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RESEARCH ARTICLE

Newborns Hospitalized in Pediatric Cardiac Intensive Care Unit Due to Supraventricular Tachyarrhythmia: A Single-Center Experience

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ABSTRACT

Objective: Tachyarrhythmias are frequently observed arrhythmias in newborns. This study aimed to evaluate infants hospitalized due to supraventricular tachyarrhythmia (SVT) in our cardiac center.

Materials and Methods: The study was conducted between August 01, 2020, and August 01, 2022, in neonates hospitalized in the pediatric cardiac intensive care unit due to SVT. General characteristics, echocardiographic findings, type and localization of tachyarrhythmia, and medical treatments were evaluated.

Results: There were 22 cases during the study period. About 50% of the cases were male. The median age was 21 days (interquartile range [IQR] 15–27), and the median weight was 3.6 kg (IQR 3.2–4) at the time of diagnosis. The most common symptoms were restlessness in 50% (n = 11) and rapid breathing in 30% (n = 7). Tachyarrhythmia was detected during a routine examination in six cases and during fetal echocardiography in two cases. Left ventricular dysfunction was present on echocardiography in four patients initially. Congenital heart disease (CHD) was detected in four patients and cardiac tumor in two patients. Arrhythmia mechanisms were atrioventricular reentry tachycardia (n = 10), four of them were Wolff-Parkinson-White syndrome, and two of them were permanent junctional reciprocating tachycardia, focal atrial tachycardia (n = 6), atrial flutter (n = 4), and congenital junctional ectopic tachycardia (n = 1). Radiofrequency catheter ablation was performed in one patient due to resistance to medical treatment and left ventricular dysfunction.

Conclusion: SVTs are the leading cause of arrhythmias in newborns and the majority of them originate from the accessory pathway. Neonatal patients should be investigated for CHD and cardiac rhabdomyoma and if these conditions are detected, multiagent treatment should be considered in prophylactic medical therapy.

Keywords: Cardiovascular intensive care unit, heart failure, newborn, rhabdomyoma, supraventricular tachyarrhythmia

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INTRODUCTION

Supraventricular tachyarrhythmia (SVT) is the most common cause of arrhythmias requiring medical treatment in childhood, with a prevalence of 0.6/1000 in neonates, which is lower than in other childhood age groups.[1]

Clinical findings may vary according to the type of tachyarrhythmia and the duration of SVT in newborns. Cases that presented with different clinical findings such as restlessness, rapid breathing, pallor, and cardiogenic shock have been reported.[2,3]

The main goal in the acute treatment of SVT is to rapidly convert the rhythm to sinus rhythm and to ensure the sustainability of this rhythm. Considering that tachyarrhythmia may regress in one-third of cases up to the age of 1 year, single or combined antiarrhythmic treatment options are implemented in different clinics. In addition, ablation therapy is

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also used as a treatment option in cases that are refractory despite medical treatment or in cases where heart failure cannot be kept under control.[2–4]

In this study, neonatal patients hospitalized in the pediatric cardiac intensive care unit (PCICU) of our cardiac center due to SVT were evaluated. The aim of the study was to evaluate the demographic characteristics of the cases, type of SVT, treatments applied, and outcomes of treatments.

MATERIALS and METHODS

This study was conducted retrospectively in neonates with SVT admitted to the PCICU between August 01, 2020, and August 01, 2022. Premature cases, sinus tachycardia, ventricular tachycardia, and post-operative tachyarrhythmias were excluded from the study. The study was carried out in accordance with the Declaration of Helsinki after obtaining permission from the Local Committee.

A study form was prepared for each patient including gender, weight, age at diagnosis, presenting complaint, 12-lead electrocardiography (ECG) and echocardiography findings, 24-h Holter ECG result, antiarrhythmic drugs used, and presence of ablation.

Symptoms and complaints were categorized into four main groups: (a) restlessness, absence of suckling, and pallor, (b) rapid breathing or difficulty breathing, (c) routine physical examination, and (d) routine fetal echocardiography.

ECG was conducted in 12 leads at 25 mm/s and 10 mm/mV amplitude using a Philips Page Writer Trim II device. Tachycardia is defined as a heart rate of 95th percentile or higher according to age-specific standard values. 12-lead ECG and 24-h Holter recordings were evaluated for the classification of arrhythmias. Similar to the previous studies arrhythmia was diagnosed either by standard electrocardiographic criteria or invasive electrophysiology study demonstrating a non-sinus tachycardia mechanism in each patient.[2–6]

The echocardiographic evaluation was performed as recommended by the American Society of Echocardiography guideline.[7] Systolic dysfunction was noted in case of an ejection fraction of less than 55% or shortening fraction of <28%. Patients with systolic dysfunction and a left ventricular end diastolic diameter Z score >+2 were classified as dilated cardiomyopathy.

Medical treatment was divided into three categories: (a) abortive therapies; (b) acute management, which includes therapies used to achieve heart rate control or to improve the likelihood of arrhythmia abortion; and (c) prophylactic therapies used to prevent SVT recurrence.[8]

Abortive therapy was defined as the use of adenosine or cardioversion at any given time. Acute therapy was defined as amiodarone or esmolol if initiated on the 1st day after diagnosis. Prophylactic therapy was defined as amiodarone, esmolol, or any other beta-blocker, digoxin, or flecainide if initiated on the 1st day after diagnosis or any given time.

Treatment-refractory tachyarrhythmia was defined as systolic or diastolic dysfunction and/or despite treatment with two or more anti-arrhythmic agents the worsening of heart failure findings. These patients underwent electrophysiologic study and a catheter ablation procedure.

Statistical Analysis

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS, Chicago, Illinois, USA) Version 21.0 for Windows. The descriptive analysis (median, frequency, and interquartile range (IQR)) was performed to identify the general and specific features of the studied sample.

RESULTS

Study Population Characteristics

Twenty-two patients fulfilled the inclusion criteria. Among these 22 patients, 11 were male, and 11 were female. The median age was 21 days (IQR 15–27), and the median weight was 3.6 kg (IQR 3.2–4).

The most common symptoms were restlessness (n=11), tachypnea (n=7), or tachycardia determined during routine physical examination (n=6) or fetal echocardiography (n=2). One patient with restlessness later had cardiopulmonary arrest.

Five patients had congenital heart disease (CHD). Twenty-five percentages of patients had systolic dysfunction in the initial echocardiography. Two patients had arrhythmia-induced dilated cardiomyopathy. The demographics of patients are summarized in Table 1.

Arrhythmia Classification

Tachycardia was subclassified by ECG and Holter ECG in 15 patients with SVT. Focal atrial tachycardia (FAT) was diagnosed in six patients and the most common form of SVT. Wolff-Parkinson-White syndrome (WPW) and atrial flutter, seen in four patients each, were second most common form of tachycardia. Concealed accessory pathway and permanent junctional reciprocating tachycardia (PJRT) seen in two patients each. Congenital junctional ectopic tachycardia was the least common form. And seen only in one patient, only patient with an unclassified form of tachycardia had SVT with narrow QRS and short RP (probably atrioventricular re-entry tachycardia).

Table 1. General characteristics of patients

Variable	n=22	%
Age/day	21 (15–27)	
Weight/kg	3.6 (3.2–4)	
Male	11	50
Symptom		
Restlessness	11	50
Tachypnea	7	30
Routine physical examination	6	27
Tachycardia in fetal ultrasonography	2	9
Initial Electrocardiography		
Normal	9	40
WPW	4	18
PJRT	2	9
JET	1	5
AF	4	18
Initial echocardiography		
Normal	10	44
Ebstein's anomaly	1	5
Corrected transposition of the great arteries	1	5
LV non-compaction cardiomyopathy	1	5
Dilated cardiomyopathy or LV dysfunction	4	18
PDA	2	9
ASD	2	9
Rhabdomyoma	2	9
Inotrope	8	38
Mechanical Ventilation	6	27
Arrhythmia Type		
AVRT (concealed accessory pathway)	4	18
WPW	4	18
PJRT	2	9
FAT	6	27
AF	4	18
Congenital JET	1	5

WPW: Wolff-Parkinson-White, given as median (IQR) or n, %; IQR: Interquartile range; PJRT: Permanent junctional reciprocating tachycardia; JET: Junctional Ectopic Tachycardia; AF: Atrial Flutter; LV: Left ventricle; PDA: Patent ductus arteriosus; ASD: Atrial septal defect; AVRT: Atrioventricular re-entry tachycardia; FAT: Focal atrial tachycardia

A patient with WPW syndrome had associated patent ductus arteriosus. Another patient with WPW was also Ebstein's anomaly. One patient with corrected transposition of the great arteries (cTGA) had SVT, while another patient with cTGA had WPW syndrome. Two patients with dilated cardiomyopathy had SVT also. While two patients with rhabdomyoma had FAT, another patient with left ventricular non-compaction also had FAT. Two patients with PJRT and one patient with congenital JET were not associated with CHD.

Table 2. Treatment options in cases

Treatment	n=22	%
a) Abortive therapies		
Adenosine	18	81
Cardioversion	8	36
b) Acute treatment		
Esmolol	5	23
Amiodarone	8	36
Flecainide	3	16
c) Prophylactic therapies		
Monotherapy		
Propranolol	6	27
Amiodarone	4	18
Multidrug Therapy		
Digoxin+Propranolol	1	5
Propranolol+Amiodarone	5	23
Propranolol+Amiodarone+Flecainide	2	9
Extracorporeal Membrane oxygenator	2	9
Radiofrequency ablation	1	5

Medical Therapy and Catheter Ablation

Out of 22, in 21 (95%) patients, tachycardia control with medical therapy was effective.

a. Abortive therapy: Adenosine was the first line treatment in 18 patients. In eight patients, medical therapy was combined with cardioversion.

b. Acute therapy: Amiodarone was the mostly used acute therapy (n=8), followed by esmolol infusion (n=5). Acute therapy was more frequently used in infants with CHD when compared with those without CHD (5/5 patients, 100%, vs. 4/17 patients 23%, p=0.02).

c. Prophylactic therapy was administered in 19 out of 22 (88%) infants. Propranolol was initiated as monotherapy in six patients and amiodarone in four patients.

The most common combination therapy was propranolol and amiodarone (n=7), followed by propranolol, amiodarone, and flecainide combination (n=3). Almost 95% of patients (n=21) with tachycardia were treated by medical therapy, while the remaining one patient was treated with catheter ablation due to either the failure of medical therapy and had left ventricular dysfunction. This patient was diagnosed with PJRT and was successfully converted to sinus rhythm with ablation therapy.

One patient with atrial flutter (LV dysfunction in the fetal period and septicemia) and one patient with WPW (concurrent COVID-19 infection) were received ECMO support. Although tachyarrhythmia was controlled in both patients, they died due to ECMO-related complications and secondary causes. The characteristics of the patients treated with medical therapy are detailed in Table 2.

DISCUSSION

In this study, neonates hospitalized in the PCICU due to SVT were evaluated. It was observed that neonates with SVT may present with different complaints and findings may be accompanied by CHD or cardiac tumors. The majority of SVT develops with atrioventricular reentry mechanism and different antiarrhythmic therapies can be used in mono or combined treatment. The present study is significant according to include the results of our unit, which is a pediatric heart center and in a high-volume pediatric hospital.

The presenting complaint in newborns with SVT varies, and the mechanism of arrhythmia, duration, and age at diagnosis are the main factors.[3,4] Tunca Sahin et al.[2] reported that in their series including 99 cases younger than 1 year of age, the initial admission was due to palpitations and restlessness in 49%, routine physical examination in 25%, and tachypnea in 12%.

In the present study, the most common reasons for admission were restlessness in 50%, routine physical examination in 27%, and tachypnea in 30%.

The incidence of arrhythmia in patients with CHD is higher than in the general population (7–27% vs. 0.8%).[1,9] The association of SVT with CHD in infants has been observed in different studies with rates ranging from 7 to 27%. Ebstein anomaly and cTGA were reported as the most frequent concomitant heart disease and the necessity of echocardiographic examination was demonstrated. In addition, different authors have suggested that heart failure findings may be associated with a rate of 34–48%.[10,11] In the present study, the incidence of SVT and CHD was 32% and the rate of the left ventricular dysfunction on echocardiography was 25%. In different series reported in neonates and infants, AVRTs constitute the majority of SVTs. In the series of Bjelosevic consisting of 116 cases, AVRT was reported as 70% (49% concealed, 18% WPW, and 3% PJRT), FAT (23%), AF (6%), and congenital JET (1%).[11] Similarly, in our study, the most common arrhythmia types were AVRT (45%) and FAT (27%).

Adenosine is the first-line abortive therapy for most of the infants and should be the primary medication used in the treatment of SVT except atrial flutter. Cardioversion should be the first treatment option in patients with atrial flutter. Tunca Sahin et al.[2] preferred adenosine in all cases in their series and stated that cardioversion was implemented in 17% of cases. In a study of 2848 infants with SVT, 48% (n=1379) of the patients had abortive therapy. Adenosine was administered in 90% of them, and the remaining 10% of the patients had cardioversion.[8]

In the present study, adenosine was used in 80% of cases and cardioversion in 36% of cases. This may be due to the fact that a relatively high number of atrial flutter patients and use of cardioversion as the first option.

The acute management of SVT in neonates and infants may differ in practice.[12] This may be due to the heterogeneity of patient groups or the lack of studies identifying the optimal treatment. Esmolol, amiodarone, and procainamide are the most common treatments and are used in case of failure of the abortive treatment or immediately recurring SVT.[12,13]

In this study, the most common medical treatment for the acute management of SVT was amiodarone. Esmolol was administered in 23% of patients. The preference of amiodarone in patients with impaired cardiac functions might be the reason for its predominant use.

In general, antiarrhythmic prophylaxis is recommended for a period of 12 months. However, there is a significant regional variability in prophylactic antiarrhythmic pharmacotherapy selection. Antiarrhythmics such as sotalol, propafenone, digoxin, propranolol, amiodarone, and flecainide were administered as monotherapy or in combination.[11,14] While propranolol or amiodarone were the most preferred medications as monotherapy, regarding the use of combined medications, we prefer the combination of propranolol and amiodarone the most.

Radiofrequency or cryoablation has been used as an alternative treatment in patients with tachycardia-associated cardiomyopathy or refractory to medical therapy and has yielded favorable results.[2,15] A catheter ablation case series (two cryoablation and three RFA) of five patients with a mean age of 3.3±3.9 months (12 days–9.5 months) and with an average weight of 5.4±2.2 kg (3.5–9 kg) was reported by Akdeniz et al.[16] None of them developed a major complications and the acute success rate was reported as 100%.

In our study, RFA was performed in a patient with PJRT due to the development of tachycardia-induced cardiomyopathy despite antiarrhythmic therapy and it was successful.

Study Limitations

The main limitation of this study is that it was conducted in a single-center and retrospectively on a limited number of patients. Another limitation is that the follow-up data of the patients were not included in the evaluation.

CONCLUSION

SVT is one of the important causes of arrhythmias in newborns and the majority of them are caused by atrioventricular reentry mechanism. Newborns with tachyarrhythmia should be investigated for concomitant CHD and cardiac rhabdomyoma. If detected, prophylaxis with combined antiarrhythmic therapy should be considered.

Disclosures

Ethics Committee Approval: The study was approved by the Başakşehir Çam and Sakura Hospital Clinical Research Ethics Committee (No: 2022.09.357, Date: 14/09/2022).

Informed Consent: Written informed consent was obtained from all patients.

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