Sensorineural hearing loss associated with Kawasaki disease

Robert P. Sundel, MD, Jane W. Newburger, MD, MPH, Trevor McGill, MD, Sandra S. Cleveland, MEd, William W. Miller, MD, Boyce Berry, MD, Andrew M. Klein, MD, and Jane C. Burns, MD

From the Divisions of Immunology (Rheumatology) and Infectious Diseases, Department of Medicine, and the Departments of Cardiology and Otorhinolaryngology, Children's Hospital, Boston, Massachusetts; St. Mary's Hospital of Richmond, Richmond, Virginia; and Johnson City Medical Center Hospital, Johnson City, Tennessee

In five children who met the diagnostic criteria for Kawasaki Disease, sensorineural hearing loss developed in association with the acute illness. The children, aged 7 months to 13 years, had deficits ranging from mild to profound bilateral sensorineural hearing loss. There were no associated neurologic abnormalities, and immunologic investigations and magnetic resonance imaging failed to reveal a cause. Treatment regimens differed among the children, but none had high salicylate levels (>20 mg/dl) or received other ototoxic medications. Antiinflammatory therapy was not obviously beneficial in any case, and four of the children have persistent hearing deficits. We conclude that auditory involvement may be a complication of Kawasaki disease; screening of clinically affected children should be considered. (J PEDIATR 1990;117:371-7)

Kawasaki disease is a self-limited vasculitis affecting small and medium-sized arteries,[1] and is marked by profound immunoregulatory changes.[2] Coronary artery abnormalities, including aneurysms and ectasia, occur in approximately 20% of untreated patients.[3] Nondeforming arthritis, aseptic meningitis, gastrointestinal involvement (diarrhea and hepatitis), and sterile pyuria are also seen in a subset of patients.[4] Neurologic involvement, however, is rare. Cranial nerve palsy, especially involving the seventh nerve, has been reported,[5-16] as have hemiparesis caused by cerebral thrombosis and infarction,[12, 17] and convulsions.[11] A recent Japanese article[18] described eight cases of sensorineural hearing loss in children who were in the acute phase of Kawasaki disease (four patients) or who had recovered from it (four patients). We report here the association of SNHL with KD in five additional patients.

METHODS

Patients. The subjects were four boys and one girl, aged 7 months to 13 years, who were treated for KD between February 1984 and May 1989. (Table I). All were brought to the authors' attention because of the coincidence of KD and hearing loss. No active or passive surveillance was performed, and no incidence figures can be estimated. However, seven additional patients who had a severe coronary artery aneurysm as a sequela of KD were selected retrospectively for auditory evaluations 2.8 to 12 years after their acute disease; none was clinically suspected of decreased hearing acuity.

ABSR	Auditory brain-stem response
daPa	Dekapascal
IVGG	Intravenously administered γ-globulin
KD	Kawasaki disease
SNHL	Sensorineural hearing loss

All children met Centers for Disease Control criteria for the diagnosis of KD and were examined within 10 days of

Supported in part by grants No. HL01855, No. 5 MO1 RR02172-08, and No. HL34545 from the National Heart, Lung, and Blood Institute. Dr. Sundel is supported by National Institutes of Health training grant No. 5T32AHD07321-04.

Submitted for publication Oct. 31, 1989; accepted April 11, 1990.

Reprint requests: Robert P. Sundel, MD, Division of Immunology, Children's Hospital Medical Center, 300 Longwood Ave., Boston, MA 02115-5747.

9/20/21524

Table I. Summary of clinical characteristics, laboratory data, and treatment

Patient No.	Age	Specific signs and symptoms	Echocardiogram	CBC*
1	4 yr 6 mo	Persistent fever despite IVGG; urethral erythema Day 9: left knee arthritis Day 10: complains of difficulty hearing	Normal vessels Normal LV function	WBC 23,800 (PMN 70%, band forms 18%) Platelets 661,000† Hematocrit 31.0%
2	12 yr	Persistent fever despite IVGG Day 14: complains of difficulty hearing Day 20: bilateral knee and hip arthritis	Normal vessels Normal LV function	WBC 16,500 (PMN 72%, band forms 11%) Platelets 573,000 Hematocrit 28.7%
3	7 mo	Febrile seizure ×2 (days 2 and 3); extreme irritability Transient left peripheral CN VII palsy	Transient LCA, RCA, and LAD dilation	WBC 20,800 (PMN 65%, band forms 2%) Platelets 1,248,000 Hematocrit 30.9%
4	6 yr 6 mo	Abdominal pain and tenderness, emesis Day 6: polyarthritis, meningismus Day 18: complains of difficulty hearing	Borderline RCA dilation	WBC 24,600 (PMN 87%) Platelets 881,000 Hematocrit 31.5%
5	13 yr 8 mo	Nausea, vomiting, diarrhea, and abdominal pain Day 14: ataxia, tinnitus, difficulty hearing, nystagmus, transiently upgoing plantar response, anterior uveitus Day 21: left knee arthritis	Normal vessels; normal LV function	WBC 23,800 (PMN 83%, band forms 8%) Platelets 900,000 Hematocrit 33.6%

CBC, Complete blood cell count; *WBC*, white blood cell count; *U/A*, urinalysis; *hpf*, high-power field; *LP*, lumbar puncture; *PMN*, polymorphonuclear cells; *MRI*, magnetic resonance imaging; *ASLO*, antistreptolysin O; *CN*, cranial nerve; *CT*, computed tomography; *IV*, intravenously. *NP*, nasopharyngeal; *LCA*, left coronary artery; *RCA*, right coronary artery; *LAD*, left anterior descending coronary artery; *LV*, left ventricular.
*Obtained at initial evaluation unless otherwise indicated.
†Platelet count represents maximum during course of illness.
‡Iveegam brand (Immuno AG, Vienna, Austria).
§Gamimune N brand (Cutter Biological, Emoryville, Calif.).

the onset of fever.[9] The erythrocyte sedimentation rate was increased in all five patients, and all bacterial and viral cultures were negative. Of the five children with hearing loss, one was treated with aspirin alone, three received a single infusion of intravenously administered γ-globulin, 1 or 2 gm/kg, plus aspirin, and one received a 4-day course of IVGG, 400 mg/kg/day, plus aspirin (Table I).

Hearing evaluations. All patients had audiologic evaluations in a sound-treated booth that met current American National Standards Institute specifications.[19] Manual puretone air and bone conduction thresholds were obtained with a standard ascending procedure for the frequency range of 250 or 500 Hz to 8000 Hz.[20] Evaluations were conducted on a model GSI-10 or GSI-1704 audiometer (Grason-Stadler, Inc., Littleton, Mass.) meeting ANSI specifications for audiometers.[21]

Audiologic methods included either a conventional hand-raising technique or play audiometry task, depending on the age and developmental level of the patient. Patient 3, who was too young to test by behavioral methods, was assessed with auditory brain-stem response threshold measures using click stimuli and 500 to 4000 Hz tone bursts. Patients 2 and 5 underwent ABSR examination after detection of hearing loss to assess absolute and interpeak latencies at suprathreshold hearing levels. Measurements were made with surface electrodes placed on the forehead and in each mastoid region. Finally, each patient had tympanometry by means of an Amplaid model 702 or 720 impedance meter (Amplus Corp., Boulder, Colo.)

Retrospective examination of the seven patients was by behavioral audiometry.

Assay for anti-cochlear antibodies. Serum from selected patients was collected and stored at −20° C. Purification of inner-ear antigens and antibody screening by immunoblotting were performed by Drs. Richard Moscicki (Massachusetts General Hospital, Boston) and Jeffrey Harris (University of California at San Diego School of Medicine) as previously described.[22]

RESULTS

Confirmed SNHL developed in four patients during the acute phase of KD. In one additional child, significant loss of hearing was suspected by the mother after KD but was not formally evaluated until approximately 2 years later. The deficits varied in severity from mild to profound, and were bilateral in four of five patients. Findings of complete

Other*	Antibiotics and other medications	IVGG	Aspirin (level after 16 doses)
U/A: 30 WBC/hpf (dipstick negative) LP: glucose normal; protein 135 mg/dl; cells 168/ml; (83% PMN) MRI: normal	Prednisone, 2 mg/kg ×2 wk begun 3 mo after KD	2 gm/kg over 12 hr‡	80 mg/kg divided q 6 hr (13.7 ng/dl)
U/A: 100 WBC/hpf (dipstick negative) ASLO: negative	Days 3-5: penicillin Days 5-8: dicloxacillin Days 8-13: erythromycin	2 gm/kg over 10 hr‡	100 mg/kg divided q 6 hr ×2 wk; then 3 mg/kg/day (20.0 ng/dl)
LP: 10 WBC/ml; (90% lymphocytes) glucose/protein normal	Days 1-3: amoxicillin Days 4-6: chloramphenicol (IV)	None	80 mg/kg divided q.i.d. ×3 wk (not tested)
U/A: 10-15 WBC/hpf (dipstick negative) LP: normal MRI: normal CT: normal Electronystagmography; abnormal (absent calorics)	Days 3-5: nafcillin Days 6-9: cefaclor Prednisone, 2 mg/kg ×10 days, begun 2 mo after KD Prednisone 2 mg/kg ×10 days, begun 3 weeks after KD; Triamterene-hydrochlorothiazide 1 mo after KD	400 mg/kg ×4 days§ 1 gm/kg over 6 hr§	100 mg/kg divided q.i.d. (not tested) 30 mg/kg divided q.i.d. (not tested)

neurologic examinations were otherwise entirely normal, except for a transient seventh cranial nerve palsy in one patient and nystagmus and ataxia in another (Table I).

Audiologic examination of the five patients revealed SNHL of varying degrees. In patients 1 and 5, this loss was bilateral; severity was moderate to severe in patient 1 and mild to moderate in patient 5. Tympanometry revealed normal middle ear compliance and pressure (0 daPa). Patient 2 had a mild conductive hearing loss in the right ear and a primarily SNHL of a mild degree in the left ear (Figure). Tympanometry revealed reduced middle ear compliance at −300 daPa in the right ear and slightly reduced compliance at −200 daPa in the left ear. However, even after tympanometry results became normal, a mild high-frequency hearing loss persisted bilaterally.

Patient 3 also had sensorineural and conductive components to his hearing loss. The degree of loss was moderate to moderately severe in the right ear and profound in the left (Figure). Tympanometry revealed flat tracings bilaterally, suggestive of fluid in the middle ear. However, ABSR threshold evaluation of the right ear (see below) and severity of hearing loss in the left ear suggested a significant sensorineural component. Patient 4 had unilateral loss, with persistent severe upward sloping to moderate SNHL in the left ear. Results of audiometric screening 2 and 4 years before the onset of KD were entirely normal.

Some recovery of hearing was noted in patients 1, 2, and 5. Patient 1 was treated with corticosteroids for 2 months with some improvement, but significant deficit remained. The hearing in patient 2 spontaneously recovered to within the normal range during the 20 days after diagnosis. Patient 5 was treated with prednisone and triamterene-hydrochlorothiazide and had fluctuations from a moderate degree of SNHL to normal hearing with a mild high-frequency loss. Final reevaluation 2 months after diagnosis showed a residual mild to moderate bilateral SNHL. Patient 4, also given high doses of steroids, showed no improvement.

Speech discrimination ability was assessed when technically feasible. The aided speech discrimination ability of patient 1 was initially poor (0% correct identification) but gradually improved to good (84% correct) during the ensuing 2 months. Patient 2 was examined after his hearing had returned to normal, and speech discrimination was excellent (100% correct) bilaterally. Patient 3 was too young to test. Patient 4 had poor discrimination (16% correct) in the affected (left) ear. Patient 5 initially had excellent speech discrimination, but final evaluation 2 months later suggested poor (40% correct) discriminating ability on the left.

The severity of the hearing loss in patients 1 and 3 precluded evaluation of ABSR absolute and interpeak latencies. Threshold testing of ABSR in patient 3, however, revealed wave V latencies in the better ear that are suggestive of SNHL. In patients 2 and 5, absolute and interpeak latencies were normal in both ears, with no indication of retrocochlear abnormality. Patient 4 was not tested.

Additional evaluations were performed in an attempt to

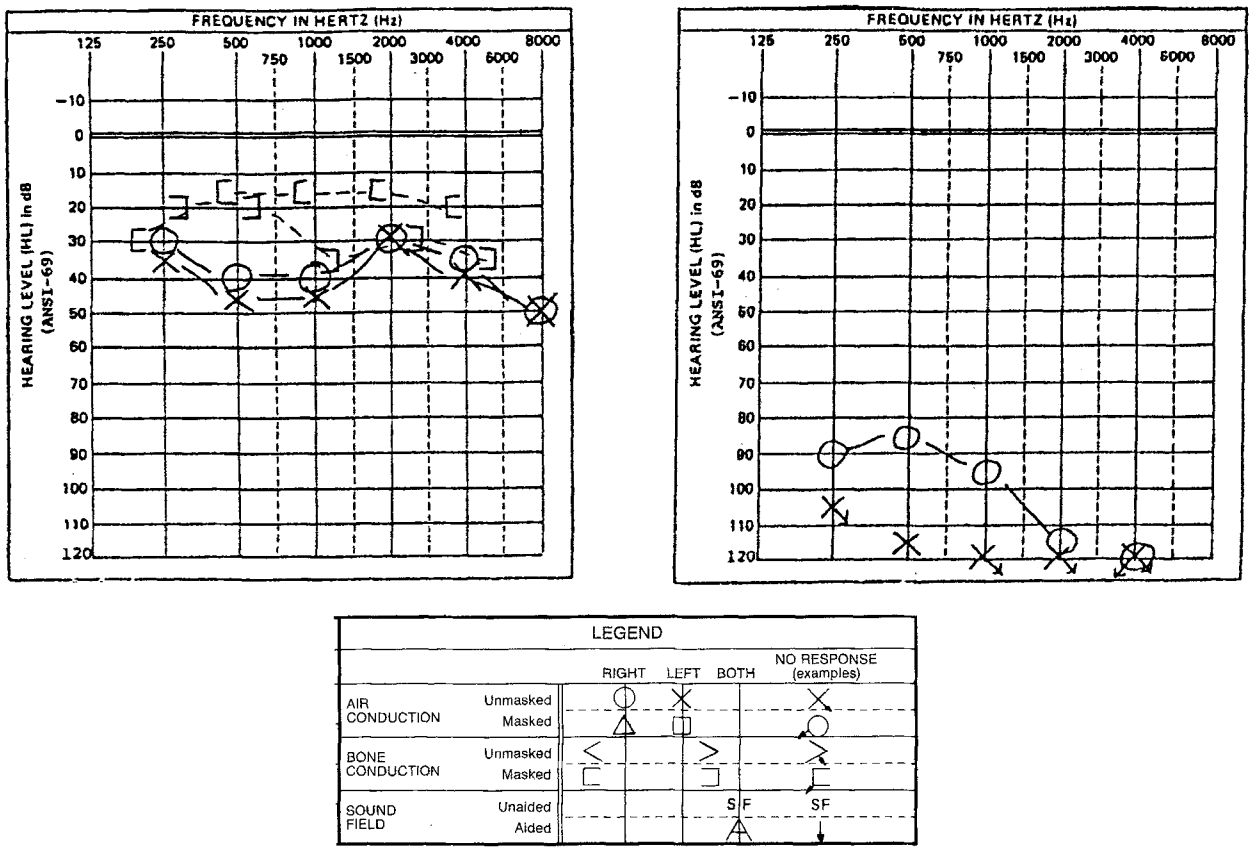

Figure. Typical audiograms from patients with KD and SNHL. *Left:* Patient 2. Initial evaluation indicated bilateral mild hearing loss that largely resolved, leaving persistent bilateral mild high-frequency hearing loss. *Right:* Patient 3. Most recent evaluation indicated bilateral hearing loss, moderate to moderately severe on *right* and profound on *left*.

determine the cause of the hearing loss. These included magnetic resonance imaging through the inner ear, with normal results in two patients (patients 1 and 4); testing by Clq binding for circulating immune complexes, which were not detected in two (patients 1 and 2); and immunoblotting for anti-cochlear antibodies, which were not detected in two (patients 1 and 2).

All seven children with coronary artery aneurysms after KD who were examined retrospectively for decreased hearing acuity had normal results on audiologic assessment.

DISCUSSION

The sudden onset of SNHL is a rare occurrence in childhood. A prevalence of approximately 10 cases per 100,000 population has been reported in adults, but a significant proportion of those cases were attributed to diseases seldom seen in children (e.g., acoustic neuroma, macroglobulinemia). Hearing loss in children frequently is not detected until the age of speech acquisition or beyond, so distinction between congenital and acquired causes is difficult. Nonetheless, in the pediatric age group, specific causes of SNHL in published series include meningitis (25%), late expression of genetic syndromes (25%), sequelae after chronic otitis (17%), and presumed infantile Menière disorder (8%).[23] In approximately one third of deaf children, there is no known explanation for their hearing loss.[24]

Even in patients in whom a cause is recognized, the pathophysiology of hearing loss is poorly understood. In cases of viral labyrinthitis or cochleitis, atrophy of the organ of Corti, cochlear nerve, and vestibular end organs has been reported. Atrophy in these cases appears to be due to direct viral cytopathic effects. Hearing loss in collagen-vascular diseases, such as Cogan syndrome (nonsyphilitic interstitial keratitis and vestibuloauditory dysfunction) or systemic lupus erythematosus, has been ascribed to autoimmune mechanisms. These include demonstration of anti–inner ear autoantibodies, lymphocytes reactive to inner ear antigens, and immune complex deposition within the otic capsule.[25] Finally, occlusion of cochlear vessels or of the vasa nervorum of the eighth cranial nerve can lead to ischemic damage to the membranous labyrinth or the auditory nerve itself.[26] This has been postulated to be the cause

Table II. Summary of Japanese patients with Kawasaki disease and associated sensorineural hearing loss

Case No. (yr)	Age at onset of KD (yr)	Interval between KD and detection of SNHL	Nature of hearing loss	Comments
1 (1976)	4	1 yr	Right unilateral deafness	*
2 (1983)	4	28 days	Bilateral severe SNHL	Aspirin, 80 mg/kg/day, + steroids
3 (1984)	5	5 yr	Right unilateral hearing loss	*
4 (1984)	5	5 yr	Right unilateral high frequency loss	*
5 (1985)	1	10 days	Left unilateral 35 dB loss, improved after 1 mo	Aspirin IVGG, 200 mg/kg ×2 days Transient facial palsy
6 (1986)	3	10 days	Bilateral severe SNHL	Aspirin, 60 mg/kg/day Dipyridamole, 5 mg/kg/day Steroid "pulsed" doses
7 (1988)	5	6 mo	Bilateral severe SNHL	Aspirin, 50 mg/kg/day
8 (1988)	1	13 days	Bilateral moderate SNHL, improved after 1 mo	Aspirin, 50 mg/kg/day IVGG, 400 mg/kg Transient facial palsy

Data from Suzuki H, Yanagawa T, Kihira S, et al. Clin Pediatr (Jpn) 1988;41:167-72.
*Treatment not specified.

of hearing loss in hypercoagulable states and some vasculitides; in some animal models the damage may be unilateral.[27]

To our knowledge, SNHL has been reported in association with KD only from Japan. Six cases from the Japanese literature and two additional cases were recently reviewed[18] (Table II). Four of these eight cases were temporally associated with acute KD. In two patients, SNHL was transient and was associated with facial nerve palsy, which also remitted. These patients both received IVGG, 200 mg/kg/dose for two doses and 400 mg/kg in a single dose, respectively. Other patients received aspirin alone or with steroids. Details of therapy were not specified for the other patients. One patient had transient coronary artery aneurysms documented by echocardiogram and unusual neurologic manifestations, including coma and seizures, all of which resolved spontaneously. Five of eight Japanese patients and four of our five patients were significantly older than the mean for KD patients.[4, 28]

In a total of three patients from the Japanese and the American series, SNHL was transient and minimally symptomatic, so the absence of previous reports may represent a failure to consider the possibility of mild hearing loss in children too young to complain. Nonetheless, the onset of hearing loss concurrent with or shortly after KD in five children in our series and in four children in the Japanese series suggests a causal relationship. The absence of demonstrable hearing loss in the seven patients we retrospectively examined—screened because the presence of coronary artery aneurysms suggested that they were among the most severely affected—precludes a direct correlation between hearing loss and intensity of inflammation. The mechanism whereby KD and SNHL are associated, therefore, remains a matter of speculation.

Acute KD is characterized by increased percentages of activated CD4-positive cells, decreased percentages of CD8-positive cells, and an increase in spontaneous immunoglobulin secretion by B cells.[29] Each of these abnormalities has been associated with organ-specific autoimmunity in other conditions. Autoantibodies generally have not been demonstrable in KD,[30] although anti–endothelial cell autoantibodies[31] and anti–neutrophil cytoplasm antibodies[32] have been postulated to play a role in the pathophysiology of the vasculitis of KD. Direct damage to cochlear vessels or vasa nervorum could lead to labyrinthine or auditory nerve damage. Although magnetic resonance imaging of the inner ear in two patients revealed no abnormalities, the technique may be insufficiently sensitive to identify such a lesion. Finally, a viral cause of KD has been postulated.[33, 34] Direct viral injury is a cause of cochlear damage and hearing loss in a number of viral infections, including measles and rubella.[35]

The relationship of the hearing loss to the various treatment modalities must be considered. All patients in our series received high doses of aspirin, which is ototoxic. However, aspirin-induced SNHL is proportional to salicylate

level, and no patient in whom measurements were available had a level greater than 20 mg/dl; it is usually heralded by tinnitus, and only one of the patients had such a complaint. We cannot exclude the possibility that in the face of the hypoalbuminemia frequently present in KD, free (unbound) salicylate levels might have been elevated to the toxic range. Salicylate ototoxicity in adults, however, is uniformly reversible within 72 hours, regardless of the duration of the insult.[36] Thus permanent severe or profound SNHL is unlikely to be due to salicylates.

Patients received no other medications with a demonstrated potential for ototoxicity. Immunoglobulin was administered to most of the children, but to our knowledge IVGG therapy is not known to cause hearing loss. Two of the three most profoundly affected patients in this series received a single intravenous dose of γ-globulin. However, one patient received no IVGG, a second had hearing loss before treatment, and only two of eight patients in the Japanese series received IVGG. Further, no ototoxic effects have been reported in the numerous other diseases in which IVGG is used, including those in which a similar dose is employed.

We conclude that these data suggest that SNHL of varying severities is a rare complication of KD. Clinicians caring for patients with KD should be aware of this potential association and should consider audiometric screening for their patients when clinically indicated. The optimal treatment of acute hearing loss in these patients remains unknown.

We thank Richard Haas, MD, and Mark Howell, MD, who helped examine the patients; Tomisaku Kawasaki, MD, who brought the Japanese reports to our attention; Masonobu Tayama, MD, who kindly translated the Japanese papers; Ellen Friedman, MD, who provided helpful discussion; and Marilyn McEnhill, RN, and the nurses and staff of the Children's Hospital Clinical Research Center.

REFERENCES

1. Landing BH, Larson EJ. Pathological features of Kawasaki disease. Am J Cardiovasc Pathol 1987;1:215-29.
2. Leung DYM, Siegel RL, Grady S, et al. Immunoregulatory abnormalities in mucocutaneous lymph node syndrome. Clin Immunol Immunopathol 1982;23:100-12.
3. Suzuki A, Kamiya T, Kuwahara N, et al. Coronary arterial lesions of Kawasaki disease: cardiac catheterization findings of 1100 cases. Pediatr Cardiol 1986;7:3-9.
4. Yanagihara R, Todd JK. Acute febrile mucocutaneous lymph node syndrome. Am J Dis Child 1980;134:603-14.
5. Amano S, Hazama F. Neural involvement in Kawasaki disease. Acta Pathol Jpn 1980;30:365-73.
6. Nigro G, Midulla M. Facial nerve paralysis associated with Kawasaki disease [Letter]. Ped Infect Dis J 1988;7:889-90.
7. Kleinman MB, Passo MH. Incomplete Kawasaki disease with facial nerve paralysis and coronary artery involvement. Pediatr Infect Dis J 1988;7:301-2.
8. Murayama J. An autopsy case of acute febrile mucocutaneous lymph node syndrome with coronary embolism. Acta Pediatr Jpn 1974;78:15-21.
9. Morens DM, Anderson LJ, Hurwitz ES. National surveillance of Kawasaki disease. Pediatrics 1980;65:21-5.
10. Meade RH III, Brandt L. Manifestations of Kawasaki disease in New England outbreak in 1980. J PEDIATR 1982;100:558-62.
11. Salo E, Pelkonen P, Pettay O. Outbreak of Kawasaki syndrome in Finland. Acta Pediatr Scand 1986;75:75-80.
12. Terasawa K, Ichinose E, Matsuishi T, Kato H. Neurological complications in Kawasaki disease. Brain Dev 1983;5:371-4.
13. Aso T, Wantanabe J. Neurological complications in Kawasaki disease. Jpn J Pediatr 1984;37:541-8.
14. Tamai K, Teai M, Sugimoto K, Nagai Y, Toba T. Four cases of mucocutaneous lymph node syndrome with seventh nerve palsy. Jpn J Pediatr 1984;37:549-52.
15. Sabatino G, Midulla M, Morgese G, Verini M, Squarcia U. Kawasaki syndrome: description of four cases. Pediatr Med Chir 1984;6:521-27.
16. Hattori T, Tokugawa K, Fukushige J, Tasaki H, Nanri T, Ueda K. Facial palsy in Kawasaki disease. Eur J Pediatr 1987;146:601-2.
17. Laxer RM, Dunn HG, Flodmark O. Acute hemiplegia in Kawasaki disease and infantile polyarteritis nodosa. Dev Med Child Neurol 1984;26:814-21.
18. Suzuki H, Yanagawa T, Kihira S, et al. Two cases of hearing loss associated with Kawasaki disease. Clin Pediatr (Jpn) 1988;41:167-72.
19. American National Standards Institute. American National Standard for permissible ambient noise during audiometric testing. New York: American National Standards Institute, 1977.
20. American Speech and Hearing Association. Guidelines for manual pure-tone threshold audiometry. Washington, D.C.: American Speech and Hearing Association, 1978.
21. American National Standards Institute. American National Standard specifications for audiometers. New York: American National Standards Institute, 1970.
22. Harris JP, Sharp PA. Inner ear autoantibodies in patients with rapidly progressive sensorineural hearing loss. Laryngoscope 1990;100:516-24.
23. Newton VE. Aetiology of bilateral sensori-neural hearing loss in young children. J Laryngol Otol (Suppl) 1985;10:1-57.
24. Parving A. Epidemiology of hearing loss and aetological diagnosis of hearing impairment in children. Int J Pediatr Otorhinolarngol 1983;5:151-65.
25. Harris JP. Immunologic mechanisms in disorders of the inner ear. In: Cummings CW, ed. Otolaryngology: head and neck surgery. St. Louis: CV Mosby, 1986:380-95.
26. Veldman JE. Cochlear and retrocochlear immune-mediated inner ear disorders. Ann Otol Rhinol Laryngol 1986;95:535-40.
27. Harris JP. Experimental autoimmune sensorineural hearing loss. Laryngoscope 1987;97:63-76.
28. Newburger JW, Takahashi M, Burns JC, et al. The treatment of Kawasaki syndrome with intravenous gamma globulin. N Engl J Med 1986;315:341-7.
29. Leung DYM, Chu ET, Wood N, Grady S, Meade R, Geha RS. Immunoregulatory T-cell abnormalities in mucocutaneous lymph node syndrome. J Immunol 1983;130:2002-4.
30. Lee LA, Burns J, Glode M, Harmon C, Weston WL. No au-

toantibodies to nuclear antigens in the Kawasaki syndrome [Letter]. N Engl J Med 1983;308:1034.
31. Leung DYM, Collins T, Lapierre L, Geha RS, Pober JS. IgM antibodies present in the acute phase of Kawasaki syndrome lyse cultured vascular endothelial cells stimulated by gamma interferon. J Clin Invest 1986;77:1428-35.
32. Savage COS, Tizard J, Jayne D, Lockwood CM, Dillon MJ. Antineutrophil cytoplasm antibodies in Kawasaki disease. Arch Dis Childh 1989;64:360-3.
33. Burns JC, Geha RS, Schneeberger EE, et al. Polymerase activity in lymphocyte culture supernatants from patients with Kawasaki disease. Nature 1986;323:814-6.
34. Shulman S, Rowley AH. Does Kawaskai disease have a retroviral etiology? Lancet 1986;2:545-6.
35. Cole RR, Jahrsdoerfer RA. Sudden hearing loss: an update. Am J Otol 1988;9:211-5.
36. Myers EN. Salicylate ototoxicity. Arch Otolaryngol 1965; 82:483-9.