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Research article

Clinical features of Kawasaki disease and analysis of risk factors for coronary damage

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Abstract: Objective: To investigate the clinical characteristics and risk factors for coronary artery lesion (CAL) in Kawasaki disease (KD) through a comprehensive analysis of 418 pediatric cases, thereby enhancing the diagnostic and therapeutic approaches for this condition. **Methods:** We conducted a retrospective analysis of 418 children diagnosed with KD and hospitalized between January 2017 and January 2024. Data on clinical manifestations, laboratory findings, echocardiography results, and treatment outcomes were systematically reviewed. **Results:** Among the 418 KD patients, the male-to-female ratio was 2.07:1 (276 males, 66.03%; 142 females, 33.97%), with 84.92% (355/418) under 5 years of age. The cohort included 292 cases (69.86%) of typical KD and 126 cases (30.14%) of incomplete KD. Coronary artery lesions were identified in 11.72% (49/418) of patients, with significantly higher incidence in the incomplete KD group [23.02% (29/126)] compared to the typical KD group [6.85% (20/292); $\chi^2 = 16.00$, $P < 0.001$]. Subgroup analysis revealed that infants < 1 year old had a higher CAL rate [24.72% (22/89)] than 1–5-year-olds [9.40% (25/266); $\chi^2 = 11.95$, $P < 0.001$]. Regarding treatment timing, the CAL incidence was significantly lower in patients receiving intravenous IVIG within 7 days of fever onset [6.74% (18/267)] compared to those treated at 7–10 days [20.53% (31/151); $\chi^2 = 16.53$, $P < 0.001$]. **Conclusions:** Kawasaki disease primarily affects infants, with children under 1 year at higher risk for coronary artery lesions. Incomplete cases often present with atypical symptoms, requiring prompt diagnosis through imaging and lab tests. Early Intravenous immunoglobulin (IVIG) (2 g/kg) combined with aspirin within 7 days of onset significantly reduces coronary complications (6.74% vs. 20.53% with delayed treatment). Glucocorticoids are reserved for severe or IVIG-resistant cases. Immediate treatment initiation, regular

echocardiography monitoring (using Z-score), and anticoagulation for high-risk patients are essential. Long-term follow-up is mandatory, with lifetime management for coronary abnormalities. The key strategy involves early recognition, standardized treatment within 10 days (optimally 7 days), and systematic follow-up to improve outcomes.

Keywords: Kawasaki disease; coronary artery lesions; clinical features; incomplete Kawasaki disease

1. Introduction

Kawasaki disease (KD), or mucocutaneous lymph node syndrome, is an acute systemic vasculitis predominantly affecting medium and small arteries, with a particular predilection for children under five years of age. Characterized by heterogeneous clinical manifestations and the absence of pathognomonic diagnostic tests, KD diagnosis currently relies on a combination of clinical criteria, laboratory findings, and echocardiography evaluation [1]. While the precise etiology remains elusive, KD is well-established as a leading cause of acquired pediatric heart disease through its propensity to induce coronary artery abnormalities. These range from transient dilation to aneurysm formation (occurring in 15–25% of untreated cases) and, in severe instances, may progress to thrombosis or myocardial infarction. Although typically self-limiting with favorable outcomes in most patients, approximately 5% of cases develop coronary complications despite a timely administration of high-dose intravenous IVIG during the acute phase [2].

To better characterize disease presentation and optimize therapeutic approaches, we conducted a retrospective analysis of 418 pediatric KD cases treated at our institution between January 2017 and January 2024.

2. Data and methods

2.1. Study population

This retrospective study included 418 pediatric patients diagnosed with Kawasaki disease (KD) and hospitalized between January 2017 and January 2024.

2.2. Diagnostic criteria

2.2.1. KD (Kawasaki disease) and CAL (Coronary artery lesion)

Typical Kawasaki disease [3,4]: fever ≥5 days, ineffective antibiotic treatment, with the following 4 (or more) main clinical features, diagnosis can be made after exclusion of other similar diseases:

(1) Enlarged cervical lymph nodes: unilateral lymphadenopathy, diameter ≥1.5 cm, surface not red, medium or hard texture, tenderness, no suppuration.

(2) Polymorphic erythema: can be accompanied by perianal peeling.

(3) Hand and foot symptoms: hard swelling of hands and feet, palm and plantar flushing in the acute stage, and membranous peeling of the ends of fingers and toes in the recovery stage.

(4) Diffuse congestion of oral mucosa: including strawberry tongue and erythematous lips.

(5) Bulbar conjunctival congestion: bilateral non-purulent. Scarlet fever, juvenile idiopathic arthritis, systemic lupus erythematosus, and other similar diseases need to be excluded.

Coronary artery lesion (CAL) [5]:

(1) Coronary artery dilation: the internal diameter of the coronary artery ≥2.5 mm in the age of 0–3 years, ≥3.0 mm in the age of 3–9 years, and ≥3.5 mm in the age of 9–14 years.

(2) Coronary artery lesion severity grading: A, normal (0 degree), no coronary artery dilation; B, mild (I degree), aneurysmal dilation is obvious and limited, internal diameter <4 mm; C, moderate (II degree), can be single, multiple, or extensive, internal diameter of 4~7 mm; D, severe (III degree), giant aneurysms with internal diameter of ≥8 mm, mostly extensive, involving more than 1 branch.

(3) Coronary artery aneurysm: the internal diameter of the coronary artery >3 mm, irregular shape, and local internal diameter is more than 1.5 times the nearby internal diameter.

(4) Coronary artery thrombosis: echocardiography or coronary angiography shows thrombus in coronary artery.

(5) Coronary artery stenosis: ≥50% stenosis of coronary artery internal diameter compared with normal.

(6) Abnormal origin of coronary artery: the coronary artery originates from an abnormal location.

2.2.2. IKD (Incomplete Kawasaki disease)

Incomplete Kawasaki disease: fever ≥5 days, ineffective antibiotic treatment, possession of 2 or 3 of the above 5 major clinical manifestations, and exclusion of other diseases with similar manifestations.

2.3. Methods

The clinical data of 418 children with Kawasaki disease were explored and analyzed, including children's age, gender, season of onset, duration of hospitalization, clinical manifestations (including fever, bulbar conjunctival congestion, changes in the lips and mouth, changes in the extremities, rash, perianal desquamation, enlarged cervical lymph nodes and comorbidities, etc.), auxiliary examinations (white blood cell count, platelet count, hemoglobin, hemoglobin, hemoglobin, C-reactive protein, chest X-ray, echocardiography, etc.), treatment, and regression.

3. Results

3.1. General information

A total of 418 children were included in this study, including 276 males and 142 females, with a male-to-female ratio of approximately 1.94:1. The age range of the children was from 5 months to 11 years and 4 months, with 84.92% of the children under 5 years of age. The specific age distribution was as follows: 89 cases <1 year old, 181 cases between 1 and 3 years old, 85 cases between 3 and 5 years old, and 63 cases >5 years old. In terms of diagnostic classification, there were 292 children who met the diagnostic criteria for typical Kawasaki disease and 126 children who met the diagnostic criteria for incomplete Kawasaki disease. Among the children with incomplete Kawasaki disease, 36 cases were <1 year old. In terms of length of hospitalization, there were 40 cases with a length of hospitalization <7 days, 352 cases with 7–14 days, and 26 cases with >14 days. In terms of seasonal

distribution, there were 95 cases with onsets in spring, 97 cases in summer, 140 cases in fall, and 86 cases in winter.

3.2. Clinical manifestations

Among the 418 children with Kawasaki disease, all of them had fever symptoms, of which 25 cases showed intermittent fever. The distribution of other clinical manifestations was as follows: 398 cases of chapped lips, 346 cases of lymphadenopathy in the neck, 355 cases of bulbar conjunctival congestion, 294 cases of membranous desquamation of the ends of the fingers and toes during the recovery period, 219 cases of transient rash, 178 cases of scleroderma of the hands and feet, 200 cases of strawberry tongue, 203 cases of redness or peeling of perianal skin, and 199 cases of Bacillus Calmette-Guérin（BCG） scarring erythema. In addition, the children were also combined with other systemic symptoms, including cough in 184 cases, diarrhea in 158 cases, stomatitis in 119 cases, and arthralgia of the extremities in 78 cases. The percentage of each specific symptom is shown in Figure 1.

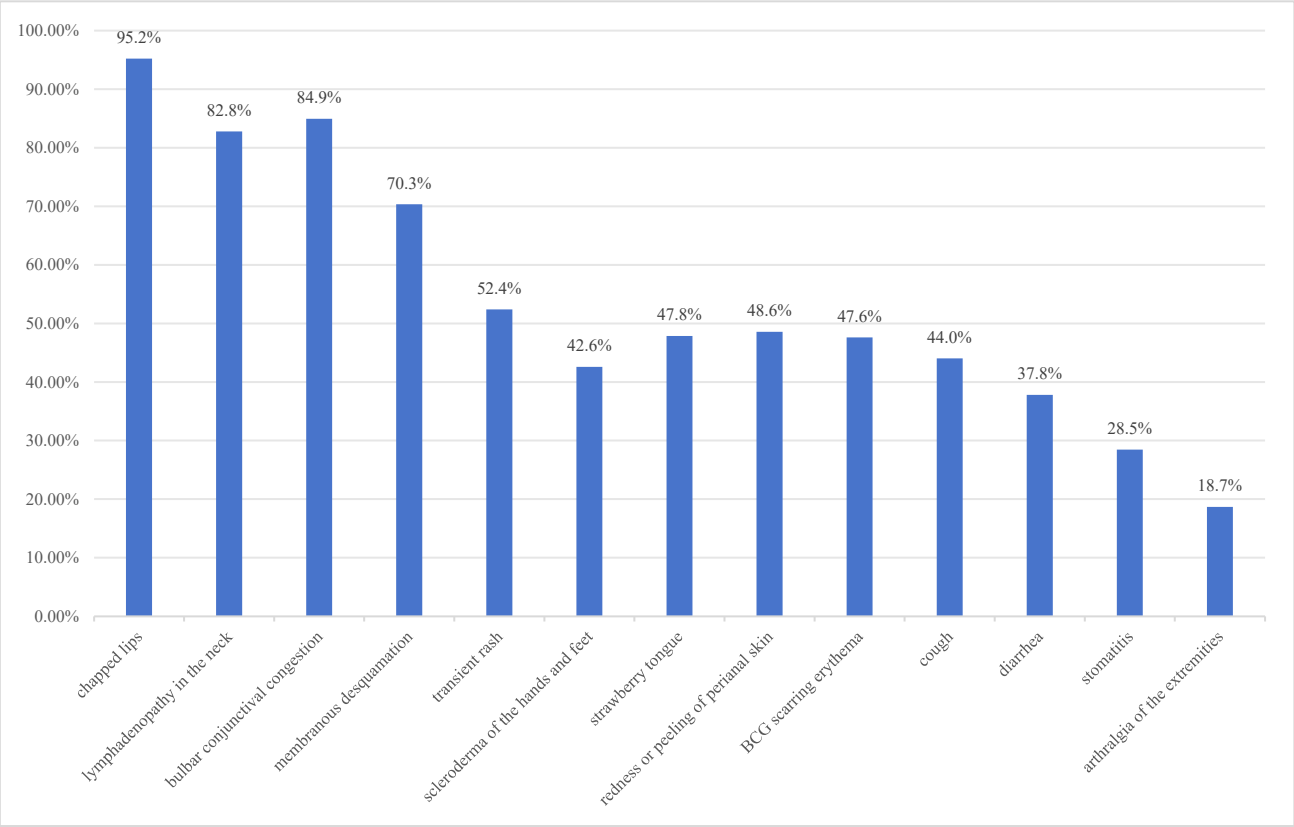

Figure 1. Probability of occurrence of clinical manifestations of KD.

3.3. Auxiliary examinations

There were 388 cases of elevated white blood cell counts, including 225 cases of elevated neutrophils; 391 cases of elevated platelet count, most of which appeared on the 6th–10th day of the disease; 390 cases of increased blood sedimentation; 340 cases of elevated C-reactive protein; 287 cases of mild anemia; 20 cases of pleural effusion; and 32 cases of pericardial effusion. Eventually,

echocardiography showed coronary artery damage in a total of 49 cases, including 8 cases of coronary artery aneurysmal dilation.

In terms of the occurrence of coronary artery lesions, of the 292 children in the typical Kawasaki disease group, 20 cases were combined with coronary artery lesions; of the 126 children in the incomplete Kawasaki disease group, 29 cases had CAL, including 5 cases of aneurysmal dilation of the coronary arteries. Specific data are shown in Table 1.

In terms of age stratification, there were 89 cases of children with Kawasaki disease under 1 year of age, including 22 cases of coronary artery damage, with a prevalence rate of 24.72%; there were 266 cases of children with Kawasaki disease aged 1–5 years of age, including 25 cases of coronary artery damage, with a prevalence rate of 9.40%. Specific data are shown in Table 2.

Table 1. Comparison of CAL between the two groups of typical KD and incomplete KD (cases).

Category\results	CAL		Incidence of a disease (%)	Total
	CAL+(Actual/expected[1])	CAL−(Actual/expected)		
Typical KD	20 (33.64)	272 (258.36)	6.85	292
Incomplete KD	29 (15.36)	97 (110.64)	23.02	126
Total	49	369	11.72	418

Note: The SPSS27.0 chi-square test yielded $\chi^2 = 16.00$, $P < 0.001$, and the difference between the two groups was statistically significant. KD: Kawasaki disease; CAL: Coronary artery lesion.

Table 2. Comparison of CAL between the two groups of KD (<1 year old) and KD (1–5 years old) (cases).

Category\results	CAL		Incidence of a disease (%)	Total
	CAL+(Actual/expected)	CAL−(Actual/expected)		
KD (<1 year old)	22 (11.68)	67 (77.32)	24.72	89
KD (1–5 years old)	25 (35.32)	241 (230.68)	9.40	266
Total	47	308	13.24	355

Note: The SPSS27.0 chi-square test yielded $\chi^2 = 11.95$, $P < 0.001$, and the difference between the two groups was statistically significant. KD: Kawasaki disease; CAL: Coronary artery lesion.

3.4. Treatment and regression

418 children with confirmed Kawasaki disease were treated with intravenous IVIG combined with oral aspirin. The dose of IVIG was 2 g/kg intravenously; the oral dose of aspirin was 30–50 mg/kg/d in 3 divided doses. For children with comorbid coronary artery disease, the aspirin dose was reduced to 1/2 of the initial dose 3 days after the fever subsided, and further reduced to 3–5 mg/kg/d 2 weeks after the fever subsided until the coronary arteries returned to normal. In children without coronary artery disease, the aspirin dose was reduced to 3–5 mg/kg/d 3 days after the fever subsided for 2 months. If the child had a high platelet count, dipyridamole 3–5 mg/kg/d was added and given

[1] "Actual" is directly obtained data, "expected" is calculated statistically under the assumption that there is no difference between the two groups (the same below).

orally in 3 divided doses. In terms of therapeutic response, 399 children had normalized body temperature within 36 hours after receiving IVIG. However, there were still 19 children who did not respond to the initial IVIG drip. Of these children, 14 had a decrease in temperature after receiving a second IVIG treatment (1–2 g/kg intravenously), and 5 had a return to normal after receiving methylprednisolone drip.

In terms of the association between the timing of treatment and the incidence of coronary artery lesions, this study found that of the 267 children who received IVIG within 7 days of the onset of the disease, 18 developed coronary artery damage, with an incidence rate of 6.74%; of the 151 children who received IVIG within 7–10 days, 31 developed coronary artery damage, with an incidence rate of 20.53%. Specific data are shown in Table 3.

Table 3. Comparison of CAL between the two groups of IVIG within 7 days and IVIG within 7–10 days (cases).

Category\results	CAL		Incidence of a disease (%)	Total
	CAL+(Actual/expected)	CAL−(Actual/expected)		
IVIG within 7 days	18 (31.64)	249 (235.36)	6.74	267
IVIG within 7–10 days	31 (17.36)	120 (133.64)	20.53	151
Total	49	369	11.72	418

Note: The SPSS27.0 chi-square test yielded $\chi^2 = 16.53$, $P < 0.001$, and the difference between the two groups was statistically significant. KD: Kawasaki disease; CAL: Coronary artery lesion; IVIG: Intravenous immunoglobulin.

4. Discussion

Kawasaki disease is an acute rash disease. Its onset age is common in infants and young children and presents a certain regional prevalence and seasonality. The most common and serious complications of the disease are coronary artery damage and the formation of coronary aneurysms. It is currently one of the most common causes of acquired heart disease in children, with an incidence of 15–25%. In recent years, Kawasaki disease has become one of the risk factors for ischemic heart disease in adults.

Our study showed that 84.92% of the children evaluated were under 5 years of age; also, the disease was more common in boys, accounting for 66.03% of the cases. Kawasaki disease onset occurs in all seasons of the year but is relatively more common in the fall and winter. In terms of clinical manifestations, all children presented with fever. Furthermore, the incidence of chapped lips, lymphadenopathy in the neck, bulbar conjunctival congestion, and membranous desquamation was high, while the incidence of other related symptoms was relatively low. In addition, some of the children had a combination of systemic multi-system and organ involvement, such as the respiratory system, digestive system, and joints, which was consistent with the pathologic changes of systemic medium and small arteritis in Kawasaki disease [3].

The results of the ancillary test showed that white blood cell counts were elevated in 92.82% (388 cases), and neutrophils were elevated in approximately half of the total cases (225 cases). Blood sedimentation increased in 93.30% (390 cases), and C-reactive protein was elevated in 81.33% (340 cases). Platelet counts were mostly normal early in the course of the disease and increased significantly after 1 week in 391 cases. Mild anemia was found in 68.66% (287 cases), and pleural effusion was

found in 20 cases. Echocardiography showed pericardial effusion in 32 cases and coronary artery dilation (internal diameter 2.5–3.5 mm) in 49 cases, including coronary artery aneurysmal dilation (internal diameter 4–8 mm) in 8 cases. In the typical Kawasaki disease group (292 cases), 20 cases were combined with coronary artery lesions; in the incomplete Kawasaki disease group (126 cases), coronary artery lesions occurred in 29 cases, including 5 cases of coronary artery aneurysmal dilation. The overall incidence of coronary artery damage was 11.72%, which was higher in the incomplete Kawasaki disease group than in the typical Kawasaki disease group ($\chi^2 = 16.0$, $P < 0.001$). In age classification, 89 children with Kawasaki disease under 1 year of age had 22 combined coronary artery lesions, and 266 children in the Kawasaki disease group of 1–5 years of age had 25 coronary artery lesions [6]. The incidence of coronary artery lesions was higher in the Kawasaki disease group of under 1 year of age than in the group of 1–5 years of age ($\chi^2 = 11.95$, $P < 0.001$).

According to our data, the incidence of coronary artery lesions in children under 1 year of age is higher than in other age groups, especially in the incomplete Kawasaki disease group, which is more likely to involve the coronary arteries, according to reports in the literature [7–9]. This may be closely related to factors such as atypical clinical symptoms, difficulty in diagnosis, delay in diagnosis, and delay in standardized treatment.

Coronary artery lesions in KD are remarkably characteristic, and their potential harm cannot be ignored. Coronary artery dilation is of critical importance in the diagnosis of KD and is often regarded as one of the most important bases for confirming the disease. In the 2017 American Heart Association (AHA) guidelines [10], the Z-score was explicitly proposed as an important assessment index. The Z-score can reflect the relative position of an individual in a normal population with the same body surface area, and the magnitude of its value intuitively reflects the degree of coronary artery dilation in patients with KD in terms of its deviation from the normal value. Therefore, the Z-score has a non-negligible clinical value in assessing coronary artery dilation in KD. According to the specific classification criteria of this guideline, coronary artery dilation is determined when the Z-score is ≥2.5; when the Z-score is ≥5, it is diagnosed as a medium-sized aneurysm; and when the Z-score is ≥10, it is recognized as a giant aneurysm. However, it is worth noting that due to the existence of differences in genetic polymorphisms, there are some differences in the method of calculating Z-score in different regions, which may lead to bias in its numerical results, which could potentially affect the development of clinical treatment decisions. However, coronary artery dilation occurs in the subacute stage of the disease, and early diagnosis and timely treatment of KD are crucial to improving the prognosis [1]. Therefore, the decision to use intravenous IVIG therapy based solely on the presence or absence of coronary artery dilation is incomplete and risky. Studies have shown that in the acute phase of KD, coronary artery dilation tends to be more pronounced and is dominated by coronary aneurysm formation. In contrast, narrowing of the internal diameter of the coronary arteries and combined thrombosis are relatively rare [11]. Giant coronary aneurysms are a rare and serious complication. Prompt assessment of coagulation in children and prompt intervention are clinically important to prevent coronary aneurysms and their complications. Patients who develop aneurysms require ongoing follow-up to monitor for thrombosis, which can lead to ischemic heart disease. However, once coronary artery dilation occurs, the recovery time is usually long, and the risk of thrombosis is significantly increased, which further aggravates the potential damage to the coronary arteries and may have a profound impact on the long-term cardiovascular health of the child [12]. Therefore, in clinical practice, the dynamic monitoring of children's coagulation function should be highly emphasized, and the treatment plan should be adjusted according to the monitoring results in order to ensure that the

children can obtain the best treatment effect. In children with KD, once the diagnosis is confirmed, intravenous IVIG treatment should be initiated as early as possible, rather than relying solely on the presence or absence of coronary artery dilation to delay therapeutic decisions. Early intervention not only helps reduce the inflammatory response of the coronary arteries and decrease the incidence of coronary artery disease but also effectively shortens the course of the disease and reduces the occurrence of complications. In addition, regular review of echocardiography is important for monitoring dynamic changes in coronary artery lesions, evaluating the effectiveness of treatment, and detecting potential coronary complications in a timely manner [13]. Early diagnosis, timely treatment, and standardized follow-up monitoring can minimize the long-term damage of KD to children's hearts and improve their prognosis.

Currently, high-dose IVIG combined with aspirin is the most effective regimen for the treatment of Kawasaki disease. Clinical studies have shown that the rate of coronary artery lesions is significantly reduced in children treated with IVIG at an early stage [14]. The application of IVIG within 10 days of the onset of the disease rapidly reduces fever and decreases the incidence of coronary artery lesions. However, glucocorticoids (GC) alone should not be used in clinical management unless the child has severe concomitant myocarditis or is a severe case of persistent hyperthermia. Histological studies in relevant guidelines [3,15] show that arteritis usually appears on day 8 or 9 after the onset of KD. Therefore, IVIG treatment administered before day 10 of the disease course is an effective means of preventing coronary artery damage. In some countries and regions, such as Italy, KD guidelines state that the optimal time for IVIG application in children with KD is 5–10 days after the onset of the disease, with the best effect achieved within 7 days, which is effective in suppressing the development of diverticulitis [6]. Based on this, this study compared the coronary artery damage of children in two groups of IVIG within 7 days and IVIG from 7 to 10 days. The results showed that coronary artery damage occurred in 18 out of 267 children who received IVIG within 7 days, with a prevalence rate of 6.74%, while 31 out of 151 children who received IVIG for 7–10 days, with a prevalence rate of 20.53%. The difference between the two groups was statistically significant using the SPSS 27.0 software chi-square test, $\chi^2 = 16.53$, $P < 0.001$. This suggests that a timely application of IVIG within 7 days significantly reduces the incidence of coronary artery lesions, whereas delayed application of IVIG may lead to a higher incidence of coronary lesions. Some studies have found that children under 6 months of age, with more than 10 days of initial IVIG therapy, and unresponsive to IVIG therapy are at high risk for coronary damage. The clinical symptoms of KD in infants are often atypical, which can lead to delayed diagnosis, which in turn can lead to a more severe inflammatory response and an increased risk of coronary artery disease [16].

Children with incomplete KD under 1 year of age have a high incidence of coronary artery lesions, and their clinical manifestations may be atypical, leading to diagnostic delays. As such, diagnostic criteria should be appropriately relaxed when dealing with such children to reduce the rate of misdiagnosis. In children with suspected KD, echocardiography should be performed immediately after additional laboratory tests during the clinical evaluation phase [3]. If the echocardiogram results are positive, the diagnosis is confirmed, and treatment should be initiated immediately. Specifically, coronary echocardiography is recommended to be included in the diagnostic process as a routine examination. For patients with poor coronary imaging results or without significant improvement in inflammation, an early review of imaging is required within 4–6 weeks [17]. In patients with a coronary Z-score >2.5, echocardiography was repeated at least twice weekly during hospitalization until confirmation of coronary artery dilatation or cessation of aneurysm progression. When potential

lesions in the coronary arteries are identified early, serious complications such as coronary artery dilation or coronary artery aneurysm can be detected in a timely manner, thus avoiding the delay in diagnosis and missing the optimal time for the application of intravenous IVIG. Early, accurate diagnosis and prompt treatment are essential to prevent cardiac complications.

In children who are resistant to IVIG therapy, the treatment regimen should be adjusted immediately. Based on current research and clinical practice, the addition of a second dose of IVIG may be considered to enhance the immunomodulatory effect [15]. Additionally, the combined use of glucocorticoids and IVIG is an effective therapeutic strategy to enhance the therapeutic effect through synergistic effects. For children with more severe disease, infliximab or immunosuppressive agents can be considered [18–20]. According to relevant guidelines classifying CAL risk in KD patients (Table 4) [16], children with CAL risk class IV and above need to receive both antiplatelet and anticoagulation therapy. Thrombolysis may be considered if acute coronary obstruction occurs in such children. The choice of these treatment options should be individually assessed based on the child's specific condition, response to treatment, and potential risks, and should be implemented in collaboration with a multidisciplinary team to ensure the safety and efficacy of treatment.

After Kawasaki disease has been cured, regular review of echocardiography is important to prevent the later development of coronary artery dilation, especially coronary aneurysms [21–23]. According to the clinical risk classification of coronary artery lesions and its follow-up management strategy (Table 5), the follow-up schedule for children with different classifications is as follows [24]: for children with classifications I and II, the follow-up time is 1 month, 2–3 months, 6 months, 1 year, and 5 years of the disease duration, respectively; for children with classification III, the follow-up time is once a year after the follow-up visit of 1 year of the disease duration with corresponding assessment and guidance; children with classification IV need lifelong follow-up, with follow-ups every 3–6 months after 1 year of follow-up, and appropriate assessment and guidance. Regular echocardiography can dynamically monitor the morphology and function of the coronary arteries, detect the potential progression of the disease in time, and provide a basis for the adjustment of the treatment program. Regular echocardiography can dynamically monitor the morphological and functional changes in the coronary arteries and detect potential progression of the lesions over time. For children who already have coronary artery disease, regular review helps assess the stability and progression of the lesions and the effectiveness of treatment, thus providing an important basis for subsequent treatment decisions. In children without coronary artery disease, regular follow-up can also help to detect possible lesions early and to take timely interventions to minimize the risk of coronary artery complications [25]. Therefore, it is recommended that all children with KD have regular echocardiography follow-ups as prescribed by their physician after cure, to ensure long-term cardiac health.

Table 4. Risk classification of Kawasaki disease CAL.

Risk class	Criteria for classification
I	No coronary artery involvement at any time (Z-score <2)
II	Mild dilatation of the coronary arteries in the acute phase, returning to normal within 30 days of the course of the disease
III	Single small-to-medium-sized coronary artery aneurysm remaining after 30 days of disease duration
IIIa	Small coronary artery aneurysm (Z-score 2.5~ <5)
IIIb	Medium-sized coronary artery aneurysm (Z-score 5 to <10 and absolute internal diameter <8 mm)
IV	Giant coronary aneurysm (Z-score ≥10, or absolute internal diameter ≥8 mm), or multiple aneurysms in 1 coronary artery, not reaching grade V
V	Coronary aneurysm with coronary artery stenosis
Va	Without myocardial ischemia
Vb	With myocardial ischemia

Note: CAL: Coronary artery lesion.

Table 5. Follow-up management strategy of Kawasaki disease CAL.

CAL classification	Time to perform echocardiography follow-up
I II	Clinical follow-up for 5 years: follow-up at 1 month, 2-3 months, 6 months, 1 year, and 5 years of disease duration.
IIIa	Long-term follow-up: follow-up at 1 month, 2–3 months, 6 months, 1 year of disease duration, then annually; every 2 years if return to normal; assessment of inducible myocardial ischemia every 3–5 years; cardiovascular risk assessment and guidance given.
IIIb	Lifelong follow-up: follow-up at 1 month, 2–3 months, 6 months, and 1 year of disease duration, then annually; assessment of inducible myocardial ischemia every 1–3 years; cardiovascular risk assessment and guidance given.
IV	Lifelong follow-up: follow-up at 1 month, 2–3 months, 6 months, 9 months, and 1 year of disease duration, and every 3–6 months thereafter; assessment of induced myocardial ischemia every 6–12 months; assessment of cardiovascular risk and guidance given.
Va	Same as level IV
Vb	Same as level IV, but the follow-up program is individualized, with a variety of tests chosen at different follow-up times depending on conditions.

Note: CAL: Coronary artery lesion.

5. Conclusions

In conclusion, the age of onset of Kawasaki disease is relatively limited, and children under 1 year of age with KD should be closely evaluated for the appearance of coronary artery disease. Meanwhile, the clinical symptoms of this disease are all nonspecific, especially in the incomplete Kawasaki disease, and the clinical manifestations are atypical and easy to misdiagnose. To improve the level of early diagnosis of incomplete Kawasaki disease, the application of an appropriate therapeutic regimen is crucial to the treatment and prognosis of this disease. Also, intravenous IVIG in combination with aspirin within 7 days of the onset of the disease can significantly reduce the rate of coronary artery damage (6.74% vs. 20.53% with delayed treatment). Efficacy decreases after a delay of up to 10 days and has the potential to increase the incidence of coronary lesions. Glucocorticoids are used only in severe or IVIG-resistant patients. Treatment needs to be initiated immediately after

diagnosis, with regular echocardiography monitoring of coronary changes (Z-score to assess the degree of dilation) and anticoagulation in high-risk children. Long-term follow-up according to risk classification is required after cure, and those with coronary artery abnormalities require lifelong management. The core prevention and treatment strategies for both typical and atypical Kawasaki disease are early recognition, standardized treatment within 10 days (ideally within 7 days), and systematic follow-up to improve prognosis.

Author contributions

All authors were involved in the collection of data, analysis/interpretation of data, statistical analysis, critical review of the intellectual content of the article, administrative, technical, or material support, mentoring, and supportive contributions.

Use of AI tools declaration

The authors declare they have not used artificial intelligence (AI) tools in the creation of this article.

Ethical approval of the research and informed consent

Ethical permission and retrospective study exemption from informed consent were obtained from the Ethics Committee of Yan'an University Hospital (IRB number: IIT-R-20250129).

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Conflict of interest

The authors declare no conflict of interest.

References

1. Huang GY, Wang TY (2022) *Pediatrics*. People's Health Press. (Book in Chinese)
2. Park WY, Sang YL, Kim GB, et al. (2021) Clinical aspects for differential diagnosis of Kawasaki disease shock syndrome: a case control study. *BMC Pediatr* 21. https://doi.org/10.1186/s12887-020-02488-w
3. Center for Diagnosis and Treatment of Kawasaki Disease/Children's Hospital of Shaanxi Provincial People's Hospital, National Children's Medical Center/Beijing Children's Hospital, Capital Medical University, Children's Hospital, Shanghai Jiao Tong University School of Medicine, et al. (2023) Evidence-based guidelines for the diagnosis and treatment of Kawasaki disease in Chinese children (2023). *Chinese J Contemp Pediatr* 25: 1198–1210. https://doi.org/10.7499/j.issn.1008-8830.2309038 (Article in Chinese)

4. Kobayashi T, Ayusawa M, Suzuki H, et al. (2020) Revision of diagnostic guidelines for Kawasaki disease (6th revised edition). *Pediatr Int* 62: 1135–1138. https://doi.org/10.1111/ped.14326
5. Hu YM (2015) *Zhufutang practical pediatrics (8th Eds.).* People's Health Publishing House (PRC), 778–788. (Book in Chinese)
6. Mastrangelo G, Cimaz R, Calabri GB, et al. (2019) Kawasaki disease in infants less than one year of age: an Italian cohort from a single center. *BMC Pediatr* 19: 321. https://doi.org/10.1186/s12887-019-1695-0
7. Imasawa T, Saito C, Kai H, et al. (2023) Long-term effectiveness of a primary care practice facilitation program for chronic kidney disease management: an extended follow-up of a cluster-randomized FROM-J study. *Nephrol Dial Transplant* 38: 158–166. https://doi.org/10.1093/ndt/gfac041
8. Cai JH, Tang M, Zhang HX, et al. (2023) Therapeutic window of intravenous IVIG and its correlation with IVIG-resistant in Kawasaki disease: a retrospective study. *J Pediatr* 99: 161–167. https://doi.org/10.1016/j.jped.2022.07.003
9. Portman MA, Dahdah NS, Slee A, et al. (2019) Etanercept with IVIg for acute Kawasaki disease: a randomized controlled trial. *Pediatrics* 143: e20183675. https://doi.org/10.1542/peds.2018-3675
10. McCrindle BW, Rowley AH, Newburger JW, et al. (2017) Diagnosis, treatment, and long-term management of Kawasaki disease: a scientific statement for health professionals from the American Heart Association. *Circulation* 135: e927–e999. https://doi.org/10.1161/CIR.0000000000000484
11. Guo YS, Tao YF, Yao FF (2024) Diagnostic value of echocardiography in children with acute Kawasaki disease with coronary artery dilation. *J Rare Dis* 31: 63–65. https://doi.org/10.3969/j.issn.1009-3257.2024.7.025 (Article in Chinese)
12. Saliba T, Nevesny F, Antiochos P, et al. (2025) Progressive coronary aneurysms in Kawasaki disease: a case report and long-term follow-up. *Radiol Case Rep* 20: 2459–2462. https://doi.org/10.1016/j.radcr.2025.01.090
13. Luo P, L JL, L CL (2022) Comparison of the value of CT and echocardiography in the assessment of cardiac function in pediatric patients with coronary artery lesions in Kawasaki disease. *Chinese J CT MRI* 20: 85–87. https://doi.org/10.3969/j.issn.1672-5131.2022.01.027 (Article in Chinese)
14. Ren J, Wang Y (2019) A case report of neonatal Kawasaki disease. *Chinese J Evid Based Pediatr* 14: 220–222. https://doi.org/10.3969/j.issn.1673-5501.2019.03.012. (Article in Chinese)
15. Cardiovascular Group of Chinese Medical Association Pediatrics, Rheumatology Group of Chinese Medical Association Pediatrics, Immunology Group of Chinese Medical Association Pediatrics, et al. (2022) Expert consensus on the diagnosis and acute phase treatment of Kawasaki disease. *Chinese J Pediatr* 60: 6–13. https://doi.org/10.3760/cma.j.cn112140-20211018-00879 (Article in Chinese)
16. Fukazawa R, Kobayashi J, Ayusawa M, et al. (2020) JCS/JSCS 2020 guideline on diagnosis and management of cardiovascular sequelae in Kawasaki disease. *Circ J* 84: 1348–1407. https://doi.org/10.1253/circj.CJ-19-1094
17. Jone PN, Tremoulet A, Choueiter N, et al. (2024) Update on diagnosis and management of Kawasaki disease: a scientific statement from the American Heart Association. *Circulation* 150: e481–e500. https://doi.org/10.1161/CIR.0000000000001295

18. Honkanen VE, McCrindle BW, Laxer RM, et al. (2003) Clinical relevance of the risk factors for coronary artery inflammation in Kawasaki disease. *Pediatr Cardiol* 24: 122–126. https://doi.org/10.1007/s00246-002-0063-1
19. Nakamura Y, Yashiro M, Uehara R, et al. (2012) Epidemiologic features of Kawasaki disease in Japan: results of the 2009-2010 nationwide survey. *J Epidemiol* 22: 216–221. https://doi.org/10.2188/jea.je20110126
20. Ma WW, Zhao DA (2024) Research progress of cardiovascular complications in Kawasaki disease. *Modern Clinical Medicine* 50: 230–233. (Article in Chinese)
21. Wang SB, Pan SL, Luo G, et al. (2023) Systematic evaluation and meta-analysis of the efficacy and safety of infliximab in the treatment of IVIG-naïve Kawasaki disease. *J Pediatr Pharm* 29: 34–38. https://doi.org/10.13407/j.cnki.jpp.1672-108X.2023.01.011 (Article in Chinese)
22. The Subspecialty Group of Cardiology, the Society of Pediatrics, Chinese Medical Association, the Editorial Board, Chinese Journal of Pediatrics, Huang GY (2020) Recommendations for clinical management of coronary artery lesions in Kawasaki disease (2020 revision). *Chinese J Pediatr* 58: 718–724. https://doi.org/10.3760/cma.j.cn112140-20200422-00421 (Article in Chinese)
23. Wang QH (2023) Clinical characterization of incomplete Kawasaki disease. *China Contemp Med* 30: 88–91. https://doi.org/10.3969/j.issn.1674-4721.2023.06.022 (Article in Chinese)
24. Kindgren E, Guerrero-Bosagna C, Ludvigsson J (2019) Heavy metals in fish and its association with autoimmunity in the development of juvenile idiopathic arthritis: a prospective birth cohort study. *Pediatr Rheumatol* 17: 33. https://doi.org/10.1186/s12969-019-0344-3
25. Wang Y, Jiang JY, Deng Y, et al. (2025) Diagnosis of coronary artery lesions in children based on Z-score regression model. *Chinese J Contemp Pediatr* 27: 176–183. https://doi.org/10.7499/j.issn.1008-8830.2405030 (Article in Chinese)

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