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ORIGINAL ARTICLE

Cardiac Rhythm in Inpatient Physical Therapy and Rehabilitation Patients

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Abstract

Introduction: This study aimed to document the presence of cardiac arrhythmia in inpatient physical therapy and rehabilitation patients and to evaluate whether physical therapy and exercises cause an increase in cardiac arrhythmias.

Methods: The study was conducted with patients hospitalized in the physical therapy and rehabilitation clinic due to any neuromusculoskeletal system disease between January 2022 and June 2022. Twenty-four-hour Holter recordings were performed before any treatment was initiated and again on the 21st day of hospitalization during treatment. Arrhythmias were then evaluated.

Results: A total of 63 patients (mean age: 58±14.5 years; range, 22–86 years) were included. The frequency of supraventricular and ventricular premature beats was 65.1% and 50.8%, respectively, in the initial 24-hour Holter recordings. Ventricular bigeminy was detected in 11.1%, ventricular trigeminy in 11.1%, ventricular couplets in 15.9%, nonsustained ventricular tachycardia in 9.5%, >1000 ventricular premature beats in 9.5%, and sinus pauses over 1.8 seconds in 11% of patients. No statistically significant difference was observed between the first and second 24-hour Holter recordings regarding supraventricular and ventricular arrhythmias.

Discussion and Conclusion: The incidence of arrhythmia in inpatient physical therapy and rehabilitation patients is higher than in the general healthy population. Although the frequency of arrhythmia did not increase during the treatments in our study population, meticulous follow-up for cardiac symptoms and signs is recommended, considering the high risk of cardiovascular disease in this patient group.

Keywords: Adverse events; Cardiac arrhythmia; Rehabilitation.

Physical therapy and rehabilitation departments are generally considered to be at lower risk of adverse events than other departments because the treatments applied are generally conservative. However, there is a possibility of encountering unfavorable events, especially during inpatient rehabilitation, since the population served is mostly composed of elderly patients in the post-acute period with low functional levels and various health problems. Unfortunately, due to the lack of reporting of unfavorable situations observed during inpatient rehabilitation, few data are available on this subject. In addition, it is observed that different terms such as adverse event, adverse outcome, and complication are used in these studies, and the terminological standardization is poor [1-7].

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Adverse events are defined as any unfavorable sign, symptom, or disease that occurs during or after the use of a drug or intervention, whether or not considered drug- or intervention-related. Additionally, the severity of adverse events can range from asymptomatic to fatal [8-10]. Siegler et al. [3] classified the adverse events that developed during inpatient treatment according to their severity and stated that serious surgical, infectious, cardiac, and thromboembolic complications were observed, and complications were generally observed in patients with deconditioning or spinal cord injury. The rate of development of cardiac complications was 9.5%, and 4 out of 5 deaths observed during the study were due to cardiac causes.

Detailed examination of cardiac signs and symptoms in inpatient rehabilitation patients is important for the prevention and control of these adverse cardiac events. Arrhythmias are well-known indicators of cardiovascular disease-related morbidity and mortality, with or without cardiovascular risk factors [11]. In this study, we aimed to document the presence of cardiac arrhythmia in inpatient physical therapy and rehabilitation patients and to evaluate whether physical therapy and exercises cause an increase in cardiac arrhythmias.

Materials and Methods

Design

The study was carried out as a cross-sectional study at the Physical Medicine and Rehabilitation Clinic of Trakya University Faculty of Medicine between January 2022 and June 2022. Participants volunteered for the study in accordance with the Declaration of Helsinki and signed the informed consent form. Approval of the local ethics committee (TUTF-BAEK 2021/423) was obtained for the study. Financial support for this study was provided by the Trakya University Scientific Research Project Unit with decision no 2021/161.

Participants

Patients over the age of 18 who were scheduled to receive inpatient physical medicine and rehabilitation treatment due to any neuromusculoskeletal system disease were included in the study. Exclusion criteria were initiation or change in dose of medication affecting heart rhythm in the last two weeks and failure to complete both 24-hour Holter recordings.

Clinical Evaluations

At study initiation, all patients were clinically evaluated, and exercise and physical agents required by their clinical condition were prescribed. In addition to recording the patients' age, gender, body mass index, smoking and alcohol use status, comorbidities, and drugs used, 10-year atherosclerotic cardiovascular disease (ASCVD) risk categories were determined by examining their medical records. Patients were grouped as low risk (<5%), borderline risk (5%–7.4%), high risk (7.5%–19.9%), and very high risk (≥20%) in terms of 10-year ASCVD risk [12].

24-hour Holter Electrocardiogram (ECG) Evaluations

Twenty-four-hour Holter ECG recordings were performed before any treatment was started (first 24-hour Holter recording) and during treatment (second 24-hour Holter recording) on the 21st day of hospitalization using a 24-hour Holter ECG recorder (BORSAM Biomedical Instrument Co., Ltd. Shenzhen). On the day of the first 24-hour Holter recording, patients were instructed to rest except for eating and toilet needs, and no treatment (medical, physical agents, or exercise) was initiated. During the second 24-hour Holter recording, the medical treatments, exercises, and physical agent applications the patients were receiving were continued. On 24-hour Holter recording days, patients were instructed to record all activities throughout the day with corresponding times.

Arrhythmias were evaluated using the 24-hour Holter recordings by the principal investigator, who specializes in both cardiology and physical medicine and rehabilitation. In addition, the types and durations of exercises applied to the patients were recorded, and the maximum heart rates observed during these periods were compared with patients' resting heart rates.

Statistical Analysis

The obtained data were analyzed using the SPSS program. The distribution normality of the data was evaluated with the Shapiro-Wilk test. McNemar test was used to compare categorical dependent variables, and Wilcoxon signed rank test was used for repeated measurement comparisons of dependent groups. A p-value of <0.05 was considered statistically significant.

Table 1. Clinical characteristics of the patients

Variables	n	%	Mean±SD (min-max)
Age (year)			58±14.5 (22-86)
BMI (kg/m²)			28.7±5.7 (15.2-46.7)
Smokers	25	39.7	
Alcohol users	8	12.7	
Comorbidities			
Hypertension	30	47.6	
Hyperlipidemia	24	38.1	
Diabetes mellitus	11	17.5	
Coronary artery disease	11	17.5	
Cerebrovascular disease	16	25.4	
Pulmonary disease	9	14.3	
Thyroid disease	9	14.3	
Drugs used			
Analgesics	46	73	
Antihypertensives	30	47.6	
Negative Chronotropic Drugs	14	22.2	
Levothyroxine	9	14.3	
Beta agonists	8	12.7	
10-year risk for ASCVD			
Low risk	24	41.4	
Borderline risk	8	13.8	
Moderate risk	14	24.1	
High risk	12	20.7	

ASCVD: atherosclerotic cardiovascular disease. Chronotropic Drugs: Beta blockers, digoxin, non-dihydropyridine calcium channel blocker, amiodarone.

Results

A total of 203 patients were screened to determine eligibility, and 78 met the criteria to participate. The second 24-hour Holter recordings could not be performed and were excluded from the study, as 12 patients had a hospital stay shorter than 3 weeks, 1 patient had tuberculosis, 1 patient had coronavirus disease 2019 (COVID-19), and 1 patient was referred to another clinic because of acute myocardial infarction. Data of 63 patients, 41 (65.1%) women and 22 (34.9%) men, were analyzed. Table 1 presents patients' age, body mass index, smoking and alcohol use, comorbidities, medications that may affect heart rate and blood pressure, and 10-year atherosclerotic cardiovascular risk levels.

The frequency of patients with arrhythmia according to the first and second 24-hour Holter recordings is shown in Table 2. None of these arrhythmias were symptomatic. Multifocal atrial tachycardia, atrial flutter, atrial fibrillation, atrioventricular nodal tachycardia, atrioventricular nodal reentrant tachycardia, sustained ventricular tachycardia, Torsades de Pointes, and ventricular fibrillation were not detected in any of the patients in the first and second 24-hour Holter recordings.

No statistically significant difference was observed between the first and second 24-hour Holter recordings in terms of heart rate (resting, maximum, and minimum) and the number of supraventricular premature beats, ventricular premature beats, ventricular bigeminy, ventricular trigeminy, ventricular couplets, and nonsustained ventricular tachycardia (Table 3) ($p>0.05$).

When the maximum heart rate values during different exercise types and the differences compared to resting heart rate were evaluated, it was observed that the highest heart rate (116.5±24.45 bpm) occurred during isotonic exercises, with an average increase of 38.87±21.49 beats compared to resting heart rate. This was followed by aerobic, balance, range of motion, isometric, stretching, and breathing exercises, respectively (Table 4).

Table 2. Comparison of the frequency of patients with arrhythmia in the first and second 24-hour Holter recordings

Variables	First 24-hour Holter recording n (%)	Second 24-hour Holter recording n (%)	*p
Supraventricular premature beats	41 (65.1)	45 (71.4)	0.424
Ventricular premature beats	32 (50.8)	31 (49.2)	1.00
Ventricular bigeminy	7 (11.1)	8 (12.7)	1.00
Ventricular trigeminy	7 (11.1)	9 (14.3)	0.687
Ventricular couplet	10 (15.9)	9 (14.3)	1.00
Nonsustained ventricular tachycardia	6 (9.5)	6 (9.5)	1.00
Frequent (>1000) ventricular premature beats	6 (9.5)	6 (9.5)	1.00
Sinus pause (>1.8 seconds)	7 (11.1)	8 (12.7)	1.00

*p value by McNemar test. Statistically significant p–value < 0.05.

Table 3. Analysis of the number of the arrhythmias and the heart rates detected in the first and second 24-hour Holter recordings

Variables	First 24-hour Holter recording Mean±SD Median (min-max)	Second 24-hour Holter recording Mean±SD Median (min-max)	p*
Number of supraventricular premature beats/24 h	899.46±2359.77 14 (0-13165)	706.84±2362.68 37 (0-13300)	0.389
Number of ventricular premature beats/24 h	456.06±1449.96 2 (0-8159)	457.92±1667.09 0 (0-9919)	0.572
Number of ventricular bigeminy/24 h	5.54±35.26 0 (0-276)	4.87±30.65 0 (0-241)	0.918
Number of ventricular trigemini/24 h	12.92±81.32 0 (0-629)	17.92±112,47 0 (0-884)	0.385
Number of ventricular couplets/24 h	4.73±24.79 0 (0-189)	3.62±15.33 0 (0-107)	0.559
Number of nonsustained ventricular tachycardia/24h	2.11±14.55 0 (0-115)	0.48±2.21 0 (0-15)	0.876
Resting heart rate (bpm)	77.69±9.84 78 (50-100)	78.17±9.62 79 (56-105)	0.886
Maximum heart rate (bpm)	119.28±20.30 118 (78-170)	119.49±21.08 120 (75-184)	0.997
Minimum heart rate (bpm)	55.04±9.06 56 (35-72)	53.80±9.02 54 (35-76)	0.107

*p value by Wilcoxon signed rank test. Statistically significant p–value < 0.05.

Table 4. Maximum heart rates detected during exercises and their differences compared to resting heart rates

Type of exercises	n (%)	Maximum heart rate during exercise (bpm) Mean±SD (min-max)	Difference with resting heart rate (bpm) Mean±SD (min-max)
Range of motion exercise	50 (79.4)	95.48±13.04 (73-123)	19.62±10.81 (0-45)
Isometric strengthening exercise	46 (73)	98.84±13.77 (72-142)	22.73±11.82 (1-64)
Isotonic strengthening exercise	8 (12.7)	116.5 ± 24.45 (86-150)	38.87±21.49 (16-72)
Balance exercise	35 (55.6)	103.51±20.09 (73-165)	27.74±17.16 [(-2)-87]
Stretching exercise	24 (38.1)	93.87±12.63 (72-123)	16.04±12.12 ([-3]-49)
Aerobic exercise	4 (6.3)	106±11.22 (91-118)	27.75±4.99 (23-33)
Breathing exercises	13 (20.6)	86.07±16.14 (60-111)	13.30±13.51 ([-4]-36)

Discussion

In the current study, heart rhythms were observed with 24-hour Holter recordings at admission and after 3 weeks of treatment in inpatient physical therapy and rehabilitation patients. While the frequency of supraventricular and ventricular premature beats was 65.1% and 50.8%, respectively, in the first 24-hour Holter recordings, arrhythmias with greater clinical importance—such as ventricular bigeminy, ventricular trigeminy, ventricular couplets, nonsustained ventricular tachycardia, >1000 ventricular premature beats, and sinus pause (>1.8 seconds)—were observed in approximately 1 out of every 10 patients, and these rates were higher than those in the general healthy population [13].

In their study of 24-hour Holter ECG recordings in healthy adults, Hingorani et al. [13] observed supraventricular premature beats in 60.8% of volunteers, ventricular premature beats in 43.4%, multifocal premature ventricular beats in 5.3%, >200 ventricular premature beats in 3.3%, supraventricular tachycardia in 2.2%, nonsustained ventricular tachycardia in 0.7%, and sinus pause for >3 seconds in 0.3%. This indicates that inpatient physical therapy and rehabilitation patients constitute a high-risk group in terms of complex arrhythmias.

However, when the first and second Holter recordings were compared, it was observed that physical agents and exercises did not increase cardiac arrhythmias. In addition, nearly half of the patients were at moderate or high risk for atherosclerotic cardiovascular disease. Moreover, one patient (excluded) experienced a heart attack while the study was in progress. For these reasons, meticulous monitoring of inpatient physical therapy and rehabilitation patients for cardiac signs and symptoms is essential.

The main purpose of patient rehabilitation is to improve the functional status of patients, and the main options used are therapeutic exercise and physical agents, in addition to medical treatment. Although the treatments applied in physical therapy and rehabilitation clinics usually do not involve a high risk of adverse events, this should not mean that there is no risk at all. Studies have shown that the most common adverse event in patients receiving inpatient rehabilitation is falling [5-7]. However, the risk of life-threatening complications is <1%, which is quite low, and deaths occur mainly due to cardiac and pulmonary causes [3,14]. It is important to determine the cardiovascular risk factors of patients as well as to assess known cardiovascular diseases at the time of admission to prevent these cardiovascular adverse events. When defining pre-exercise screening procedures in the Australian Sports Medicine system, 43–73% of men and 44–61% of women stated that they would need medical screening [15]. Typically, hyperlipidemia, hypertension, smoking, diabetes mellitus, and obesity are risk factors for cardiovascular disease [16]. Kirkness et al. [17] found the prevalence of hypertension and diabetes in patients referred for outpatient physical therapy to be 70.4% and 13.2%, respectively. In the current study, the prevalence of hypertension, hyperlipidemia, diabetes, and coronary artery disease was 47.6%, 38.1%, 17.5%, and 17.5%, respectively. In addition, 44.8% of patients had a moderate or high 10-year ASCVD risk. On the other hand, studies have shown that the rate of routine evaluation of vital signs in physical therapy and rehabilitation practice is as low as 14.8–50% [18-20].

Increased exercise and physical activity levels are associated with a reduced risk of cardiovascular disease, including myocardial infarction, cardiovascular disease-related death, and all-cause death, although the potential adverse effects of vigorous exercise levels and the ideal intensities of exercises continue to be explored [21]. Vigorous exercise may pose various cardiovascular risks, especially in individuals with cardiovascular or structural heart diseases, and in physically inactive individuals when exercise is not graded or when the exercise prescription is not individually adapted [22]. One of the most important pieces of evidence regarding the safety of rehabilitation programs is whether cardiac arrhythmia is observed during and after treatment. Benninghoven et al. [23] evaluated cardiac arrhythmias such as atrial fibrillation, ventricular tachycardia, and cardiac syncope in patients with Marfan syndrome by monitoring them during personalized exercises in a 3-week inpatient rehabilitation program and reported that no side effects disrupting the heart rhythm of the patients were observed.

In recent years, the use of 24-hour Holter ECG recordings has become increasingly common due to their ability to detect transient and infrequent arrhythmias in cardiac safety studies for both drugs and interventions. We also preferred to perform 24-hour Holter ECG follow-up before and during the 3rd week of inpatient rehabilitation in order to document whether there were cardiac rhythm abnormalities, symptomatic or otherwise. According to the first 24-hour Holter recordings, the arrhythmia rates observed in the patients were higher than in the normal healthy population. While the percentages of supraventricular premature beats, ventricular premature beats, ventricular bigeminy, ventricular trigeminy, nonsustained ventricular tachycardia, and sinus pause were 60.8, 43.4, 0.6, 0.5, 0.7, and 4, respectively, in a 24-hour Holter examination by Hingorani et al. [13] in healthy volunteers aged 18–65 years, these percentages were 65.1, 50.8, 11.1, 11.1, 9.5, and 11.1, respectively, in the current study.

Although it is accepted that supraventricular and ventricular extra beats in healthy individuals are not prognostic, recent studies show that high-frequency ventricular premature beats are associated with an increased risk of heart failure and death in individuals with normal ejection fraction [24,25]. In particular, more is known about the prognostic value of ventricular beats in relation to subsequent arrhythmic events and sudden death in people with myocardial pathologies. The Lown classification is valuable for understanding the prognostic value of ventricular premature beats. In this system, in which ventricular premature beats are classified according to their frequency and origin, Lown class 3 and above—that is, multiform ventricular premature beats, ventricular couplets, ventricular tachycardia of ≥3 beats, and early-cycle ventricular premature beats—are predictors for all-cause deaths after acute myocardial infarction [26,27].

In the current study, the incidence of ventricular tachycardia with a frequency of 15.9%, ventricular couplets with a frequency of 9.5%, and frequent ventricular premature beats with a frequency of 9.5% in inpatient physical therapy and rehabilitation patients is important for demonstrating the risk level of this patient group in terms of cardiac arrhythmias. Therefore, the holistic evaluation of patients by physicians is very important for proper management.

Irsay et al. [28] stated that in patients with degenerative knee osteoarthritis with or without heart disease, no significant increase was observed in heart rate, supraventricular premature beats, or ventricular premature beats during and immediately after electrotherapy with 24-hour Holter recording. Similarly, in this study, it was observed that there was no significant increase in the number and incidence of arrhythmias during physical therapy and rehabilitation in inpatients.

Changes in heart rate and blood pressure during exercise types differ due to the varying autonomic responses to dynamic and static exercises. In our study, the increase in heart rate compared to rest during different exercise types was evaluated, and it was seen that the exercise that caused the highest increase in heart rate was isotonic strengthening exercise. Iellamo et al. [29] also stated that isotonic exercise increased heart rate 50% more than isometric exercise. In our study, aerobic and balance exercises were observed to be the other exercise types that caused the highest increase in heart rate following isotonic exercise. In fact, it is expected that more cardiovascular load would develop during aerobic exercises, since only one extremity muscle is used during isotonic exercises, whereas all body muscles are engaged during aerobic exercises. However, in our study, aerobic exercises were applied with monitoring within the predetermined heart rate limits; therefore, it is not appropriate to evaluate them as the exercise type with the highest heart rate increase. On the other hand, it is noteworthy that the heart rate increase observed in isotonic and balance exercises was comparable to the target heart rate level in aerobic exercises. This finding raises the question of whether monitoring may also be required during some exercises other than aerobic exercises, especially in patients with high cardiovascular risk.

The study had a prospective design that provided objective and comparable data with Holter recordings before and during treatment. Twenty-four-hour Holter recording is an effective method to analyze arrhythmias in detail and to increase the reliability of the results [30]. The standardization of the time interval between Holter recordings for all patients enhanced the homogeneity of the results. In addition to these advantages, our study also had some limitations. The sample size was not calculated, as all eligible patients within the given time period were included. The 21-day study focused on short-term effects and did not provide information on long-term outcomes. The study was limited to a single clinic; therefore, the generalizability of the results to other centers is restricted. Furthermore, the types and specific indications of the physical agents used, as well as the body parts to which they were applied, were not recorded, limiting the ability to examine treatment-related changes in detail. Future studies with larger sample sizes and subgroup analyses may provide more comprehensive information about the cardiac safety of physical medicine and rehabilitation treatments, taking into account different indications, types of physical agents, and application sites.

Conclusion

A significant portion of the population served in inpatient physical therapy and rehabilitation consists of patients of advanced age with various comorbidities and drug use that can affect heart rhythm. The incidence of arrhythmia in these patients is higher than in the general healthy population. No increase in cardiac arrhythmias was observed during and after the application of physical agents and exercises in our study population. However, considering the high risk of cardiovascular disease, it is recommended that this patient group be followed meticulously for cardiac symptoms and signs.

Ethics Committee Approval: The study was approved by Trakya University Clinical Research Ethics Committee (No: TUTF-BAEK 2021/423, Date: 15.11.2021).

Conflict of Interest: The authors declare that there is no conflict of interest.

Informed Consent: The study's participants gave their written informed consent.

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