



Abdominal Pain as an Initial Manifestation of Paroxysmal Supraventricular Tachycardia in Children

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Abstract

Objectives: The aim of this study was to evaluate the importance of abdominal pain in children with paroxysmal supraventricular tachycardia (PSVT).

Methods: The authors reviewed the medical records of patients aged between three and 18 years old, who were diagnosed and treated for PSVT between March, 2011 and February, 2016. According to the presence of abdominal pain, they were grouped and analyzed for the difference of patient's age, gender, interval between symptom onset and diagnosis, response to adenosine infusion, and the relationship with levels of N-terminal fragments of pro-brain natriuretic peptide (NT-proBNP).

Results: A total of 43 patients (24 males and 19 females) were registered and the mean age at diagnosis of PSVT was 10.65 ± 4.81 years old. Although palpitation was the most common symptom ($n = 29, 67.4\%$), abdominal pain was also common ($n = 18, 41.9\%$) with more frequent symptoms under 10 years old ($n = 15/16, 93.8\%$ versus $n = 3/27, 11.1\%$ in older than 10 years old). The PSVT patients with abdominal pain (group 1) were younger, had more frequent vomiting, less palpitation, and longer time to diagnosis of PSVT than subjects without this complication (group 2). In group 1, the level of NT-proBNP was shown significantly higher than group 2 (776.07 ± 913.57 versus 93.72 ± 51.25 pg/mL, $P < 0.001$).

Conclusions: Abdominal pain may be an initial presentation of PSVT in children, especially under 10 years old.

Keywords: Paroxysmal Supraventricular Tachycardia, Abdominal Pain, Children

1. Background

The incidence of PSVT in children is unknown and whatever the mechanism, symptoms of paroxysmal supraventricular tachycardia have a broad spectrum, from simple sensation of palpitation to syncope or chest pain (1, 2). Neonates and infants with PSVT present signs of acute congestive heart failure with diaphoresis, vomiting, pulmonary, and intestinal congestion (1). In school-aged children and adolescents, palpitation is the most common symptom, whereas syncope during PSVT is a rare occurrence (2, 3). Because arrhythmias in children can develop at any time from fetal life to adolescence and symptoms vary depending on their age, recognition of presence of arrhythmia requires high index of suspicion, especially in young patients. The detection of the presence of arrhythmia is sometimes achieved on physical examination due to young patients' insufficiency in expression of symptoms. In this regard, the current study found that abdominal pain was not frequently discussed in relation to PSVT in the previously cited literature, and it has been reported

that patients with PSVT have significantly elevated level of cardiac troponin I (4, 5).

2. Objectives

The first aim of the present study was to report the clinical importance of abdominal pain as a common and occasionally unique presentation in children with PSVT and to investigate the relationship with levels of NT-proBNP and the presence of abdominal pain in children with PSVT.

3. Methods

The Institutional Review of Board of Sungkyunkwan University Health System approved this retrospective study (IRB 2017-08-003). The researchers reviewed the medical records of patients, who were diagnosed and treated for PSVT at Samsung Changwon Hospital between March 2011 and February 2016. Because this study was

designed to focus on pediatric patients with PSVT, the researchers selected patients younger than 19 years. Patients under three years old were excluded because of inaccuracy of expression about their clinical symptoms. Data related to patient's age, gender, chief complaint, associated symptoms, interval between any symptom onset related to PSVT and diagnosis by electrocardiography (ECG), response to adenosine infusion, response to amiodarone or verapamil infusion, recurrence, prescription of prophylactic beta blocker, and performance of radiofrequency catheter ablation (RFCA), were obtained. Patients were divided to two groups, according to the presence of abdominal pain when they were diagnosed for PSVT, and the difference of patient's age, gender, interval between symptom onset and diagnosis, and response to adenosine infusion, was compared.

The IBM SPSS for Windows (version 21.0, Chicago, IL, USA) was used for statistical analysis. The chi-squared test was used to assess statistically significant differences in the values of independent variables. To compare data among the two groups, analysis of variance was employed, followed by Fisher's exact test. All parameters were expressed as mean \pm standard deviation or number, as appropriate. P values of less than 0.05 were considered statistically significant.

4. Results

A total of 43 patients, who were between three and 18 years old with PSVT, were registered during the study period. There were 24 males and 19 females. Only two patients had a family history of PSVT; one patient's older sister had already performed RFCA and was not diagnosed at the hospital of the current study, and the other patient's older brother was diagnosed at another hospital and he had not performed RFCA. There were 16 patients younger than 10 years old. The mean age at diagnosis of PSVT was 10.65 ± 4.81 years old, and among them, 16 patients performed RFCA for the first time at the mean age of 14.65 ± 1.64 (range, 11 to 17) years old. Although palpitation was the most common symptom in the PSVT ($n = 29$, 67.4%) and then chest pain was the second common symptom ($n = 20$, 46.5%), abdominal pain was also common ($n = 18$, 41.9%) and a more frequent symptom under 10 years old ($n = 15/16$, 93.8% versus $n = 3/27$, 11.1% in older than 10 years old). When the two groups were divided according to the presence (group 1) and absence (group 2) of abdominal pain when diagnosed for PSVT, group 1 composed of total 18 patients (male : female = 9:9) and group 2 had 25 patients (male : female = 15:10). [Table 1](#) demonstrates the clinical findings of the two groups. When the visiting course to the hospital was checked, most of group 1 patients (88.9%) were referred for suspicion of tachycardia during physical examination from other hospitals (they

usually complained of symptoms other than palpitation), whereas, most of group 2 patients (96%) primarily visited the clinic or emergency room, where the current research was conducted, due to palpitation. Group 1 patients were 6.33 ± 3.77 (range, 3 to 15) years old at diagnosis and associated symptoms were palpitation ($n = 4$, 22.2%), chest pain ($n = 7$, 38.9%), and vomiting ($n = 8$, 44.4%). In group 1, the interval between PSVT-related symptom onset and diagnosis was 5.03 ± 3.51 hours. [Table 2](#) indicates that among group 1 patients, six patients were successfully achieved normal sinus rhythm with initial adenosine of 0.1 mg/kg infusion, however, six patients received a second dose of adenosine (0.2 ~ 0.3 mg/kg) and the remaining six patients did not respond to this second dose of adenosine. Therefore, they were treated with amiodarone (5 mg/kg) or verapamil (0.15 mg/kg) infusion for conversion to normal sinus rhythm. On the other hand, group 2 patients were 13.76 ± 2.53 (range 6 to 17) years old and their associated symptoms were palpitation ($n = 25$, 100%), chest pain ($n = 13$, 52%), and vomiting ($n = 1$, 4%). In group 2, the interval between PSVT-related symptom onset and diagnosis was 1.46 ± 1.16 hours. Twenty patients successfully achieved normal sinus rhythm with initial adenosine infusion, however, one patient received a second dose of adenosine and the remaining four patients were treated with amiodarone or verapamil infusion for conversion to the normal sinus rhythm. Comparing the two groups, there were statistically significant differences as followings; Group 1 patients were younger, had more frequent vomiting, had less palpitation, and had longer time to diagnosis of PSVT than group 2 patients. However, there were no significant differences in gender, presence of chest pain, and degree of response to adenosine infusion between the two groups ([Tables 1](#) and [2](#)). In the laboratory results ([Table 3](#)), there was no statistically significant difference between the two groups in the complete blood cell counts, erythrocyte sedimentation rate (ESR), C-reactive protein, and creatinine kinase-myoglobin (CK-MB). However, patients with chest pain had more elevated level of troponin-I than subjects without chest pain when presence of chest pain was compared (0.0317 ± 0.0028 versus 0.0178 ± 0.0019 ng/mL, $P = 0.003$). This result is shown in [Table 4](#). However, elevated level of troponin-I was not correlated with the presence of abdominal pain (0.0227 ± 0.0018 versus 0.0239 ± 0.0023 ng/mL, $P = 0.525$, [Table 3](#)) and rather, the researchers observed that group 1 patients had much higher level of NT-proBNP than group 2 patients (776.07 ± 913.57 pg/mL in group 1 versus 93.72 ± 51.25 pg/mL in group 2, $P < 0.001$). There were no significant differences in echocardiographic findings, such as ejection fraction between the two groups and there were no cases with significantly decreased left ventricular function in both groups.

Table 1. Clinical Characteristics of Patients with Paroxysmal Supraventricular Tachycardia According to the Presence of Abdominal Pain

Characteristics	Group 1 (Abdominal Pain (+))	Group 2 (Abdominal Pain (-))	P Value
Male/Female, No.	9/9	15/10	0.652
Age, y	6.33 ± 3.77 (3 -15)	13.76 ± 2.53 (6 -17)	< 0.001
Visiting course, No. (%)			
Primary visit	2 (11.1)	24 (96)	< 0.001
Referral from other hospitals	16 (88.9)	1 (4)	< 0.001
Associated symptoms, No. (%)			
Palpitation	4 (22.2)	25 (100)	0.007
Chest pain	7 (38.9)	13 (52)	0.696
Vomiting	8 (44.4)	1 (4)	0.031
Interval ^a , h	5.03 ± 3.51	1.46 ± 1.16	< 0.001

^aInterval: Duration between any symptom onset related to paroxysmal supraventricular tachycardia and diagnosis by electrocardiography.

Table 2. Pharmacological Treatment Responses of Patients with Paroxysmal Supraventricular Tachycardia According to Abdominal Pain^a

Sinus Rhythm Conversion to Adenosine Infusion	Group 1 (Abdominal Pain (+))	Group 2 (Abdominal Pain (-))	P Value
One time	6 (33.3)	20 (80)	0.068
Second time	6 (33.3)	1 (4)	0.464
Amiodarone or verapamil infusion	6 (33.3)	4 (16)	0.175

^aValues are expressed as No. (%).

Table 3. Laboratory and Echocardiographic Findings of Patients with Paroxysmal Supraventricular Tachycardia According to Presence of Abdominal Pain

Variables	Group 1 (Abdominal Pain (+))	Group 2 (Abdominal Pain (-))	P Value
WBC, / μ L	7,600 ± 1,230	6,812 ± 1,452	0.591
ESR, mm/h	12.43 ± 11.21	15.46 ± 13.12	0.312
CRP, mg/L	0.3 ± 0.21	0.46 ± 0.18	0.151
CK-MB, ng/mL	1.37 ± 0.65	1.26 ± 0.47	0.058
TnI, ng/mL	0.0227 ± 0.0018	0.0239 ± 0.0023	0.525
NT-proBNP, pg/mL	776.07 ± 913.57	93.72 ± 51.25	< 0.001
Echocardiographic findings			0.425
EF, %	67.3 ± 14.1	64.7 ± 17.3	

Abbreviations: CK-MB, creatinine kinase myoglobin; CRP, C-reactive protein; EF, ejection fraction; ESR, erythrocyte sedimentation rate; NT-proBNP, N-Terminal Fragments of the pro-brain natriuretic peptide; TnI, troponin I; WBC, white blood cell.

5. Discussion

From the viewpoint of adult patients, supraventricular tachycardia (SVT) is a general term related to any narrow (< 120 milliseconds) QRS complex tachycardia (> 150 beats/min (bpm)), which means that arrhythmia originates from or above the bundle of His (6). Furthermore, SVT is the most common symptomatic tachyarrhythmia in infants, children, and adolescents (1, 2). Although the exact incidence of SVT in children is unknown, it has been reported as 1 per 25,000 to as high as 1 per 250 children. It has been also reported that 25% of children with PSVT

have wolf-parkinson-white (WPW) syndrome on their resting ECG (7). In children or adolescent patients with normal heart structure, SVTs are divided to three or four major categories: Atrioventricular reentrant or reciprocating tachycardia (AVRT) due to an accessory pathway, atrioventricular nodal reentrant tachycardia (AVNRT), and ectopic atrial tachycardia, including permanent form of junctional reciprocating tachycardia (PJRT), according to some authors (1, 6, 7). Compared to adult patients, AVRT due to an accessory atrioventricular pathway, including WPW syndrome, is the most common type of PSVT in children. However,

Table 4. Clinical and Laboratory Findings of Patients with Paroxysmal Supraventricular Tachycardia According to Presence of Chest Pain

Variables	Group 1 (Chest Pain (+))	Group 2 (Chest Pain (-))	P Value
Male/Female, No.	11/9	13/10	0.574
Age, y	11.56 ± 3.18 (3-17)	12.16 ± 1.59 (6-15)	0.428
WBC, / μ L	6,700 ± 1,730	6,918 ± 1,813	0.394
ESR, mm/h	12.43 ± 11.21	15.46 ± 13.12	0.312
CRP, mg/L	0.44 ± 0.18	0.49 ± 0.14	0.281
CK-MB, ng/mL	1.67 ± 0.35	1.46 ± 0.38	0.076
TnI, ng/mL	0.0317 ± 0.0028	0.0178 ± 0.0019	0.003
NT-proBNP, pg/mL	316.28 ± 214.89	293.46 ± 198.37	0.107

Abbreviations: CK-MB, creatinine kinase myoglobin; CRP, C-reactive protein; ESR, erythrocyte sedimentation rate; NT-proBNP, N-Terminal Fragmentations of the pro-brain natriuretic peptide; TnI, troponin I; WBC, white blood cell.

whatever the mechanism of PSVT, symptoms of PSVT involve a broad spectrum, from simple sensation of palpitation to syncope or chest pain (1, 2, 7), whereas occasionally, there are no symptoms (2). According to the literature, the incidence of sudden cardiac death in WPW syndrome during childhood has been estimated as high as 0.5% (8). Symptoms of PSVT depend on the consequences of hemodynamic changes during tachycardia. During episodes of PSVT, increased heart rate impairs the diastolic filling of both ventricles and results in decreased cardiac output (1). Neonates and infants with PSVT present signs of acute congestive heart failure with diaphoresis, vomiting, and pulmonary and intestinal congestion (1, 2, 7). These symptoms develop rapidly and progress, making misdiagnose a common acute illness of that age group (1). Although in school-aged children and adolescents palpitation is the most common symptom, syncope during SVT is a rare occurrence (2, 3). Sensation of shortness of breath, chest pressure or pain, and feeling lightheaded or dizzy are occasionally experienced in PSVT patients (2). Pediatric practitioners in primary care units are on the foremost front in the diagnosis of childhood arrhythmias. Because arrhythmias in children can appear at any time and symptoms vary depending on age, recognition of arrhythmia requires high index of suspicion, especially in neonates and infants. The detection of the presence of arrhythmia is sometimes achieved on physical examination due to young patients' insufficiency of expression of their symptoms. In fact, in the current study, suspicion of tachycardia during physical examination was the most common cause of referral to the hospital in young age groups. In this regard, the researchers found that abdominal pain was not frequently discussed in the previously reported literature. However, according to the current results, abdominal pain was a common symptom of adolescent PSVT (n = 18, 41.9%), being especially more frequent in under 10-year-olds (n = 15/16, 93.8% versus n = 3/27, 11.1% in older than 10 years old). In the

current results, PSVT patients with abdominal pain were younger, had more frequent vomiting, had less palpitation, had longer time to diagnosis for PSVT, and had much higher level of NT-proBNP than the subjects without abdominal pain. These findings might mean that younger age is associated with more poor expression of symptoms, such as palpitation related to PSVT, and thus abdominal pain develops more frequently in young patients due to intestinal congestion by decreased cardiac output during PSVT. When the visiting course to the hospital was checked, most of group 1 patients (88.9%) were referred from other hospitals to confirm PSVT, however, most of group 2 patients (96%) primarily visited the clinic or emergency room of the hospital, where the current study was conducted, due to palpitation. This means that younger patients cannot clearly express their symptoms and they referred from other doctors after physical examination to rule out PSVT. Therefore, they may be misdiagnosed as having common acute gastroenteritis and have longer time to diagnosis for PSVT and this delay in diagnosis may contribute much more to overloading of ventricular and/or atrial stretch during PSVT to increase the release of NT-proBNP (9). However, adolescents feel and express their symptoms easily and they visited the clinic or emergency room directly, so the interval between symptom onset and diagnosis was shorter than group 1 and the level of NT-proBNP was lower than that of group 1. Interestingly, although elevated levels of CK-MB are well known to be associated with coronary artery disease (9), there was no significant difference in the level of CK-MB regardless of the presence of chest pain or abdominal pain in this study. While the exact mechanism about elevation of troponin-I is not fully understood in PSVT, the increased myocardial oxygen demand and decreased myocardial oxygen delivery due to shortened diastolic filling during paroxysmal attack are considered to be the result of a transient myocardial ischemia (4, 5, 10). Similarly, this study found that patients with chest pain had

more elevated level of troponin-I than subjects without chest pain. However, elevated level of troponin-I was not correlated with the presence of abdominal pain and rather, the researchers observed that high level of NT-proBNP was correlated with presence of abdominal pain. Although the mechanisms regulating myocardial production or release of NT-proBNP in the PSVT remain unclear, enough loading of ventricular and/or atrial stretch during PSVT may enhance the release of NT-proBNP (11, 12). Magioncalda et al. reported that the conversion to sinus rhythm in PSVT was achieved in a low percentage of patients with NT-proBNP levels > 4500 pg/mL, while the majority of those with levels < 1500 pg/mL were normalized, even by means of antiarrhythmic drugs alone (13). They suggested that a medium-low level of NT-proBNP indicated an acute response to the distension of the atrial tissue induced by PSVT; in contrast, highly elevated levels were probably also caused by ventricular dysfunction and therefore indicated a lesser likelihood of restoring sinus rhythm (13). In the current study, because a small number of patients were enrolled and among them, a few patients received second infusion of adenosine or further infusion of amiodarone or verapamil, it was not statistically meaningful to compare the relationship with the level of NT-proBNP and possibility of conversion to sinus rhythm. Also, although laboratory tests, including NT-proBNP were performed at the time of diagnosis, there was time variation of performing echocardiography in PSVT patients (at diagnosis or after discharge). There were no specific measurements of both ventricular function using various echocardiographic parameters, such as Tei index, E/E' ratio, and tricuspid annular plane systolic excursion (TAPSE), except ejection fraction for all cases. This variation might contribute as a bias, therefore, there were no significant differences of echocardiographic findings between the two groups and there were no cases with significantly decreased left ventricular function in both groups. In this regard, the researchers hypothesize that prolonged abdominal pain in PSVT is related to higher level of NT-proBNP and this is correlated with decreased cardiac function in the echocardiographic findings. Further prospective studies are required regarding the relationship with the level of NT-proBNP and cardiac function measured by various parameters, such as Tei index, E/E' ratio, and TAPSE when diagnosing PSVT in children with abdominal pain.

5.1. Limitation

This study had some limitations. This study had a retrospective design, was performed at a single hospital, and included a small number of patients. Therefore, the results of this study might not allow generalization to the overall pediatric population. Because the onset of PSVT-related symptoms were dependent on patient's or parent's

description, the interval between symptom onset and diagnosis was not exact. The time of performing echocardiography was dependent on various situations, and echocardiography, including various parameters, was inconsistent, therefore, it was not statistically meaningful to assess the relationship between the level of NT-proBNP and cardiac function in PSVT patients.

5.2. Conclusions

In conclusion, PSVT in children and adolescents can present at any time and its recognition requires high index of suspicion, especially in young patients. Abdominal pain is also a common presentation of PSVT, like palpitation, especially in under 10-year-olds and it is often a unique clinical presentation. Therefore, primary practitioners should take careful physical examination when treating young children with abdominal pain in regards to PSVT.

- Although the incidence of paroxysmal supraventricular tachycardia (PSVT) in children is unknown, there is a broad spectrum of symptoms, from simple sensation of palpitation to syncope or chest pain.

- The mean age at diagnosis of PSVT was 10.65 ± 4.81 years old for a total of 43 patients. Although palpitation was the most common symptom (n = 29, 67.4%), abdominal pain was also common (n = 18, 41.9%).

- PSVT patients with abdominal pain were younger, had more frequent vomiting, less palpitation, and longer time to diagnosis of PSVT than subjects without this complication.

- Abdominal pain may be an initial presentation of PSVT in children, especially under 10 years old.

Footnotes

Authors' Contribution: Yoo Jung Jeon and Sung Hoon Kim contributed equally to this study. All authors contributed to the concept and design of the study; data gathering, analysis, and interpretation; and preparing the manuscript for submission. Especially, Yoo Jung Jeon and Sung Hoon Kim contributed to the study design, data collections and analysis and carried out the initial manuscript; Ju Suk Lee conceptualized much of the study, designed the measures analyzed; Jinyoung Song and I-Seok Kang interpreted the results and contributed to statistics; June Huh interpreted the results, reviewed and revised the initial manuscript, and approved the final manuscript as submitted.

Conflict of Interests: None declared.

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