Long-Term Control of Macular Edema With Adalimumab After Cataract Surgery in a Japanese Child With Juvenile Idiopathic Arthritis: Case Report and Review of 26 Japanese Patients

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Abstract
Juvenile idiopathic arthritis–associated uveitis is rare in the Japanese population. In this article, we report a child whose macular edema was controlled for years after cataract surgery with adalimumab, and reviewed 26 Japanese patients in the literature. In this case report, a 4-year-old boy developed band keratopathy, posterior iris synechiae, and complicated cataract in both eyes. Oral prednisolone prescribed at another hospital was discontinued due to high intraocular pressure in both eyes as a steroid responder. At the age of 5 years, he started oral methotrexate 8 mg weekly for recurrent bilateral iridocyclitis and then underwent lensectomy with core vitrectomy in both eyes. Planned intraocular lens implantation was cancelled at surgery because the anterior vitreous had severe inflammatory opacity with diffuse retinal edema in both eyes. Due to persistent macular edema in both eyes 5 months postoperatively, at the age of 6 years, he began to use adalimumab injection 20 mg every 2 weeks. The macular structure depicted by optical coherence tomography became normal in 2 months. At final visit at the age of 11 years, he had the best-corrected visual acuity of 0.8 in the right eye and 0.4 in the left eye, with adalimumab 40 mg every 2 weeks and methotrexate 8 mg weekly. In conclusion, macular edema persistent despite oral methotrexate after cataract surgery could be controlled for long term by adalimumab in a child with juvenile idiopathic arthritis. In the Japanese literature, only 26 additional cases with juvenile idiopathic arthritis–associated uveitis have been reported so far.

Keywords
juvenile idiopathic arthritis, JIA, macular edema, uveitis, adalimumab, steroid responder, cataract surgery, methotrexate, literature review, Japanese

Background
Juvenile idiopathic arthritis is relatively common in the Caucasian population but appears to be rare in the Japanese population.¹⁻³ Caucasian ethnicity is a risk factor for developing juvenile idiopathic arthritis,¹ but the incidence of juvenile idiopathic arthritis in different populations is yet to be determined. To establish the common ground for the diagnosis, the International League of Associations for Rheumatology (ILAR) has published classification criteria for juvenile idiopathic arthritis.⁴ Recently, the Pediatric Rheumatology Association of Japan (PRAJ) has surveyed the prevalence of uveitis as 6.1% in Japanese patients with the diagnosis of juvenile idiopathic arthritis, based on the ILAR classification criteria.⁵ The prevalence of juvenile idiopathic arthritis–associated uveitis in the Japanese population is at the lower end of the prevalence in the other populations (4.7% to 20.5%).⁵

In the field of ophthalmology, band keratopathy, posterior iris synechiae, and complicated cataract in both eyes have been described in textbooks as hallmark features of uveitis in children with juvenile idiopathic arthritis.⁶⁻⁸ Indeed, these clinical features are sequela to persistent iridocyclitis. Recent advances in clinical imaging such as optical coherence tomography have demonstrated macular edema as...
a vision-threatening feature of uveitis in children with juvenile idiopathic arthritis. Uveitis is more dominant at younger ages and often associated with oligoarticular (pauciarticular) juvenile idiopathic arthritis that tends to lack apparent systemic manifestations such as fever. Arthritis may appear after the onset of uveitis. Therefore, children with juvenile idiopathic arthritis–associated uveitis have more chance to be presented first to ophthalmologists and to be referred later to pediatricians.

In this study, we report a Japanese child with oligoarticular juvenile idiopathic arthritis who underwent cataract surgery during the course of oral methotrexate. Persistent macular edema was dramatically controlled with the induction of adalimumab for the following years. We also reviewed Japanese patients with juvenile idiopathic arthritis–associated uveitis in the literature.

Case Report

A 4-year and 8-month boy was referred from a local eye doctor to our hospital for band keratopathy, posterior iris synechiae, and complicated cataract in both eyes. The best-corrected visual acuity was 0.3 with +1.75 diopters and cylindrical −1.0 diopters at axis of 30° in the right eye and 0.1 with +3.75 diopters and cylindrical −2.25 diopters at axis of 170°, determined by cycloplegic refraction with topical 1% cyclopentolate. The intraocular pressure was 10 mm Hg in both eyes. He had no active inflammation in both eyes as evidenced by neither aqueous cells nor keratic precipitates. The retina in both eyes could be visualized as normal through the pupil with synechiae. The patient was referred to a pediatric rheumatologist and was diagnosed as juvenile idiopathic arthritis because he had intermittent joint symptoms. At the time of the diagnosis, he had no arthritis, and thus was followed with no medication. Antinuclear antibody, rheumatoid factor, and anti–cyclic citrullinated peptide (anti-CCP) antibody were negative throughout the course.

He was delivered with the birthweight of 2420 g by emergency Cesarean section at 41 weeks of gestation because of a reduced heart rate to 50 per minute when the mother suffered from the exacerbation of pregnancy-induced hypertension, proteinuria, and lower limb edema. He had been well except for hand, foot, and mouth disease at the age of 1 year and 9 months, and varicella at the age of 3 years and 8 months. Family history had nothing particular except for the mother who later developed immunoglobulin A (IgA) nephropathy at the age of 40 years.

At the age of 5 years and 1 month, oral prednisolone at daily dose of 20 mg (1 mg/kg of body weight) for 2 weeks, followed by 15 mg daily, was prescribed at another hospital where the mother sought the consultation at her own discretion. At the visit back to our hospital in 3 weeks after the start of oral prednisolone, the intraocular pressure was 40 mmHg in the right eye and 30 mmHg in the left eye. No iridocyclitis was noted in both eyes. With the diagnosis of a steroid responder who showed the elevation of intraocular pressure in response to corticosteroid administration, the dose of oral prednisolone was reduced to 5 mg daily and discontinued in a week. Topical 0.1% fluorometholone 4 times daily was replaced by topical bromfenac twice daily. The intraocular pressure became 9 mmHg in both eyes. Oral ibuprofen 600 mg daily was prescribed by the pediatrician.

At the age of 5 years and 6 months (Figure 1A and B), oral methotrexate 10 mg/m² (8 mg) weekly was initiated by the pediatrician for recurrent bilateral iridocyclitis in both eyes, and 2 months later (Figure 1C and D), he underwent posterior synechialysis, anterior capsulotomy, and lens cortex aspiration with a 25-gauge vitrectomy cutter under the irrigation with a 25-gauge irrigating cannula, both of which were inserted through 2 ports at the corneal limbus. Planned intraocular lens implantation was cancelled at this time point of surgery because the anterior vitreous was visualized through the posterior capsule to have severe inflammatory opacity with diffuse retinal edema in both eyes. Total posterior capsulotomy and core vitrectomy was done through the limbal side ports (Figure 1E and F).

Postoperative visual acuity by correction with glasses (+14.75 diopters in the right eye and +14.25 diopters in the left eye on the focus of 50 cm from the eyes) remained at 0.04 in both eyes due to macular edema (Figure 2A and B) when he used oral methotrexate 10 mg in a week and topical 0.1% fluorometholone 4 times daily. At the age of 6 years, 5 months postoperatively, he began to use subcutaneous injection of adalimumab 20 mg every 2 weeks. In 2 months with scheduled injection of adalimumab, the macular retina was demonstrated to have normal structure by optical coherence tomography (Figure 2C and D). He gained the best-corrected visual acuity of 0.5 in the right eye and 0.2 in the left eye at the age of 6 years and 4 months when he was admitted to a local elementary school. The intraocular pressure in both eyes was kept in the normal range by occasional switching of topical bromfenac to topical 0.1% fluorometholone when keratic precipitates as a sign of iritis appeared.

At the age of 7 years and 4 months, he started topical latanoprost once daily when the intraocular pressure in the right eye had tendency to show a higher value of 25 mmHg. One month later, 0.5% timolol gel–forming solution once daily was prescribed in addition to latanoprost but was discontinued in the event of an asthma attack. At the final visit at the age of 11 years and 6 months, he had the best-corrected visual acuity of 0.8 in the right eye and 0.4 in the left eye (Figure 2E and F), with adalimumab 40 mg every 2 weeks and methotrexate 8 mg in a week. He had no intraocular inflammation with no topical steroid and maintained normal intraocular pressure in the range of 10 to 15 mmHg in both eyes with topical latanoprost and brinzolamide (Figure 1G and H). He had experienced no systemic adverse event in the course of adalimumab.

Methods

To analyze historical cases from the literature, the Japanese literature was searched for the keywords...
“juvenile idiopathic arthritis (in Japanese)” or “juvenile rheumatoid arthritis (in Japanese)” and “uveitis (in Japanese)” in the bibliographic database of medical literature in Japanese (Igaku Chuo Zasshi, Japana Centra Revuo Medicina, Ichushi-Web), published by the Japan Medical Abstracts Society (JAMAS). Old literatures were

Figure 1. Slit-lamp biomicroscopic photographs. At the age of 5 years and 6 months (A, right eye; B, left eye) when oral methotrexate was started. At the age of 5 years and 8 months just before cataract surgery (C, right eye; D, left eye) and 5 days after the surgery (E, right eye; F, left eye). At the age of 7 years (G, right eye; H, left eye). 1 year after the start of adalimumab. Note that dense band keratopathy in both eyes (C, D) has been scaled off and that inflammation has subsided in aphakic eyes (E, F).
further collected from references cited in the articles identified during the literature search. PubMed was also searched for the keywords “juvenile idiopathic arthritis” and “uveitis” or “juvenile rheumatoid arthritis” and “uveitis.” The sufficient description was found in 26 Japanese patients with juvenile idiopathic arthritis–associated uveitis in 22 case reports written in Japanese except for one in English (Table 1).17–38

Figure 2. Optical coherence tomography. At the age of 5 years of 11 months (A, right eye; B, left eye), 1 month before the start of adalimumab. At the age of 6 years and 2 months (C, right eye; D, left eye), 2 months after the start of adalimumab. At the age of 8 years and 1 month (E, right eye; F, left eye). Note that macular edema in both eyes (A, B) has been resolved in 2 months (C, D) after the start of adalimumab. Note also that ellipsoid zone at the fovea (arrows in E, F), indicative of photoreceptor outer segments, is more well visualized in the right eye (E) compared with the left eye (F), explaining better visual acuity in the right eye.
Table 1. Review of 27 Japanese Patients With Juvenile Idiopathic Arthritis–Associated Uveitis Including the Present Patient.

| Case no./gender | Age at onset | Category | ANA | RF | Preceding treatment before uveitis | Age at uveitis | Eye manifestations | Eye(s) involved | Systemic treatment for uveitis | Eye surgery | Visual acuity at final visit, right/Left | Author |
|-----------------|--------------|----------|-----|----|-----------------------------------|----------------|-------------------|----------------|--------------------------------|-------------|----------------------------------------|--------|
| 1/Male          | 3 years      | Systemic| ND  | ND | ND                                | 7 years        | Band keratopathy | Bilateral       | Prednisolone                  | Left iridectomy | 0.9/0.1                                | Urayama and Sakuragi |
| 2/Female        | 3 years      | Oligo   | ND  | No | Simultaneous onset                |                | Iridocyclitis     | Right           | No                             | No          | 0.03/1.5                               | Urayama and Sakuragi |
| 3/Female        | 7 years      | Systemic| Yes | No | Simultaneous onset                |                | Iridocyclitis     | Bilateral       | Betamethasone                 | No          | 0.9/0.9                                | Tabuchi et al |
| 4/Female        | 4 years      | Systemic| ND  | ND | Simultaneous onset                |                | Iridocyclitis     | Bilateral       | Prednisolone                  | No          | 1.2/0.4                                | Fujiwara et al |
| 5/Female        | 6 years      | Oligo   | Yes | No | Simultaneous onset                |                | Iridocyclitis     | Bilateral       | Prednisolone                  | Bilateral trabeculectomy | 0.1/0.7                              | Takano et al |
| 6/Female        | 2 years      | Systemic| No  | No | Aspirin                           | 4 years        | Iridocyclitis     | Bilateral       | Aspirin                       | No          | 1.5/1.5                                | Takano et al |
| 7/Female        | 2 years      | Oligo   | Yes | No | Aspirin                           | 5 years        | Band keratopathy | Bilateral       | Aspirin                       | Left cataract surgery | 1.2/0.1                               | Takano et al |
| 8/Female        | 3 years      | Poly    | ND  | ND | Prednisolone                      | 15 years       | Band keratopathy | Bilateral       | ND                            | Left trabeculectomy Bilateral cataract surgery | 0.02/0.04                          | Sakai et al |
| 9/Female        | 9 years      | Systemic| Yes | No | Simultaneous onset                |                | Iridocyclitis     | Right           | Dexamethasone                 | No          | 1.5/1.5                                | Uezato et al |
| 10/Male         | 12 years     | Oligo   | No  | No | ND                                | 13 years       | Iridocyclitis     | Bilateral       | ND                            | No          | 1.0/1.2                                | Akaki et al |
| 11/Male         | 17 years     | Systemic| No  | No | Methylprednisolone pulse          | 18 years       | Iridocyclitis     | Bilateral       | Prednisolone                  | No          | 1.0/1.0                                | Iizuka et al |
| 12/Female       | 3 years      | Systemic| No  | No | Simultaneous onset                |                | Iridocyclitis     | Bilateral       | Prednisolone                  | No          | 0.8/0.8                                | Nakayama et al |
| 13/Female       | 20 years     | Systemic| Yes | No | Simultaneous onset                |                | Iridocyclitis     | Bilateral       | Methylprednisolone pulse      | No          | 1.2/1.5                                | Igari et al |
| 14/Female       | 2 years      | Oligo   | Yes | No | ND                                | 7 years        | Iridocyclitis     | Bilateral       | Levothyroxine for Hashimoto disease | Bilateral cataract surgery | 1.5/1.5                                | Honda et al |

(continued)
| Case no./gender | Age at onset | Category | ANA | RF | Preceding treatment before uveitis | Age at uveitis | Eye manifestations | Eye(s) involved | Systemic treatment for uveitisa | Eye surgery | Visual acuity at final visit, right/Left | Author |
|----------------|-------------|----------|-----|----|----------------------------------|---------------|--------------------|----------------|-----------------------------|-------------|--------------------------------------|--------|
| 15/Male        | 12 years    | Poly     | No  | No | Simultaneous onset               | 12 years      | Iridocyclitis       | Bilateral      | Prednisolone               | No          | 1.2/1.2                              | Amano and Mochizuki |
| 16/Female      | 10 years    | Systemic | No  | No | Simultaneous onset               | 10 years      | Subretinal exudates | Bilateral      | Aspirin                    | No          | 1.0/1.2                              | Higuchi et al |
| 17/Female      | 5 years     | Systemic | No  | No | Simultaneous onset               | 5 years       | Iridocyclitis       | Bilateral      | Aspirin, Prednisolone       | No          | 1.5/1.2                              | Sakaguchi et al |
| 18/Male        | 2 years     | Systemic | Yes | No | Aspirin                          | 3 years       | Optic papillitis    | Right          | Prednisolone               | No          | ND/ND                                | Hirabayashi et al |
| 19/Female      | 12 years    | Systemic | Yes | No | ND                               | 15 years      | Iridocyclitis       | Bilateral      | Prednisolone               | No          | 1.0/1.0                              | Ishihara et al |
| 20/Female      | 5 years     | Systemic | No  | No | ND                               | 11 years      | Subretinal exudates | Bilateral      | Aspirin                    | No          | 0.8/0.6                              | Sekine et al |
| 21/Male        | 19 years    | Systemic | No  | No | Simultaneous onset               | 19 years      | Iridocyclitis       | Bilateral      | Prednisolone, Methotrexate  | No          | 1.0/1.0                              | Namba et al |
| 22/Female      | 4 years     | Oligo    | Yes | ND | Simultaneous onset               | 4 years       | Iridocyclitis       | Bilateral      | Prednisolone, Cyclosporine  | No          | 2.0/2.0                              | Matsushita et al |
| 23/Female      | 1 year 7 months | Oligo    | Yes | No | Ibuprofen                        | 11 years      | Iridocyclitis       | Bilateral      | Etanercept                 | No          | 1.0/1.0                              | Kinouchi et al |
| 24/Female      | 4 years     | Poly     | Yes | ND | Simultaneous onset               | 4 years       | Band keratopathy    | Bilateral      | Prednisolone               | Bilateral cataract surgery with IOL, Bilateral PTK | Ishikura et al |
| 25/Female      | 2 years 9 months | Oligo    | Yes | No | Simultaneous onset               | 5 years       | Iridocyclitis       | Right          | Ibuprofen, Prednisolone, Adalimumab | Right cataract surgery | Shimizu |
| 26/Male        | 5 years 1 month | Oligo    | Yes | No | Simultaneous onset               | 5 years       | Band keratopathy    | Left           | Ibuprofen, Methotrexate, Adalimumab | Left therapeutic keratectomy | Shimizu et al |
| 27/Male        | 4 years 8 months | Oligo    | No  | No | Simultaneous onset               | 5 years       | Band keratopathy    | Bilateral      | Methotrexate, Adalimumab    | Bilateral cataract surgery, Bilateral therapeutic keratectomy | Matsuo and Yashiro (this case) |

Abbreviations: ANA, antinuclear antibody; RF, rheumatoid factor; ND, not described; systemic, systemic arthritis; oligo, oligoarthritis; poly, polyarthritis; IOL, intraocular lens implantation; PTK, phototherapeutic keratectomy.

a“No” in systemic treatment for uveitis indicates topical medication only.
Results

In review of the literature, 27 patients with juvenile idiopathic arthritis–associated uveitis, including the present patient, were 8 male and 19 female, with the age at the diagnosis of juvenile idiopathic arthritis, ranging from 1 year and 7 months to 20 years (median = 5 years). The timing at the diagnosis of uveitis was the same as the onset of systemic manifestations and, hence, as the diagnosis of juvenile idiopathic arthritis in 15 patients, while the diagnosis of uveitis was delayed in 12 patients by the range from 1 year to 12 years (median = 2.5 years) after the onset of systemic manifestations. The category of juvenile idiopathic arthritis was systemic arthritis in 14 patients, oligoarthritis in 10 patients, and polyarthritis (rheumatoid factor–negative) in 3 patients. Antinuclear antibody was positive in 13 patients and negative in 10 patients, while the remaining 4 patients had no description. Rheumatoid factor was negative in all 22 patients with its description.

All 27 patients, including the present patient, showed iridocyclitis manifested as keratic precipitates and aqueous cells sometimes with synechia iris posterior. Both eyes were involved in 22 patients, only the right eye in 4 patients, and only the left eye in 1 patient. Persistent iridocyclitis was associated with band keratopathy in 7 patients and complicated cataract in 6 patients. Only 3 patients had iridocyclitis with no description of fundus (posterior segment) manifestations. Lens extraction with no intraocular lens implantation as cataract surgery was done in 4 patients while intraocular lens implantation was done in 1 patient (Case 24). Phototherapeutic keratectomy using laser was done in both eyes of 1 patient with dense band keratopathy (Case 24).

The other 24 patients had fundus manifestations: 2 of these 24 patients had fundus manifestations only and did not have iridocyclitis, one with retinal vasculitis (Case 11) and another with subretinal exudates (Case 16) in both eyes. As for fundus (posterior segment) manifestations, retinal vasculitis was described in 16 patients, optic papillitis in 12 patients, subretinal exudates in 7 patients, and macular edema in 3 patients. The retinal vasculitis manifested as vascular leakage on fluorescein angiography, diffuse retinal edema, and vascular sheathing. The optic papillitis manifested as blurred hyperemic swollen optic disc and occasionally as exudates around the optic disc. The subretinal exudates manifested usually as multiple spotty white lesions and occasionally as diffuse large exudation. The macular edema in recent patients was detected by optical coherence tomography.

In treatment for uveitis, adalimumab was prescribed in 3 most recent patients including the present patient. Oral steroids were given in 16 patients, cyclosporine combined with prednisolone in 1 patient (Case 22), and etanercept only in another patient (Case 23). Aspirin (salicylate) was given in 7 patients: independently in 2 patients and combined with prednisolone in 5 patients. Ibuprofen was used in 2 most recent patients.

Discussion

The present patient was diagnosed as antinuclear antibody–negative oligoarticular juvenile idiopathic arthritis, based on intermittent joint symptoms and typical eye signs after the exclusion of infectious uveitis and other types of noninfectious uveitis. In the field of ophthalmology, pediatric uveitis is rare, and it is mandatory to make differential diagnosis of other types of uveitis from juvenile idiopathic arthritis–associated uveitis. Bilateral iridocyclitis with retinal capillaritis in juveniles and tubulointerstitial nephritis and uveitis syndrome are 2 entities of pediatric uveitis that must be considered at this setting. In contrast with juvenile idiopathic arthritis–associated uveitis, these 2 types of uveitis have tendency not to cause severe complications of band keratopathy and cataract.

The present patient developed retinal vasculitis and macular edema, concurrently with iridocyclitis that resulted in band keratopathy and complicated cataract in both eyes. The retinal involvement was noted at the time of cataract surgery in which diffuse retinal edema, together with severe anterior vitreous inflammation, was visualized. Male gender has been shown as a risk factor for developing complicated cataract and optic papillitis associated with uveitis. Intraocular lens implantation was cancelled in the present patient with severe anterior vitreous inflammation involving the posterior capsule of the lens. Intraocular lens implantation at cataract surgery might not be a risk factor for macular edema and optic papillitis as well as glaucoma under the maximum control of inflammation, but we avoided taking a risk in the present patient under the circumstances of severe vitreous inflammation.

After cataract surgery to remove the entire lens in addition to core vitrectomy in both eyes, the intraocular inflammation became calm during the course of oral methotrexate. However, the patient had poor visual acuity in both eyes due to persistent macular edema revealed by optical coherence tomography. After 2 months of adalimumab therapy, the structure of the macula in both eyes had dramatically normalized, leading to good visual acuity that satisfied the standard for the elementary school admission. As shown in the present patient, adalimumab is now the standard therapy for juvenile idiopathic arthritis–associated uveitis with retinal complications such as macular edema. In this context, liaison between ophthalmologists and pediatricians is crucial not to miss a chance to rescue the vision by starting adalimumab. Concurrent with the present report, case series of Japanese patients with juvenile idiopathic arthritis–associated uveitis were reported by pediatricians. Those 9 patients were all in the category of oligoarthritis, and 8 of them received biologics such as adalimumab. The authors emphasized the planned transitional care for children with juvenile idiopathic arthritis.
idiopathic arthritis to avoid the blindness caused by sequelae to uveitis.

In review of the literature, In review of the literature, in the present study, most Japanese patients with juvenile idiopathic arthritis–associated uveitis had fundus manifestations such as retinal vasculitis, optic papillitis, and subretinal exudates. A high rate of fundus manifestations in juvenile idiopathic arthritis–associated uveitis might be attributed to reporting bias to describe rarer presentations. Indeed until now, fundus manifestations in juvenile idiopathic arthritis–associated uveitis have not been well described in the textbooks. Optical coherence tomography in widespread use at ophthalmology clinics would help accurate diagnosis of macular edema, which is a vision-threatening condition in uveitis associated with juvenile idiopathic arthritis, as shown in the present patient.

The present patient had 2 risk factors for developing juvenile idiopathic arthritis–associated uveitis: the younger age of onset at 4 years and the category of oligoarthritis. It should be noted in review of the literature that about a half of the historical Japanese patients with juvenile idiopathic arthritis–associated uveitis belonged to the category of systemic arthritis. This finding is in marked contrast with the recent reports that the category of oligoarthritis was predominant also in Japanese patients with juvenile idiopathic arthritis–associated uveitis, in parallel with the Caucasian population. The reason for the categorical difference between the historical cohort and the recent cohort in the Japanese population remains unknown. As described above, the historical cohort in the present study is indeed the collection of case reports that tended to describe fundus manifestations as a rare event, and thus would have reporting bias from the viewpoint of the disease category.

In conclusion, the present study focused on the Japanese patients with juvenile idiopathic arthritis–associated uveitis. In the historical Japanese patients, the category of systemic arthritis was dominant and was followed by the category of oligoarthritis. The fundus manifestations, such as retinal vasculitis, subretinal exudates, and optic papillitis, were common in addition to well-recognized features of iridocyclitis, band keratopathy, and complicated cataract in the younger ages.

Authors’ Note
Data are available on reasonable request to the corresponding author.

Author Contributions
TM, as an ophthalmologist, followed the patient and did the surgery. MY, as a pediatrician, introduced methotrexate and adalimumab and followed the patient. TM wrote the manuscript, and MY did critical review of the manuscript. Both authors read and approved the manuscript.

Declaration of Conflicting Interests
The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding
The author(s) received no financial support for the research, authorship, and/or publication of this article.

Ethics Approval
Ethics committee review was not applicable to case reports, based on the Ethical Guidelines for Medical and Health Research Involving Human Subjects, issued by the Government of Japan.

Informed Consent
Oral informed consent was obtained from the patient and the mother.

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