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ORIGINAL ARTICLE

Prevalence and characteristics of arthritis in Kawasaki disease: a Chinese cohort study

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Abstract

Arthritis is a major complication of Kawasaki disease (KD). The aims of this study were to define the frequency and the clinical characteristics of arthritis in KD in China and to analyze the relation between arthritis and coronary outcome in KD. We included 1420 KD patients followed at Jiangxi Children's Hospital from January 2014 to December 2017. Demographic, clinical and laboratory features of KD were analyzed. Among the 1420 patients enrolled, 151 had arthritis. The median age of KD patients with arthritis was 29 months and older than those without arthritis (20 months). Of the 151 patients developed arthritis, 101 patients (66.9%) had oligoarticular involvement and 50 patients (33.1%) had polyarticular involvement. Early-onset and late-onset arthritis were, respectively, observed in 123 (81.45%) and 28 (18.54%) patients. The KD patients with arthritis had significantly increased levels of inflammatory markers, and we observed a higher incidence rate of coronary artery aneurysms among those with arthritis (7.28%) compared to those without arthritis (2.75%) ($p = 0.003$), but the prevalence of coronary artery lesions (CALs) was similar in the two groups. The arthritis in KD was self-limited, left no sequelae and did not require additional medications. KD patients with arthritis were more likely to get coronary artery aneurysms than the patients without arthritis, so examination of joints in KD was necessary.

Keywords Kawasaki disease (KD) · Arthritis · Coronary artery lesions (CALs) · Articular outcome

Introduction

Kawasaki disease (KD) also known as mucocutaneous lymph node syndrome (MCLS) was first described by Tomisaku Kawasaki in 1967 [1]. It is an acute, self-limiting, systemic vascular inflammation that mainly affects the medium-vessel vasculitis [2]. CALs are the most common complication of KD, which may lead to myocardial ischemia and infarction lesions [3]. Because the incidence rate of KD has increased, the disease has replaced rheumatic heart disease as the most common cause of acquired heart disease in children in developed countries. Apart from the coronary artery lesions, KD may present with non-cardiac complications in multiple body systems during the natural course [4]. The complications of KD included aseptic meningitis, anterior uveitis, myositis, arthritis, cranial nerve palsies, ischemic colitis and pancreatitis [4–8]. Arthritis is a major complication of KD, but it was mainly described in case reports [9–12]. Few studies have looked at the relationship between the KD-related arthritis and CALs. The features of KD-related arthritis have been reported in Canada and Portuguesa [6, 13]. As we know, North-East Asian countries (notably Japan and China) have the highest incidence rate of KD [14], but no studies concerning the arthritis presenting during KD in these populations are available. Given that ethnic or geographic variations in disease presentation have been reported [14, 15], we designed the present study in a Chinese population in order to determine the prevalence, pattern and clinical course of arthritis associated with KD,

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and to elucidate the relation between the arthritis complications and coronary outcome.

Patients and methods

We did a retrospective cohort study by using the clinical records of patients with KD who were hospitalized in Jiangxi Children's Hospital from January 2014 to December 2017. The inclusion criteria for patients with KD were based on the American Heart Association (AHA) diagnostic guidelines [16]; all patients with KD were treated with intravenous immunoglobulin (IVIG) (2 g/kg) plus oral aspirin (50 mg/kg/day), and the dose of aspirin is reduced to 5 mg/kg/d after the patient has been afebrile for 48 to 72 h. Exclusion criteria included (1) receipt of initial treatment before hospitalization; (2) recurrent cases; and (3) incomplete medical data. Demographic, clinical and laboratory data were recorded in all study participants. The study was approved by the local institutional research ethic boards.

Two-dimensional echocardiography was performed at the time of diagnosis (acute phase) and repeated approximately 6–8 weeks after diagnosis (convalescent phase). Internal diameters of the right coronary artery (RCA), left main coronary artery (LMCA), left anterior descending artery (LAD) and left circumflex artery (LCX) were measured. We converted these diameters to *Z*-scores based on the patients' body surface area, body surface area and *Z* scores were calculated using the Haycock and the Montreal equations, respectively. Coronary artery dilation was defined as *Z*-score ≥ 2.0 to < 2.5. Coronary artery aneurysms was defined as *Z*-score ≥ 2.5 and diameter < 8 mm (*Z*-score ≥ 10 or diameter ≥ 8 mm for giant aneurysms) [16]. The diagnosis of KD-related arthritis was made by a board-certified pediatric rheumatologist based on joint pain with limited range of motion and/or swelling and/or evidence of synovitis on ultrasonography during the time of acute or subacute stage. Patients were excluded if infectious arthritis or other known arthritis is diagnosed. Oligoarticular involvement was defined as arthritis affecting 1–4 joints, and polyarticular involvement was defined as arthritis affecting 5 or more joints. Early-onset arthritis was defined as arthritis occurs during the first 10 days of illness, and late-onset arthritis was defined as arthritis develops after the 10th day of illness [17].

In all patients, we analyzed history data, initial laboratory test results, echocardiographic findings and the treatment effects.

Statistical analysis. Data were expressed as the mean ± standard deviation, median with interquartile range or percentage of patients. Normally distributed continuous variables were analyzed using two-sample t tests, and non-normally distributed variables were analyzed using Mann–Whitney *U* tests. Categorical data were analyzed using the Chi-squared test. A *p* value < 0 0.05 was considered to denote statistical significance. Analyses were performed using SPSS software (version 24).

Results

During the study period, a total of 1636 KD patients were hospitalized. Of the 1636 patients, 216 patients were excluded due to the following reasons: 56 patients received the initial treatment before hospitalization, 11 patients were recurrent cases and the data were incomplete in 149 patients. Of the 1420 eligible patients, 857 were boys and 563 were girls, 151 were patients with arthritis and 1269 were patients without arthritis (Fig. 1). The median age at diagnosis was 20 months (range 2–155 months). The majority of children (1112 patients 78.3%) had complete KD, and 308 patients (21.7%) had iKD. The mean time from symptom onset to definitive treatment was 5.40 ± 0.98 days. In total, 1165 patients responded to the initial IVIG treatment (82.0%), and the remaining 255 patients (18.0%) were regarded as non-responders.

The demographic and clinical characteristics of KD patients with arthritis compared with those patients without arthritis are given in Table 1. The median age of KD patients was 29 months (P25 = 20, P75 = 36) in the arthritis group and 20 months (P25 = 14, P75 = 30) in the non-arthritis group ($p < 0.001$), indicating that the older children with KD were more prone to get arthritis. There was no statistically difference in the duration of fever before treatment between two groups ($p = 0.210$). The duration of the fever after IVIG treatments was an average of 1.7 ± 0.9 days in KD patients

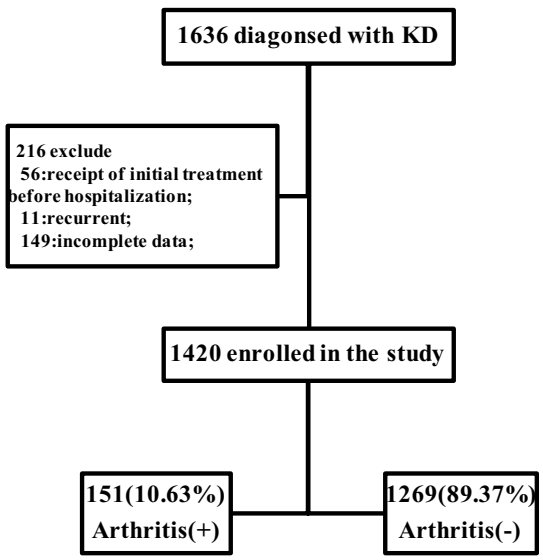

Fig. 1 Flowchart of enrollment and classification of the subjects

Table 1 Demographic and clinical characteristics of KD patients with and without arthritis

	Total	Arthritis group	Non-arthritis group	χ^2	z	p
No. of patients	1420	151	1269			
Male, *n* (%)	857 (60.3)	89 (58.9)	768 (60.4)	0.141		0.708
Age, mo					−6.925	< 0.001*
Median (IQR)	20 (14.31)	29 (20.36)	20 (14.30)			
Range	2155	8121	2155			
Mean ± SD	24.1 ± 15.4	30.9 ± 16.4	23.3 ± 15.1			
< 6 mo, *n* (%)	65 (4.6)	3 (2)	62 (4.9)	2.596		0.107
6–60 mo, *n* (%)	1312 (92.4)	139 (92.0)	1173 (92.4)	0.028		0.867
> 60 mo, *n* (%)	43 (3.0)	9 (6.0)	34 (2.7)	4.947		0.026*
Duration of fever before IVIG ± SD (median), d	5.4 ± 1.0 (5)	5.4 ± 0.9 (5)	5.4 ± 1.0 (5)		−1.254	0.210
Duration of fever after IVIG ± SD (median), d	1.3 ± 0.8 (1)	1.7 ± 0.9 (1.5)	1.3 ± 0.9 (1)		−6.609	< 0.001*
Total fever duration ± SD (median), d	6.7 ± 1.2 (6)	7.1 ± 1.3(7)	6.7 ± 1.2 (6)		−4.729	< 0.001*
Major clinical manifestations, *n* (%)						
Mucosal changes	1271 (89.5)	137 (90.7)	1134 (89.4)	0.268		0.604
Conjunctival injection	1360 (95.8)	142 (94.0)	1218 (96.0)	1.257		0.262
Rush	1175 (82.7)	127 (84.10)	1048 (82.6)	0.219		0.640
Changes in extremities	694 (48.9)	65 (43.0)	629 (49.6)	2.296		0.130
Cervical lymphadenopathy	522 (36.8)	53 (35.1)	469 (37.0)	0.201		0.654
Incomplete KD, *n* (%)	308 (21.7)	38 (25.2)	270 (21.3)	1.202		0.273
IVIG resistance, *n* (%)	255 (17.9)	32 (21.2)	223 (17.6)	1.200		0.273

p value is for comparison between arthritis group and non-arthritis group

KD Kawasaki disease, *mo* month, *d* day, *IVIG* intravenous immunoglobulin, *IQR* interquartile range, *SD* standard deviation

*Statistical significance ($p < 0.05$)

with arthritis and an average of 1.3 ± 0.9 days in KD patients without arthritis ($p < 0.001$).

As given in Table 2, the patients with arthritis had a significantly higher white blood cell (WBC) count ($p = 0.004$), neutrophil count ($p = 0.001$), platelet count ($p = 0.038$) and C-reactive protein (CRP) level ($p < 0.001$), and lower hemoglobin level ($p = 0.002$). Interestingly, no difference was found in other laboratory parameters such as erythrocyte sedimentation rate (ESR), procalcitonin (PCT) and N-terminal pro-brain natriuretic peptide (NT-proBNP), between the patients with arthritis and patients without arthritis.

CALs was found in 303 (21.33%) of the KD patients, 257 of whom (18.09%) had coronary artery dilation, 46 (3.23%) patients had coronary artery aneurysms, and 15 (1.05%) patients had giant coronary artery aneurysms (Table 3). The incidence of CALs was 26.49% in KD patients with arthritis

Table 2 Laboratory parameters of KD patients with and without arthritis

	Total	Arthritis group	Non-arthritis group	z	p
WBC ± SD (median), $\times 10^9$/L	15.0 ± 8.9 (14.1)	15.8 ± 4.1 (15.0)	15.0 ± 8.9 (14.0)	−2.882	0.004*
Neutrophil ± SD (median), $\times 10^9$/L	8.6 ± 3.8 (7.9)	9.1 ± 2.6 (9.0)	8.6 ± 3.9 (8.0)	−3.322	0.001*
Hemoglobin ± SD (median), g/L	105.4 ± 11.0 (104.0)	102.6 ± 11.3 (103.0)	105.8 ± 11.0 (105.0)	−3.108	0.002*
Platelet ± SD (median), $\times 10^9$/L	317.5 ± 116.2 (302.0)	338.6 ± 121.1 (315.0)	314.9 ± 115.4 (301.0)	−2.077	0.038*
CRP ± SD (median), mg/dL	68.6 ± 46.5 (60.0)	83.8 ± 50.5 (72.0)	66.8 ± 45.6 (56.0)	−5.473	< 0.001*
ESR ± SD (median), mm/h	57.3 ± 24.8 (55.0)	58.0 ± 29.3 (58.0)	57.2 ± 24.3 (55.0)	−0.385	0.700
PCT ± SD (median), ng/mL	2.4 ± 13.0 (1.1)	4.5 ± 37.7 (1.0)	2.1 ± 4.5 (1.0)	−1.748	0.081
NT-proBNP ± SD (median), pg/mL	785.2 ± 1145.9 (330.0)	861.2 ± 1311.0 (339.0)	776.1 ± 1124.9 (310.0)	−1.400	0.160

p value is for comparison between arthritis group and non-arthritis group

WBC white blood cell, *SD* standard deviation, *CRP* C-reactive protein, *ESR* erythrocyte sedimentation rate, *PCT* procalcitonin, *NT-proBNP* N-terminal pro-brain natriuretic peptide

*Statistical significance ($p < 0.05$)

and 20.72% in those without arthritis ($p=0.102$), but there was a higher incidence of coronary artery aneurysms in KD patients with arthritis ($p=0.003$).

The number of joints affected ranged from 1 to 27; of the 151 patients, developed arthritis 101 patients (66.9%) had oligoarticular involvement, most of them only having large joints involved (93 patients, 92.1%). Fifty patients (33.1%) had polyarticular involvement, in which various combinations of small and large joints were affected. The large joints were predominantly involved in both of the oligoarticular and polyarticular involvement patients. The median time lapse from illness onset to the appearance of arthritis was 7.0 days (P25 = 4.0, P75 = 15.0). Early-onset and late-onset arthritis were, respectively, observed in 123 (81.5%) and 28 (18.5%) patients. Interestingly, the KD patients with early-onset arthritis had a significantly higher WBC count ($p=0.037$) and CRP level ($p=0.046$) than KD patients with late-onset arthritis (Table 4). The KD patients with early-onset arthritis had a higher incidence rate of CALs (30.08%) than patients with late-onset arthritis (10.71%) with statistical significance ($p=0.036$) (Table 5). The clinical course of arthritis was short-lived in most patients, and no additional non-steroidal anti-inflammatory drug was needed in these patients. The median duration of arthritis was 10 days

Table 3 Coronary artery lesions in KD patients with and without arthritis

	Total	Arthritis group	Non-arthritis group	χ^2	*p*
CALs, *n* (%)	303 (21.33)	40 (26.49)	263 (20.72)	2.672	0.102
Dilation, *n* (%)	257 (18.09)	29 (19.20)	228 (17.96)	0.140	0.709
Aneurysms, *n* (%)	46 (3.23)	11 (7.28)	35 (2.75)	8.822	0.003*
Giant aneurysm, *n* (%)	15 (1.05)	5 (3.31)	10 (0.78)	8.220	0.004*

p value is for comparison between arthritis group and non-arthritis group

CALs coronary artery lesions

*Statistical significance ($p<0.05$)

Table 4 Laboratory parameters of KD patients with early-onset arthritis and late-onset arthritis

	Total	Early-onset group	Late-onset group	*z*	*p*
WBC ± SD (median), $\times 10^9$/L	15.8 ± 4.1 (15.0)	16.1 ± 4.4 (15.4)	14.4 ± 2.1 (14.1)	− 2.090	0.037*
Neutrophil ± SD (median), $\times 10^9$/L	9.1 ± 2.6 (9.0)	9.3 ± 2.8 (8.8)	8.1 ± 1.2 (8.1)	− 2.184	0.029*
Hemoglobin ± SD (median), g/L	102.6 ± 11.3 (103.0)	103.0 ± 11.5 (103.0)	101.0 ± 10.2 (101.5)	− 0.697	0.486
Platelet ± SD (median), $\times 10^9$/L	338.6 ± 121.1 (315.0)	334.8 ± 118.6 (311.0)	355.4 ± 132.3 (328.0)	− 0.723	0.470
CRP ± SD (median), mg/dL	83.8 ± 50.5 (72.0)	88.1 ± 54.2 (75.0)	65.0 ± 21.6 (61.5)	− 1.999	0.046*
ESR ± SD (median), mm/h	58.0 ± 29.3 (58.0)	57.9 ± 29.8 (58.0)	58.4 ± 27.3 (57.0)	− 0.184	0.854
PCT ± SD (median), ng/mL	4.5 ± 37.7 (1.0)	5.2 ± 41.7 (0.9)	1.6 ± 1.8 (1.05)	− 0.735	0.462
NT-proBNP ± SD (median), pg/mL	861.2 ± 1311.0 (339.0)	836.3 ± 1284.2 (310.0)	970.8 ± 1442.5 (370.0)	− 0.172	0.864

p value is for comparison between early-onset group and late-onset group

WBC white blood cell, *SD* standard deviation, *CRP* C-reactive protein, *ESR* erythrocyte sedimentation rate, *PCT* procalcitonin, *NT-proBNP* N-terminal pro-brain natriuretic peptide

*Statistical significance ($p<0.05$)

Table 5 Coronary artery lesions and duration of arthritis in KD patients with early-onset arthritis and late-onset arthritis

	Total	Early-onset group	Late-onset group	*z*	χ^2	*P*
CALs, *n* (%)	40 (26.49)	37 (30.08)	3 (10.71)		4.393	0.036*
Dilation, *n* (%)	29 (19.20)	27 (21.95)	2 (7.14)		3.223	0.073
Aneurysms, *n* (%)	11 (7.28)	10 (8.13)	1 (3.57)		0.189	0.664
Giant aneurysm, *n* (%)	5 (3.31)	5 (3.31)	0 (0.0)			0.585
Median duration of arthritis (IQR), d	10 (8,13)	10 (8,12)	11 (9,13.8)	− 1.921		0.056

p value is for comparison between early-onset group and late-onset group

CALs coronary artery lesions, *IQR* interquartile range

*Statistical significance ($p<0.05$)

(P25 = 8, P75 = 13), lasting no longer than 22 days, and no significant difference was found in the duration of arthritis between the early-onset and late-onset arthritis patients. All patients with arthritis recovered, with no joint sequelae, regardless of the number of joints involved.

Discussion

KD is a systemic vasculitis which occurs mainly in North-East Asian populations and may show the various symptoms and findings by involving multiple organs. Arthritis in KD has long been described and was reported in 30% of patients in the pre-IVIG era [18], but these incidences decreased after the use of IVIG in KD. Gong et al. screened 414 KD patients in the Canadian population; they identified the prevalence of arthritis in KD was decreased to 7.5% due to the anti-inflammatory effect of IVIG [6]. In a recent single-center study, Martins et al. [13] found that the prevalence of arthritis in KD was 12.7% in the Portuguese population. Although North-East Asian populations have the highest incidence rate of KD, the KD-related arthritis has been reported mainly in case reports and poorly characterized.

In our study, patients with KD were divided into arthritis group and non-arthritis group. Comparative analysis on clinical progress characteristics, laboratory tests and coronary outcome is conducted to identify the meaning of arthritis in KD. The prevalence of arthritis found in our cohort (10.6%) was similar to previous studies (7.5–12.7%) [6, 13]. KD patients with arthritis were significantly older than patients without arthritis, which means KD-related arthritis mainly affected older patients. Apart from the age, these two groups were found to have the same other demographic features. The duration of the fever after treatments was significantly longer in KD patients with arthritis, and it suggested that the response to treatment was slower in KD patients with arthritis compared to those without arthritis. But there were no statistical difference of non-responders between these two groups. Several laboratory results were different between KD patients with arthritis and those without arthritis. The WBC count, neutrophil count, platelet count and CRP level were significantly higher in KD patients with arthritis, and hemoglobin level was lower in KD patients with arthritis. The marked leukocytosis, thrombocytosis, elevated CRP, decreased hemoglobin and the longer duration of the fever after treatments in our cohort suggest a more severe inflammatory process of illness in KD patients with arthritis, which means arthritis might lead to a higher IVIG resistance rate or worse prognosis in KD. Though there were no statistical difference of IVIG resistance rate between KD patients with arthritis and without arthritis, our study indicated that KD patients with arthritis had a significantly higher frequency of coronary artery aneurysms, which is in disagreement with previous studies in Canada and Portugal [6, 13]. In their research, Gong et al. observed that systemic inflammation was more pronounced in KD patients with arthritis, but these patients did not appear to be at increased risk of CALs or coronary artery aneurysms. As our study was developed based on a Chinese population and the research of Gong et al. was developed from data in the Canada, we acknowledge that this may be due to the different region, ethnicity and sample size.

Previous reports mainly focused on the difference between patients with arthritis and without arthritis [6, 13], with few studies concerning the difference between patients with early-onset arthritis and late-onset arthritis. Our data show that WBC count and CRP level were statistically higher in KD patients with early-onset arthritis than the patients with late-onset arthritis, and the incidence rate of CALs was higher in KD patients with early-onset arthritis, which suggested that early arthritis in KD was significantly correlated with severe inflammation and the development of CALs.

Most of KD patients with arthritis experienced a rapid recovered of arthritis after treatment with IVIG and aspirin, and no additional drug was needed in these patients. All patients with arthritis recovered without any sequelae in our cohort, regardless of the severe symptomatic on presentation. This finding was in agreement with the finding of the previously studies [6, 13, 19], which demonstrated that arthritis was ultimately a benign and self-limited phenomenon in most KD patients.

Despite decades of effort, the etiology and pathogenesis of KD remain unknown. It is generally thought that KD results from a variety of infectious agents that evoke an abnormal immunologic response in genetically susceptible individuals [20, 21]. We know reactive arthritis is a kind of arthritis after infection with agents such as Shigella, Yersinia or Chlamydia [22]. Arthritis in KD, therefore, may be a reactive arthritis due to an unknown pathogen.

Although arthritis does not contribute to the principal criteria for diagnosis of KD, it is important for clinicians to be aware that it may lead to a worse outcome. Thus, we should highlight the need for the examination of joints in KD.

As far as we know, this is by far the first and the largest study to determine the clinical characteristics of KD-related arthritis in North-East Asian populations, but this study has several limitations. First, this was a retrospective, single-center study, so selection bias may exist. Second, we cannot rule out whether arthritis were undetected in infants younger than 6 months as it is difficult to diagnose arthritis in this age group.

In conclusion, we found that KD patients with arthritis had a higher incidence rate in older patients and related to leukocytosis, thrombocytosis, elevated CRP and decreased hemoglobin. KD patients with arthritis had no difference in

fever duration with those patients without arthritis before treatment, while they had longer duration of the fever after treatments and a higher rate of coronary artery aneurysms which might lead to a worse outcome. There was no joint sequelae in KD patients with arthritis, and all arthritis were self-limited without additional drug therapy.

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Author contributions ZZ and YZ contributed to the study design. YP organized the study and performed the writing of the manuscript. YP and YZ performed the statistical analysis. XL, ZD, YD, SC, ZW, KX, HK, MJ and LL performed the data entry. All authors have participated in the discussion of the manuscript and approved the final version of the manuscript.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval The study protocol was approved by the Ethics Committee of Jiangxi Province Children's Hospital.

Informed consent For this type of study, formal consent is not required.

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