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Original Article

Comparing Pediatric Cardiology Hospitalizations Before and During COVID-19 Pandemic: Changes in Patient Profiles

Pandemi Öncesi ve COVID-19 Sırasındaki Pediyatrik Kardiyoloji Hastane Yatışlarının Karşılaştırılması: Hasta Profili Değişiklikleri

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ABSTRACT

Objective: The purpose of this study is to compare patient characteristics, cardiac diagnoses, and transcatheter interventions employed before and during the coronavirus disease-2019 pandemic.

Method: This single-center retrospective study included children aged 1 month-18 years hospitalized between March 2018 and March 2022. Demographics, length of hospital stay, diagnoses, and interventions employed were compared across two-year periods. Diagnostic proportions used category-specific denominators; therapeutic proportions used procedure-event totals.

Results: Gender, mean age, and length of hospital stay of 1,196 patients retrieved from pre-pandemic (n=563) and pandemic (n=633) periods were comparable. Infants younger than 1 year of age accounted for a greater proportion of the patient population during the pandemic (27.3% vs. 21.1%, p=0.013). Among congenital diagnoses, the incidence of ventricular septal defect (VSD) decreased (18.3% vs. 25.7%, p=0.009), while that of patent ductus arteriosus did not differ significantly (25.0% vs. 20.1%, p=0.086) between pre-pandemic and pandemic periods. Among acquired diagnoses, the incidence of myocarditis increased (33.5% vs. 19.7%, p=0.004) and that of acute rheumatic fever decreased (8.4% vs. 22.0%, p<0.001). The distribution of arrhythmia diagnoses did not differ significantly between both periods. Diagnostic catheterization rates did not differ. Among therapeutic procedures, the application rate of transcatheter VSD closure decreased (5.8% vs. 16.1%, p<0.001), whereas that of balloon pulmonary valvuloplasty increased (14.9% vs. 7.8%, p=0.023) during the pandemic period.

Conclusion: Ages, selected cardiac diagnoses, and therapeutic procedure profiles of patients differed between both periods. These associations do not establish direct effects of severe acute respiratory syndrome-coronavirus-2 infection. Multicenter studies incorporating infection status, referral patterns, and outcomes are warranted.

Keywords: COVID-19, pediatric cardiology, congenital heart disease, patient profile changes, cardiac catheterization

ÖZ

Amaç: Bu çalışmanın amacı, koronavirüs hastalığı-2019 pandemisi öncesinde ve pandemi sürecinde uygulanan transkateter girişimleri, kardiyak tanıları ve hasta özelliklerini karşılaştırmaktır.

Yöntem: Bu tek merkezli retrospektif çalışma, Mart 2018 ile Mart 2022 tarihleri arasında hastaneye yatırılan 1 ay ile 18 yaş arasındaki çocukları kapsamaktadır. Demografik özellikler, hastanede yatış süresi, tanılar ve uygulanan girişimler iki yıllık dönemler halinde karşılaştırılmıştır. Tanısal oranlar hesaplanırken kategoriye özgü paydalar; tedaviye yönelik oranlar hesaplanırken ise toplam işlem sayısı kullanılmıştır.

Bulgular: Pandemi öncesi (n=563) ve pandemi (n=633) dönemlerinden dahil edilen toplam 1,196 hastanın cinsiyet, yaş ortalaması ve hastanede yatış süreleri benzer bulunmuştur. Pandemi döneminde, 1 yaşın altındaki bebeklerin hasta popülasyonu içindeki oranı daha yüksek saptanmıştır (%27,3'e karşı %21,1; p=0,013). Konjenital tanılar arasında ventriküler septal defekt (VSD) görülme sıklığı azalırken (%18,3'e karşı %25,7; p=0,009), patent duktus arteriyozus görülme sıklığında pandemi öncesi ve pandemi dönemleri

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arasında anlamlı bir fark saptanmamıştır (%25,0'a karşı %20,1; p=0,086). Edinsel kalp hastalıkları tanıları arasında miyokardit görülme sıklığı artmış (%33,5'e karşı %19,7; p=0,004), akut romatizmal ateş görülme sıklığı ise azalmıştır (%8,4'e karşı %22,0; p<0,001). Aritmi tanılarının dağılımı her iki dönem arasında anlamlı bir fark göstermemiştir. Tanısal kateterizasyon oranlarında da bir değişiklik olmamıştır. Terapötik işlemler arasında, transkateter VSD kapatma uygulaması pandemi döneminde azalırken (%5,8'e karşı %16,1; p<0,001), balon pulmoner valvüloplasti uygulaması artış göstermiştir (%14,9'a karşı %7,8; p=0,023).

Sonuç: Hastaların yaşları, belirli kardiyak tanıları ve uygulanan tedavi prosedürlerinin profilleri, her iki dönem arasında farklılık göstermiştir. Bu ilişkiler, şiddetli akut solunum sendromu-koronavirüs-2 enfeksiyonunun doğrudan etkilerini kanıtlamamaktadır. Enfeksiyon durumu, sevk süreçleri ve klinik sonuçları kapsayan çok merkezli çalışmalara ihtiyaç duyulmaktadır.

Anahtar kelimeler: COVID-19, pediatrik kardiyoloji, doğumsal kalp hastalığı, hasta profili değişimleri, kardiyak kateterizasyon

INTRODUCTION

Coronavirus disease-2019 (COVID-19), a severe acute respiratory syndrome-coronavirus-2 (SARS-CoV-2), is an infectious disease with clinical manifestations ranging from asymptomatic infection to severe respiratory illness and multisystem involvement[1]. Following its emergence in Wuhan City, Hubei Province, China, in December 2019, the disease spread rapidly worldwide and was declared a pandemic by the World Health Organization on March 11, 2020[2].

Although children generally experience milder forms of COVID-19 disease than adults, concerns have been raised regarding the potential impact of SARS-CoV-2 infection on children with underlying cardiovascular conditions, particularly congenital heart disease (CHD). Previous studies have demonstrated that cardiovascular comorbidities are associated with increased morbidity and mortality in adults with COVID-19[3]. However, the risk profile and clinical outcomes of pediatric patients with CHD during the pandemic remain incompletely understood. While several reports have suggested that children with CHD may represent a vulnerable population at increased risk for adverse outcomes, the available evidence is limited and sometimes conflicting[4]. Therefore, further investigation is required to better characterize the effects of the pandemic on this patient group.

The COVID-19 pandemic has also affected healthcare utilization patterns, hospital admissions, and the delivery of specialized pediatric cardiovascular care[5]. Understanding how the pandemic influenced the clinical characteristics of hospitalized pediatric cardiology patients may provide valuable insights into disease presentation, healthcare needs, and potential cardiovascular complications associated with SARS-CoV-2 infection.

Therefore, the present study aimed to evaluate the different adverse effects of the COVID-19 pandemic on the demographic and clinical characteristics of patients hospitalized in a pediatric cardiology unit, as well as on the distribution of cardiac diagnoses and interventional procedures. In addition, we sought to explore potential changes in disease patterns among children with congenital and acquired heart diseases during the pandemic period.

MATERIALS and METHODS

This retrospective, single-center, cross-sectional study was conducted at the Pediatric Cardiology Department of University of Health Sciences Türkiye, Dr. Behçet Uz Pediatric Diseases and Surgery Training and Research Hospital İzmir Province, Türkiye. Medical records of patients aged between 1 month and 18 years who were hospitalized between March 2018 and March 2022 were retrospectively reviewed.

The study protocol was approved by the Local Institutional Ethics Committee of University of Health Sciences Türkiye, Dr. Behçet Uz Pediatric Diseases and Surgery Training and Research Hospital (decision no: 2022/13-10, date: 11.08.2022). Informed consent was waived due to the retrospective nature of the study.

Patients with available electronic medical records containing their demographic characteristics, diagnoses at hospital admissions, length of hospital stay, and information regarding percutaneous transcatheter interventions were included in the analyses. Patients whose demographic or clinical data were incomplete, those younger than 1 month or older than 18 years, and those hospitalized for non-cardiac conditions were excluded from the study.

Patients hospitalized between March 10, 2018 and March 10, 2020 were classified as the pre-pandemic group, whereas those hospitalized between March 11, 2020 and March 10, 2022 as the pandemic group. Age was recorded in completed years; therefore, patients aged 1-11 months were coded as 0 years. Demographic characteristics, length of hospital stay, cardiac diagnoses, and percutaneous transcatheter procedures applied were recorded. Since a patient might receive more than one diagnosis or undergo more than one therapeutic procedure, recurrent diagnoses and procedure counts were analyzed separately.

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, version 25.0 and Microsoft Excel. Descriptive data were presented as frequencies and percentages for categorical variables and as mean ± standard deviation or median (minimum-maximum) values for continuous variables, as appropriate. The normality of data distribution was assessed using skewness and kurtosis values; values between -2 and +2 were considered compatible with an approximately normal distribution[6].

Comparisons between two independent groups were performed using the independent-samples t-test for normally distributed continuous variables and the Mann-Whitney U test for non-normally distributed variables. Categorical variables were compared using Pearson's chi-square test or Fisher's exact test, as appropriate. For Tables 1-4, diagnostic percentiles were calculated within each diagnostic category using the total number of entries for a specific diagnosis in that category for each study period as the denominator. Because an individual patient might receive more than one cardiac diagnosis, these denominators represent diagnosis entries rather than unique patients. For Table 5, percentages were calculated using lesion-specific patient denominators, and exact 95% confidence intervals (CIs) were calculated using the Clopper-Pearson method; while between-period comparisons were performed using Fisher's exact test. For Table 6, percentages were calculated using the total number of therapeutic catheter-based procedures during pre-pandemic, and pandemic periods (205 vs. 208); whereas diagnostic cardiac catheterizations and angiocardiographies were excluded from these denominators. Since a patient might undergo more than one therapeutic procedure, these denominators represent procedural events rather than unique patients. A two-tailed p-value of <0.05 was considered statistically significant.

RESULTS

A total of 1,196 patients were included in the study, comprising 563 patients hospitalized during the pre-pandemic period (March 10, 2018-March 10, 2020) and 633 patients hospitalized during the pandemic period (March 11, 2020-March 10, 2022).

In the pre-pandemic period 295 (52,4%) female and 268 (47.6%) male, and during the pandemic period 315 (49.8%) femaie and 318 (50.2%) male patients were included in the analyses. There was no significant difference in sex distribution between the two periods (p=0.363). The mean age of the patients who were hospitalized in the pre-pandemic, and pandemic periods were 6.22±5.52, and 5.91±5.71 years, respectively (p=0.336). The mean length of hospital stay was 4.45±4.22 and 4.67±4.94 days, respectively, with no significant difference between the groups (p=0.734). Patients younger than 1 year accounted for 21.1% (119/563) and 27.3% (173/633) of hospitalizations before, and during the pandemic periods, respectively, representing a statistically significant increase in hospitalization rates (p=0.013) (Table 1).

Within the CHD category, 389 diagnosis entries were recorded before and 460 during the pandemic. VSD accounted for 25.7% (100/389) of CHD diagnoses before the pandemic and 18.3% (84/460) of CHDs diagnosed during the pandemic, representing a significant decrease in its relative frequency (p=0.009). PDA accounted for 20.1% (78/389) and 25.0% (115/460) of cardiac diagnoses, respectively without any statistically significant intergroup difference (p=0.086). No statistically significant differences were observed for the other CHD diagnoses (Table 2).

Within the acquired cardiac disease category, 173 diagnosis entries were recorded before and 167 during the pandemic periods. Myocarditis accounted for 19.7% (34/173), and 33.5% (56/167) of acquired cardiac disease diagnoses before and during the pandemic,

Table 1. Demographic and hospitalization characteristics of patients according to the study period

Characteristics	Pre-pandemic (n=563)	Pandemic (n=633)	p-value
Sex, n (%)			0.363
Female	295 (52.4)	315 (49.8)	-
Male	268 (47.6)	318 (50.2)	-
Age, years, mean ± SD	6.22±5.52	5.91±5.71	0.336
Age <1 year, n (%)	119 (21.1)	173 (27.3)	0.013
Length of hospital stay, days, mean ± SD	4.45±4.22	4.67±4.94	0.734

The independent-samples t-test was used for age, Pearson's chi-square test for categorical variables, and the Mann-Whitney U test for length of hospital stay. The median length of hospital stay was 3 days (interquartile range 2-6) in both periods (age was recorded in completed years; therefore, patients aged 1-11 months were coded as 0 years). SD: Standard deviation

Table 2. Distribution of congenital heart disease diagnoses according to the study period			
Diagnosis	**Pre-pandemic n (%) (n=389)**	**Pandemic n (%) (n=460)**	**p-value**
Patent ductus arteriosus	78 (20.1)	115 (25.0)	0.086
Atrial septal defect	92 (23.7)	101 (22.0)	0.557
Ventricular septal defect	100 (25.7)	84 (18.3)	0.009
Pulmonary stenosis	40 (10.3)	54 (11.7)	0.500
Coarctation of the aorta	21 (5.4)	30 (6.5)	0.493
Aortic stenosis	17 (4.4)	15 (3.3)	0.398
Atrioventricular septal defect	14 (3.6)	19 (4.1)	0.690
Tetralogy of Fallot	11 (2.8)	22 (4.8)	0.142
Dextro-transposition of the great arteries	5 (1.3)	3 (0.7)	0.481
Pulmonary atresia	3 (0.8)	7 (1.5)	0.358
Tricuspid atresia	3 (0.8)	4 (0.9)	1.000
Aortic insufficiency	2 (0.5)	1 (0.2)	0.596
Truncus arteriosus	1 (0.3)	1 (0.2)	1.000
Partial anomalous pulmonary venous return	1 (0.3)	2 (0.4)	1.000
Total anomalous pulmonary venous return	**0 (0.0)**	**1 (0.2)**	**1.000**
Hypoplastic left heart syndrome	1 (0.3)	1 (0.2)	1.000
Total	**389 (100.0)**	**460 (100.0)**	**-**

Percentages were calculated within the congenital heart disease category using the total number of diagnoses listed in this table for each study period as the denominator (pre-pandemic n=389; pandemic n=460). Because an individual patient could have more than one cardiac diagnosis, diagnostic categories were not necessarily mutually exclusive at the patient level; the denominators therefore represent diagnosis entries within the corresponding category rather than unique patients. P-values compare the relative frequency of each diagnosis within the category between study periods. Pearson's chi-square test or Fisher's exact test was used as appropriate

periods, respectively representing a significant increase in its relative frequency (p=0.004). Acute renal failure (ARF) accounted for 22.0% (38/173) and 8.4% (14/167) of the casesin both periods respectively, representing a significant decrease (p<0.001). No statistically significant differences were observed for the incidence rates of other acquired cardiac disease diagnoses (Table 3).

Within the arrhythmia category, 31 diagnosis entries were recorded before and 38 during the pandemic. Supraventricular tachycardia (SVT) accounted for 38.7%

Table 3. Distribution of acquired cardiac disease diagnoses according to the study period			
Diagnosis	**Pre-pandemic n (%) (n=173)**	**Pandemic n (%) (n=167)**	**p-value**
Myocarditis	34 (19.7)	56 (33.5)	0.004
Acute rheumatic fever	38 (22.0)	14 (8.4)	<0.001
Pulmonary arterial hypertension	24 (13.9)	28 (16.8)	0.459
Dilated cardiomyopathy	16 (9.2)	13 (7.8)	0.629
Hypertrophic cardiomyopathy	10 (5.8)	11 (6.6)	0.757
Kawasaki disease	20 (11.6)	21 (12.6)	0.774
Orthostatic intolerance	4 (2.3)	1 (0.6)	0.372
Pericarditis	7 (4.0)	4 (2.4)	0.390
Postural orthostatic tachycardia syndrome	20 (11.6)	19 (11.4)	0.958
Total	**173 (100.0)**	**167 (100.0)**	**-**

Percentages were calculated within the acquired cardiac disease category using the total number of diagnoses listed in this table for each study period as the denominator (pre-pandemic n=173; pandemic n=167). Because an individual patient could have more than one cardiac diagnosis, diagnostic categories were not necessarily mutually exclusive at the patient level; the denominators therefore represent diagnosis entries within the corresponding category rather than unique patients. P-values compare the relative frequency of each diagnosis within the category between study periods. Pearson's chi-square test or Fisher's exact test was used as appropriate

(12/31), and 60.5% (23/38) of arrhythmias diagnosed before and during the pandemic periods, respectively. Although higher number of cases with SVT were diagnosed during the pandemic period, the difference was not statistically significant (p=0.071). No statistically significant differences were observed for the other diagnostic categories of arrhytmias (Table 4).

The mean ages of the patients diagnosed with Kawasaki disease before the outbreak and during the pandemic were 3.70±3.51 years and 3.95±4.50 years, respectively, with no significant age difference between the two groups (p=0.842). Therefore, no significant change in the age distribution of patients with Kawasaki disease was demonstrated.

Among patients with left-to-right shunt lesions, pulmonary arterial hypertension (PAH) was present in 12 of 100 patients with VSD (12.0%; 95% CI, 6.4-20.0) before the pandemic and in 11 of 84 patients (13.1%; 95% CI, 6.7-22.2) during the pandemic, with no significant difference between both study periods (p=0.827). Among patients with atrioventricular septal defect (AVSD), PAH was present in 1 of 14 patients (7.1%; 95% CI, 0.2-33.9) before the pandemic and in 7 of 19 patients (36.8%; 95% CI, 16.3-61.6) during the pandemic. Although the proportion was numerically higher during the pandemic period, the difference did not reach statistical significance (p=0.098) (Table 5).

Diagnostic cardiac catheterizations and angiocardiographies were performed in 295 of 563 patients (52.4%) during the pre-pandemic period and in 314 of 633 patients (49.6%) during the pandemic period, with no significant difference between both groups in terms of application rates (p=0.335). Among patients undergoing caerdiac catheterizations more than half (68.8%; 203/295) of the patients in the pre-pandemic, and 65.9% (207/314) of the patients in the pandemic period underwent at least one therapeutic intervention (p=0.447). Because some patients underwent more than one therapeutic procedure, the corresponding totals of therapeutic catheter-based procedures were 205 and 208, respectively.

Transcatheter PDA closure was the most frequently performed therapeutic procedure in both periods, accounting for 34.1% of (70/205) procedures before the pandemic and 41.3% (86/208) of them during the pandemic (p=0.131). Transcatheter ASD closures were performed in both periods for 29.8% (61/205) and 25.0% (52/208) of the patients respectively (p=0.278). The implementation rates of transcatheter VSD closure decreased significantly from 16.1% (33/205) before the pandemic to 5.8% (12/208) during the pandemic (p<0.001). In contrast, the application rates of balloon pulmonary valvuloplasty increased significantly from 7.8% (16/205) to 14.9% (31/208) (p=0.023). No statistically significant differences were observed for the frequencies of other therapeutic catheter-based procedures applied in two different periods (Table 6).

DISCUSSION

In this retrospective single-center study, we compared the demographic characteristics, diagnostic profiles, and also catheter-based interventions applied for children hospitalized in a pediatric cardiology unit during two consecutive two-year periods before the onset and during the COVID-19 pandemic. Although sex distribution, mean age, and length of hospital stay did not differ significantly between the study periods, the proportion of hospitalized

Table 4. Distribution of arrhythmia diagnoses according to the study period

Diagnosis	Pre-pandemic n (%) (n=31)	Pandemic n (%) (n=38)	p-value
Complete atrioventricular block	3 (9.7)	1 (2.6)	0.319
Supraventricular ectopy	2 (6.5)	3 (7.9)	1.000
Supraventricular tachycardia	12 (38.7)	23 (60.5)	0.071
Long QT syndrome	0 (0.0)	1 (2.6)	1.000
Ventricular extrasystole	12 (38.7)	9 (23.7)	0.177
Wolff-Parkinson-White syndrome	2 (6.5)	1 (2.6)	0.584
Total	**31 (100.0)**	**38 (100.0)**	**-**

Percentages were calculated within the arrhythmia category using the total number of diagnoses listed in this table for each study period as the denominator (pre-pandemic n=31; pandemic n=38). Because an individual patient could have more than one cardiac diagnosis, diagnostic categories were not necessarily mutually exclusive at the patient level; the denominators therefore represent diagnosis entries within the corresponding category rather than unique patients. P-values compare the relative frequency of each diagnosis within the category between study periods. Pearson's chi-square test or Fisher's exact test was used as appropriate

Table 5. Association of pulmonary arterial hypertension accompanied with ventricular and atrioventricular septal defects according to the study period

Diagnosis	Pre-pandemic n (%)	95% CI	Pandemic n (%)	95% CI	p-value
VSD + PAH	12/100 (12.0)	6.4-20.0	11/84 (13.1)	6.7-22.2	0.827
AVSD + PAH	1/14 (7.1)	0.2-33.9	7/19 (36.8)	16.3-61.6	0.098

Values are presented as n (%). Percentages were calculated within each lesion-specific subgroup, and the denominator represents the total number of patients with VSD or AVSD in the corresponding study period. Exact 95% confidence intervals were calculated using the Clopper-Pearson method. Between-period comparisons were performed using Fisher's exact test. PAH: Pulmonary arterial hypertension, VSD: Ventricular septal defect, AVSD: Atrioventricular septal defect, CI: Confidence interval

Table 6. Distribution of therapeutic catheter-based procedures according to the study period

Procedure	Pre-pandemic n (%) (n=205)	Pandemic n (%) (n=208)	p-value
Aortic balloon valvuloplasty	9 (4.4)	4 (1.9)	0.151
Aortic coarctation balloon angioplasty	8 (3.9)	17 (8.2)	0.069
Aortic coarctation stent placement	5 (2.4)	4 (1.9)	0.750
Balloon pulmonary angioplasty	3 (1.5)	2 (1.0)	0.684
Balloon pulmonary valvuloplasty	16 (7.8)	31 (14.9)	0.023
Transcatheter ASD closure	61 (29.8)	52 (25.0)	0.278
Transcatheter PDA closure	70 (34.1)	86 (41.3)	0.131
Transcatheter VSD closure	33 (16.1)	12 (5.8)	<0.001
Total therapeutic procedures	**205 (100.0)**	**208 (100.0)**	**-**

Percentages were calculated within the therapeutic-procedure category using the total number of therapeutic catheter-based procedures in each study period as the denominator (pre-pandemic n=205; pandemic n=208). Diagnostic cardiac catheterizations and angiocardiographies were not included in the analysis. Because a patient could undergo more than one procedure, these denominators represent number of procedures performed rather than unique patients. Pearson's chi-square test or Fisher's exact test was used as appropriate.
ASD: Atrial septal defect, PDA: Patent ductus arteriosus, VSD: Ventricular septal defect

patients younger than 1 year of age was significantly higher during the pandemic. Category-based analyses demonstrated a lower relative frequency of VSD among CHD diagnoses, a higher relative frequency of myocarditis and a lower relative frequency of ARF among acquired cardiac disease diagnoses, and changes in selected therapeutic catheter-based procedures, including a reduction in transcatheter VSD closure and an increase in balloon pulmonary valvuloplasty rates. In contrast, the numerical increase in SVT and the higher proportion of PAH among patients with AVSD did not reach statistical significance.

An important finding of the present study was that the total number of pediatric cardiology hospitalizations did not decrease during the pandemic period. In fact, 633 patients were hospitalized during the pandemic period compared with 563 patients during the corresponding pre-pandemic period. This finding differs from reports released from several centers describing substantial reductions in the utilization rates of pediatric cardiovascular services, particularly during the early phases of the pandemic. Sachdeva et al.[7] reported that admission rates to pediatric cardiology services decreased by approximately two-thirds and catheter interventions by 84% during the early pandemic period. Similar reductions in the number of elective catheterizations indicated for CHDs were reported in multicenter studies from the United States and Italy[8,9]. The difference in admission rates to pediatric cardiology services observed in our cohort may reflect the characteristics of our referral center, local referral pathways, and the use of two complete two-year observation periods rather than an analysis restricted to the earliest phase of the pandemic. Since referral patterns and indications for hospitalizations were not systematically recorded, these explanations remain as hypotheses.

The proportion of hospitalized patients younger than 1 year increased from 21.1% before the pandemic to 27.3% during the pandemic (p=0.013). A national survey from England similarly found that procedures for children younger than 1 year of age were relatively prioritized during several pandemic periods[10]. Although that study evaluated procedural activity rather than indications for hospitalizations, it provides context for the possibility that younger children requiring specialized cardiac care

may have been relatively prioritized during periods of healthcare disruption. Our study did not evaluate the indications or urgency of individual hospitalizations; therefore, the reason for the higher proportion of infants requiring specialized cardiac care cannot be revealed based on the present data.

Regarding CHD diagnoses, compared with the pre-pandemic period VSD accounted for a significantly lower, while PDA for significantly higher proportion of patients during the pandemic period (18.3%. vs. 25.7% p=0.009, and 20.1% vs. and 25.0% (p=0.086) with a statistically non-significant intergroup difference. Because these analyses use diagnosis entries within the CHD category as the denominator, the percentages describe the relative composition of CHD diagnoses rather than prevalence rates among all hospitalized patients. The present data do not allow these compositional changes to be attributed to SARS-CoV-2 infection or to changes in the natural history of congenital cardiac defects. Differences in age distribution, referral patterns, indications for hospitalizations, or prioritization of specialized cardiac care may have contributed to statistical estimates, but these factors were not directly measured.

Within acquired cardiac disease diagnoses, ARF accounted for a significantly lower percentages of patients during the pandemic period (8.4% vs. 22.0%, p<0.001). Similar reductions in ARF during the COVID-19 era have been previously reported[11]. Public health measures implemented during the pandemic, including school closures, physical distancing, mask use, and changes in social contact, may have reduced opportunities for transmission of group A streptococcal infection. Changes in healthcare-seeking behaviors and patterns of diagnosis may also have contributed. Since our study did not include microbiological or population-level streptococcal surveillance data, the mechanisms underlying the observed reduction cannot be determined based on the present findings.

Myocarditis accounted for a significantly, and comparatively higher proportion of acquired cardiac disease diagnoses during the pandemic period (33.5% vs. 19.7%, p=0.004). SARS-CoV-2 infection has been associated with myocardial inflammation and cardiovascular manifestations in children and young adults[3,12,13]. However, individual SARS-CoV-2 infection status was not systematically recorded in our dataset. Moreover, the present analysis reflects the relative distribution of diagnosis entries within the acquired cardiac disease category. Therefore, the observed increase in incidence rates cannot be interpreted as evidence that SARS-CoV-2 infection directly caused the higher relative frequency of myocarditis. Changes in referral patterns, diagnostic evaluation, or the composition of hospitalized cases with acquired cardiac disease may also have contributed to relatively higher incidence rates of myocarditis.

No statistically significant difference was demonstrated in the distribution of diagnosed csses of arrhythmia. SVT accounted for 38.7% of arrhythmia diagnoses before the pandemic and 60.5% of them during the pandemic (p=0.071). Although SARS-CoV-2-related myocardial inflammation may be accompanied by arrhythmias[3,12,13], our data do not establish the presence of an association between SARS-CoV-2 infection and the observed numerical differences in the incidence rates of SVT. This finding should therefore be interpreted as a non-significant temporal difference in the composition of arrhythmia diagnoses.

No significant difference was observed either in the relative frequency or the age distribution of the patients with Kawasaki disease between both periods. The mean age of patients with Kawasaki disease was 3.70±3.51 years before and 3.95±4.50 years during the pandemic (p=0.842). Although Kawasaki-like inflammatory presentations and multisystem inflammatory syndrome in children (MIS-C) have been widely described during the COVID-19 pandemic[14,15], MIS-C was not identified as a diagnostic category in our dataset. Accordingly, our findings do not provide evidence of a SARS-CoV-2- or MIS-C-related changes in Kawasaki disease. The relatively small Kawasaki disease subgroups also limit further inference.

Among patients with left-to-right shunt lesions, PAH was present in 12.0% of patients with VSD before the pandemic and 13.1% during the pandemic (p=0.827). PAH was observed in 7.1%, and 36.8% of patients with AVSD before and during the pandemic, respectively. However, this substantial numerical difference in incidence rates, it did not reach statistical significance (p=0.098), and the exact 95% CIs were wide because of the small AVSD subgroups. Consequently, this finding should not be considered evidence that the pandemic caused an increase in PAH among patients with AVSD. Delayed diagnosis or intervention could theoretically influence incidence rates of pulmonary vascular disease in patients with significant left-to-right shunts[16]; however, our study did not measure the length of diagnostic delay, interruption of follow-up, or postponement of individual procedures.

The overall proportion of patients undergoing diagnostic cardiac catheterization did not differ significantly between the study periods (52.4% vs. 49.6%, p=0.335), and the proportion of catheterized patients undergoing at least one therapeutic intervention was also comparable (68.8% vs. 65.9%, p=0.447). This relative stability contrasts with reports concerning the early pandemic period, when many pediatric and congenital cardiac catheterization programs markedly reduced elective procedures and prioritized urgent or emergent interventions[7-10]. This difference may again be related to our longer two-year observation period, which included both periods of intense healthcare restriction and subsequent normalization of health care services.

Despite the relative stability in overall catheterization rates, the distribution of therapeutic procedures differed between the study periods. Transcatheter VSD closure rates comprised 16.1% of therapeutic procedures applied before the pandemic, decreased to 5.8% during the pandemic (p<0.001), whereas balloon pulmonary valvuloplasty increased from 7.8% to 14.9% (p=0.023) between both periods. Previous reports have shown that the pandemic altered case selection and prioritization in congenital cardiac catheterization laboratories, particularly during periods when elective interventions were restricted[8-10]. The changes observed in our cohort may reflect differences in referral patterns, patient selection methods, procedural urgencies, or scheduling. However, since individual indications for cardiac interventions, urgency classification, and reasons for postponement were not available, the mechanisms underlying these procedural shifts cannot be established.

Study Limitations

Several limitations of this study should be acknowledged. First, this was a retrospective, single-center study, which may limit the generalizability of the findings to other populations and healthcare settings. Second, the analyses were based on data obtained from electronic hospital records and therefore depended on the completeness and accuracy of the available documentation. Third, individual SARS-CoV-2 infection status was not systematically available, precluding assessment of direct associations between infection and specific cardiovascular outcomes. Fourth, referral patterns, indications and urgency for hospitalizations or interventions, delays in diagnosis, and reasons for postponement of procedures were not systematically recorded; therefore, the mechanisms underlying the observed temporal changes cannot be established. In addition, because an individual patient might receive more than one cardiac diagnosis, the diagnostic categories were not necessarily and mutually exclusive at the patient level. Accordingly, the category-based diagnostic analyses describe the relative distribution of diagnostic entries within each diagnostic category rather than the prevalence of individual diagnoses among all hospitalized patients. These findings should therefore be interpreted as changes in diagnostic profiles between the study periods. Similarly, because some patients underwent more than one therapeutic procedure, procedure-based analyses represent therapeutic procedures rather than unique patients. Finally, the relatively small number of patients in certain diagnostic subgroups, particularly in the AVSD and Kawasaki disease groups, resulted in establishment of wide CIs and limited statistical power for subgroup analyses.

CONCLUSION

The COVID-19 pandemic period was associated with changes in the demographic, diagnostic, and interventional profile of children hospitalized in our pediatric cardiology unit. The proportion of hospitalized patients younger than 1 year of age was significantly higher during the pandemic period. Within the diagnostic categories of CHDs, the relative frequency of VSD was significantly lower, whereas within diagnostic categories of acquired cardiac diseases, the relative frequency of myocarditis was significantly higher and that of ARF was significantly lower during the pandemic period. No significant differences were observed in the diagnostic distribution of arrhythmias or in PAH among patients with VSD or AVSD. Although overall rates of diagnostic catheterizations applied remained relatively stable, the distribution of selected therapeutic catheter-based procedures differed between both study periods, with a significant decrease in transcatheter VSD closure rates and a significant increase in balloon pulmonary valvuloplasty rates during the pandemic period. These findings represent temporal differences between the pre-pandemic and pandemic periods and should not be interpreted as direct effects of SARS-CoV-2 infection. Multicenter studies incorporating individual SARS-CoV-2 infection status, referral patterns, procedural, and emergency indications, and long-term outcomes are needed to clarify the factors underlying these changes.

Ethics

Ethics Committee Approval: The study protocol was approved by the Local Institutional Ethics Committee of University of Health Sciences Türkiye, Dr. Behçet Uz

Pediatric Diseases and Surgery Training and Research Hospital (decision no: 2022/13-10, date: 11.08.2022).

Informed Consent: Informed consent was waived due to the retrospective nature of the study.

Declaration of AI Use: No artificial intelligence tools were used in the preparation of this manuscript.

Footnotes

Author Contributions

Surgical and Medical Practices: G.F., O.A., Ö.G., M.M.B., Concept: G.F., O.A., Ö.G., M.M.B., Design: G.F., O.A., Ö.G., M.M.B., Data Collection or Processing: G.F., Analysis or Interpretation: G.F., O.A., Literature Search: G.F., Writing: G.F., O.A., Ö.G.

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