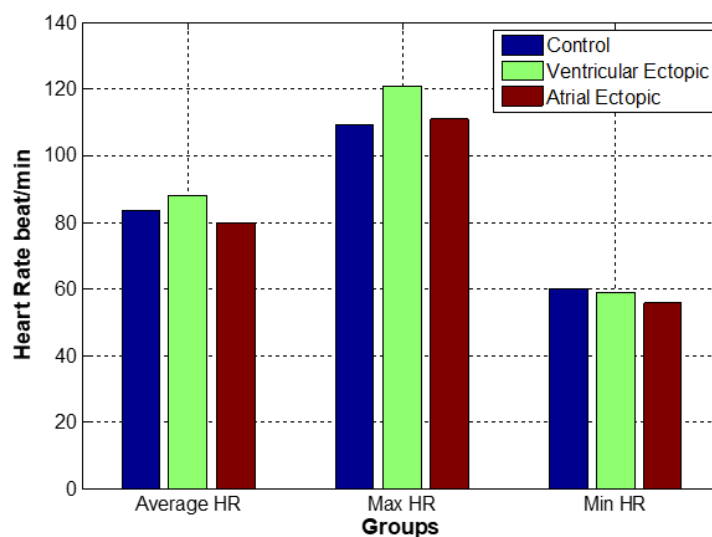


Figure (3): Changes in average, maximum, and minimum heart rates between the control, ventricular ectopic, and atrial ectopic groups. * indicates a significant difference

Heart Beats Changes between Control, Ventricular Ectopic, and Atrial Ectopic Groups

In term of total beats, our findings revealed that ventricular ectopic patients have fewer total beats than controls and atrial ectopic

patients, albeit this difference was only significant when compared to controls ($p=0.02$, signed rank Wilcoxon test). No significant difference has been observed in the number of abnormal beats between any of the three groups ($p > 0.05$).

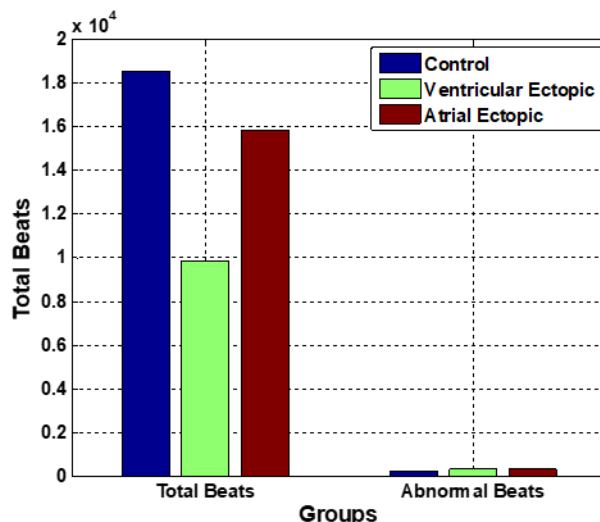


Figure (4): Total beats and abnormal beats were recorded in the three different groups. * indicates a significant difference

Age-Related Changes in Heart Rate Metrics

We then separated each of the three groups into subgroups depending on the subjects'/patients' ages in order to investigate the effect of age on heart rate metrics. Table 1 shows the differences in heart rate, maximum heart rate, and minimum heart rate for different age subgroups in controls. Despite the fact that our statistical analysis found no significant changes across all subgroups (p -value >0.05), heart rate characteristics in the subgroups (20-29, 30-39, and 40-49) appear to be nearly unchanged. The first and last age groups (10-19 and 50-60 years, respectively) are clearly distinguishable from the rest, but their differences did not reach the significance

level. It's possible that those differences are related to the fact that they have fewer subjects than others. In terms of heart rate changes in ventricular ectopic patients, our findings revealed that there are no discernible differences in heart rate, maximum heart rate, or lowest heart rate among subgroups (10-19, 30-39, 40-49, and 50-59), Table (2). On the other hand, the last two groups (60-69 and 90-100 years) and the second group (20-30 years) had remarkably similar values. Finally, atrial ectopic data showed that there are close variations in the values of the heart rate metrics between all age subgroups but subgroup (70-79) year, Table (3). Again no significant difference has been reported (p -value >0.05 , Wilcoxon test).

Table (1): Effect of Age on Heart Rate in Controls

Age Group (Year)	No. of Subjects	Average Heart Rate	Max. Heart Rate	Min. Heart Rate
10-19	1	98	141	78
20-29	8	83.25	107.5	59.5
30-39	12	83.75	109.83	59
40-49	5	86.6	110.6	63
50-60	4	77.75	99.75	56

Table (2): Effect of Age on Heart Rate in Ventricular Ectopic Patient

Age Group (Year)	No. of Subjects	Average Heart Rate	Max. Heart Rate	Min. Heart Rate
10-19	2	92	122.5	62
20-29	2	76.5	105.5	47.5
30-39	5	91.2	127.4	59
40-49	9	96.22	131.3	60.7
50-59	7	90.4	120.7	65.4
60-69	4	69.3	101.3	50.5
90-100	1	71	98	44

Table (3): Effect of Age on Heart Rate in Atrial Ectopic Patients

Age Group (Year)	No. of Subjects	Average Heart Rate	Max. Heart Rate	Min. Heart Rate
20-29	5	92	129	62
30-39	3	80.33	128.33	56.66
40-49	8	76.75	109	50.87
50-59	4	87.25	121.75	58.5
60-69	7	71.28	93.71	52
70-79	1	57	66	48
80-90	2	88	108	68

Gender-Related Changes in Heart Rate Metrics

Our results showed that there could be small differences in heart rate metrics between males and females in each group but they are

not significant (p-value > 0.05, Wilcoxon test), as shown in Table (4). Further examination is required to confirm these results.

Table (4): Effect of gender on Heart Rate

Group	Gender	Number of subjects/patients	Average Heart Rate	Max. Heart Rate	Min. Heart Rate
Control	Male	10	80.4	105.2	61.3
	Female	20	85.45	110.95	59.45
Ventricular Ectopic	Male	14	89.64	123.78	58.21
	Female	16	86.56	118.12	59.31
Atrial Ectopic	Male	11	82.81	119.18	57
	Female	19	78.15	106.10	54.84

Discussion

Researchers have recently focused on analyzing the effect of an ectopic beat on heart rate variability (HRV), which is defined by some metrics in both time domain and frequency domain and can provide physicians with useful information about the autonomic nervous system, cardiovascular system, and respiratory system, as opposed to heart rate (HR), which is limited to measuring the cardiovascular activity [16,17,18]. Despite this and to the best of our knowledge, no previous study has investigated the differences in average heart rate, maximum heart rate, minimum heart rate, and abnormal beats between controls, ventricular ectopic, and atrial ectopic patients. Thus, we looked at the differences in those characteristics between the three groups, as well as the influence of age and gender. Almost all groups exhibited no significant differences in those characteristics, according to our findings. There are, however, some distinctions that can be clinically significant and aid in the understanding of their physiological mechanisms.

Heart rate metrics (average heart rate, maximum heart rate, and minimum heart rate) in ventricular ectopic patients dropped in the 20-29, 60-69, and 90-100 year age groups as compared to other age groups. This could be due to the small number of individuals in those groups, which ranges from one to four, as seen in Table (2). The age group of (70-79) years revealed the lowest values of heart rate variables in atrial ectopic patients; however, there was one subject in that group which could be the reason for that reduction, see Table (3). We are gathering more data so that we can go

deeper into the investigation of age effect on heart rate metrics. In terms of gender, it appears that there is no significant effect on heart rate measurements.

Conclusions

Despite the fact that no significant differences were found, there were certain differences that require further examination. One of the long-term goals is to broaden this study to include ECG analysis so that the comparison between the three groups can be completed.

Recommendations

ECG can be used to detect the changes in PR interval and use it as a marker for heart rate variability, allowing us to fully assess the impact of ectopic beats on various heart rate metrics.

Source of funding: The current study was funded by our charges with no any other funding sources elsewhere.

Ethical clearance: Ethical approval was obtained from the College of Medicine / University of Diyala ethical committee for this study.

Conflict of interest: Nil

References

- [1] L. Parreira et al., "Premature ventricular contractions of the right ventricular outflow tract: upward displacement of the ECG unmasks ST elevation in V1 associated with the presence of low voltage areas," *Port. J. Cardiol.*, vol. 38, no. 2, pp. 83–91, 2019.
- [2] K. Ajiki and T. Sugimoto, "Premature ventricular contraction," *J. Clin. Med.* 49(11), pp. 2559–2563., vol. 49, no. 11, pp. 2559–2563, 2019.
- [3] Ph. Willacy, "Significance of extrasystoles," pp. 1–11, 2019.

- [4] N. S. Singhal et al., “Responsive neurostimulation for treatment of pediatric drug-resistant epilepsy,” *Epilepsy Behav. Case Reports*, vol. 10, pp. 21–24, 2018.
- [5] R. A. Winkle, “The relationship between ventricular ectopic beat frequency and heart rate,” *Circulation*, vol. 66, no. 2 I, pp. 439–446, 1982.
- [6] G. A. Ng, “Treating patients with ventricular ectopic beats,” *Heart*, vol. 92, no. 11, pp. 1707–1712, 2006.
- [7] R. F. G. Simpson, J. Langtree, and A. R. J. Mitchell, “Ectopic Beats: How Many Count?,” *EMJ Cardiol.*, no. October, pp. 88–92, 2017.
- [8] B. Paudel and K. Paudel, “The Diagnostic Significance of the Holter Monitoring in the Evaluation of Palpitation,” *J. Clin. Diagnostic Res.*, vol. 7, no. May 2012, pp. 480–483, 2013.
- [9] R. Bastiaenen et al., “The Ventricular Ectopic QRS Interval: A Potential Marker for Ventricular Arrhythmia in Ischemic Heart Disease,” *JACC Clin. Electrophysiol.*, vol. 2, no. 5, pp. 587–595, 2016.
- [10] J. K. Fitzpatrick and N. Goldschlager, “A case of narrow complex bigeminy, what is the underlying rhythm?,” *J. Electrocardiol.*, vol. 51, no. 3, pp. 379–381, 2018.
- [11] R. S. Loomba, S. Aiello, S. Aggarwal, G. Aggarwal, and R. R. Arora, “Premature Atrial and Ventricular Contractions: Prevalence, Clinical Evaluation, and Associated Morbidity as Noted from the Nationwide Inpatient Sample,” *EC Cardiol.*, vol. 5, no. January, pp. 10–16, 2018.
- [12] M. Ahn, “Current Concepts of Premature Ventricular Contractions,” *J. Lifestyle Med.*, vol. 3, no. 1, pp. 26–33, 2013.
- [13] G. M. Marcus and T. A. Dewland, “Premature Atrial Contractions: A Wolf in Sheep’s Clothing?,” *J. Am. Coll. Cardiol.*, vol. 66, no. 3, pp. 242–244, 2015.
- [14] B. G. Goel and J. Han, “Atrial ectopic activity associated with sinus bradycardia,” *Circulation*, vol. 42, no. 5, pp. 853–858, 1970.
- [15] V. Čulić, N. Silić, and D. Mirić, “Triggering of ventricular ectopic beats by emotional, physical, and meteorologic stress: Role of age, sex, medications, and chronic risk factors,” *Croat. Med. J.*, vol. 46, no. 6, pp. 894–906, 2005.
- [16] M. Malik, “Heart Rate Variability,” *Eur. Heart J.*, pp. 281–296, 1996.
- [17] H. S. Ahyoung Choi, “quantitative analysis of the effect of an ectopic beat on the heart rate variability in the resting condition.” *Frontiers in physiology*, 2018.
- [18] L. Zhao, P. Li, J. Li, and C. Liu, “Influence of ectopic beats on heart rate variability analysis,” *Entropy*, vol. 23, no. 6, pp. 1–14, 2021.

تأثير ضربات القلب المهاجرة على متوسط، الحد الأقصى، والحد الأدنى لمعدلات ضربات القلب

أسماء عباس اجود¹, مؤيد كاظم رشيد², إبراهيم طارق ابراهيم³, مصطفى عبد الكريم سلمان⁴, علي موسى جعفر⁵

الملخص

خلفية الدراسة: تعكس مقاييس معدل ضربات القلب، بما في ذلك متوسط معدل ضربات القلب والحد الأقصى لمعدل ضربات القلب والحد الأدنى لمعدل ضربات القلب، الحالة الفسيولوجية للقلب. من الناحية السريرية، يعد تحديد تأثير ضربات القلب المهاجرة البطينية والأذينية على هذه المقاييس الثلاثة أمرًا مهمًا لأنها تشير إلى مدى صعوبة عمل القلب. **اهداف الدراسة:** لبحث التغيرات في معدلات ضربات القلب لدى مرضى الضربات المهاجرة البطينية والأذينية. **المرضى والطرائق:** في هذه الدراسة، تم جمع وتحليل بيانات من 90 شخصًا (30 مصابًا بضربات القلب المهاجرة البطينية، و30 مصابًا بضربات القلب المهاجرة الأذينية، و30 شخصًا سليمًا) لمعرفة التغيرات في مقاييس معدل ضربات القلب التي قد تحدث في المرضى الذين يعانون من ضربات القلب المهاجرة. **النتائج:** وفقًا لنتائجنا، فإن مقاييس معدل ضربات القلب الثلاثة في جميع المجموعات الثلاث تقريبًا ليست ذات أهمية إحصائية قيمة ($p > 0.05$). وكان متوسط معدل ضربات القلب أعلى بكثير ($P < 0.05$) في مرضى ضربات القلب المهاجرة البطينية منه في مرضى ضربات القلب المهاجرة الأذينية. تم تقييم تأثير العمر والجنس على مقاييس معدل ضربات القلب إحصائيًا. **الاستنتاجات:** على الرغم من عدم وجود فروق ذات دلالة إحصائية في جميع المجموعات، إلا أن هناك بعض الاختلافات التي تتطلب مزيدًا من الدراسة. أحد الأهداف طويلة المدى هو توسيع هذه الدراسة لتشمل تحليل تخطيط كهربية القلب (ECG) من أجل استكمال المقارنة بين المجموعات الثلاث.

الكلمات المفتاحية: ضربات القلب المهاجرة البطينية، ضربات القلب المهاجرة الأذينية، معدل ضربات القلب

البريد الإلكتروني: asmaamedeng@gmail.com

تاريخ استلام البحث: 29 تشرين الأول 2023

تاريخ قبول البحث: 21 تشرين الثاني 2023

5,4,3,2,1 كلية الطب – جامعة ديالى – ديالى - العراق