Infective Endocarditis in Children: A Current Diagnostic Trend and the Embolic Complications

KAZUOKI YOKOCHI, M.D., HIROFUMI SAKAMOTO, M.D., TAKATOSHI MIKAJIMA, M.D.
EISEI ICHINOSE, M.D., HIROHISA KATO, M.D.
AND YOSHIHARU ETO, M.D.*

Twenty-three cases of IE, of which 91% had underlying congenital heart diseases were diagnosed by positive blood culture or vegetative lesion detected by 2-D ECHO when a patient revealed clinically suspicious episodes. VSD and TOF were the most common underlying heart diseases. The vegetation was detected successfully by 2-D ECHO in 91% of the cases. The causative organisms were identified in 83% of the cases. *Streptococcus viridans* and *Staphylococcus aureus* were the two major organisms detected. *Candida albicans* was found in 3 postoperative and fatal cases. Embolic complications occurred in 7 cases (30.5%): five cases of pulmonary infarction and two of cerebral infarction. The overall mortality was 22%. We recommend early surgical intervention whenever a patient reveals a very large vegetation with animated movability, and emphasize the importance of a proper prophylactic regimen.

INFECTIVE endocarditis (IE) remains one of the most serious complications of congenital heart disease (CHD), though the management and treatment of CHD have progressed dramatically. It has been reported that mortality from IE declined after the introduction of effective antibiotics, whereas the incidence of IE has not declined significantly in these past decades^{1,2}. Thus, the importance of prompt diagnosis which may give the patient a better prognosis should be stressed. Such prompt diagnosis is facilitated, according to our recent experience, by the use of two-dimensional echocardiography (2-D ECHO) to detect vegetative lesion.

PATIENTS AND METHODS

Twenty-three consecutive patients with IE

Key Words:

Infective endocarditis
Vegetation
Pulmonary infarction
Two-dimensional echocardiography

who were admitted between 1977 and 1985 to either Kurume University Hospital or St. Mary's Hospital were entered in this study. Their ages ranged from 2 to 15 years. The diagnosis of IE was established by either positive blood culture or the detection, using 2-D ECHO in several different echocardiographic views, of a vegetative lesion by focusing upon lesions of interest in the heart and vessels, or by both methods when a patient revealed clinically suspicious episodes such as prolonged pyrexia and embolism. 2-D ECHO using a 3.0 MHZ sector or linear scanner was recorded serially when the vegetative lesion was detected. Then the size and the movability of the vegetation were investigated. Any embolic complication was diagnosed by chest roentgenography for pulmonary infarction and by CT scan for cerebral infarction in addition to clinical symptoms such as chest pain or paralysis.

RESULTS

Twenty-one out of the 23 cases had an under-

*Department of Pediatrics and Child Health Kurume University School of Medicine, Kurume, Japan; *Division of Pediatric Cardiology St. Mary's Hospital,*

Mailing address: Kazuoki Yokochi, M.D., Department of Pediatrics and Child Health, Kurume University School of Medicine, 67 Asahi-machi, Kurume-shi, Fukuoka 830, Japan

AFFECTED SITES IN THE HEART	DETAILS	TYPE OF CHD
RIGHT SIDE (14)	TV (6) — VSD, TGA PA, PV (5) — TOF(PO) PDA VSD RVAW (1) — VSD IVS (1) — VSD	6 4 1 1 1 1
LEFT SIDE (4)	MV (2) — MV (2) — ECD(PO) VSD	2 1 1
BOTH SIDES (2)	MV, TV (2) — VSD TOF(PO)	1 1

TV: Tricuspid valve, PA: Pulmonary artery, PV: Pulmonary valve
RVAW: Right ventricular anterior wall, MV: Mitral valve,
IVS: Intraventricular septum, PO: Postoperative

Fig.1. Affected sites and complications of infective endocarditis.

	AFFECTED SITES IN THE HEART	CHD	FATAL CASE
23 CASES	RIGHT SIDE (14)	(+) 14 PE (5)	-----1
	LEFT SIDE (4)	(+) 2 (-) 2 BA (1)	-----1
	BOTH SIDES (3)	(+) 3 CI (1)	-----1
	UNIDENTIFIED (2)		

PE: Pulmonary embolus, BA: Brain abscess,
CI: Cerebral Infarction, (): Number of cases

Fig.2. Affected sites and underlying heart diseases of infective endocarditis.

lying congenital heart disease (91%) (Fig. 1). Ventricular septal defect (VSD), in 11 cases, was the most common followed by tetralogy of Fallot (TOF) in 7 cases, and patent ductus arteriosus (PDA), endocardial cushion defect (ECD), and transposition of the great arteries (TGA) in 1 case each. Seven of these 21 cases were postoperative, and of these 7, 6 had TOF (Fig. 2). The causative organisms were identified in 19 of the 23 cases (83%). *Streptococcus viridans* (6 cases) and *Staphylococcus aureus* (5 cases) were the two major organisms identified, followed by anaerobes and *Serratia marcescens*. *Candida albicans* was found in 3 cases, all of which were fatal (Fig. 3). A vegetative lesion detected by 2-D ECHO was

found in 21 cases (91%). In 14 of these, the vegetation was located in the right side of the heart (61%), i.e. in the tricuspid valve (6 cases; 43%), the pulmonary artery or the pulmonary valve (6 cases; 43%), the right ventricular anterior wall (1 case; 7%) or the intraventricular septum (1 case; 7%). All four left sided vegetations were located in the mitral valve, and two had no underlying heart disease. A vegetative lesion was found in both sides of the heart in 2 cases. Embolic complications during the clinical course of IE occurred in 7 cases. Five were pulmonary embolus manifested by chest pain. One of these 5 died suddenly because of massive pulmonary infarction and hemorrhaging (Fig. 4). The other

ORGANISMS		TYPE OF CHD
<i>S. viridans</i>	6	VSD
<i>Enterococcus</i> sp.	1	ECD
<i>S. aureus</i>	5	VSD, TOF, NSHD
<i>S. marcescens</i>	2	VSD+PS, NSHD
Anaerobes	3	VSD, TOF, PDA
<i>Candida albicans</i>	3	TOF(PO), VSD+PDA
Negative Culture	4	VSD, TOF, TGA
Total	23 cases	

NSHD: No Structural Heart Disease

Fig.3. Causative organisms of infective endocarditis.

Fig.4. 3-year-old boy in the postoperative state of tetralogy of Fallot. The vegetation was detected in the main pulmonary artery. The patient died from sudden onset of massive pulmonary hemorrhage.

2 cases suffered fatal intracranial embolus. According to the 2-D ECHO results recorded serially before and after the embolic episodes, the size of the vegetation was not observed to have changed. The overall mortality for IE was 17.4% (4/23 cases).

DISCUSSION

Most pediatric IE (close to 90%) has underlying congenital heart disease, usually VSD and TOF^{3,4}. The incidence of TOF is dominant⁵, especially in postoperative IE. In our series, 6 of 7 postoperative cases of IE had TOF. A possible explanation for the close correlation of TOF with postoperative IE is the use of artificial materials in the multiple surgical interventions, such as the closure of the ventricular septum and the reconstruction of the right ventricular outflow tract and pulmo-

nary artery. Furthermore, a certain degree of turbulent flow in RV or PA may remain postoperatively in most cases, which may be the cause of intimal damage. Another possibility is that preoperative prolonged hypoxemia may play a certain role in creating intimal damage.

It is clear that prompt and correct diagnosis of IE is essential, as it may alter the outcome of the condition. The routine use of 2-D ECHO in clinical pediatrics has resulted in much more precise and prompt detection of the vegetative lesion of IE. The sensitivity of 2-D ECHO for diagnosing the vegetative lesion has been reported to be about 80 to 90%,^{6,7} sensitivity in our study was 83%. The efficacy of 2-D ECHO is evident in our study. However, we must note that 2-D ECHO also has some potential problems such as: 1) vegetation of less than 2 to 3 mm may be undetected, 2) a proper gain setting should be es-

established to avoid misinterpretation and 3) increases in beam width may result in the loss of azimuthal resolution in the distant field, causing images to appear falsely large^{8,9}

We experienced a relatively high incidence of embolic complications in IE (30%). Five embolic complications occurred in the lung, manifested by sudden onset of chest pain and an abnormal shadow on the plane chest roentgenogram. Symptoms such as chest pain subsided spontaneously within a few days in all but one case. It has been reported that pulmonary embolus is the most frequently recognized complication of IE, although massive life-threatening pulmonary embolization is extremely rare.¹⁰ Unfortunately, we lost one postoperative patient who died suddenly with massive hemoptysis.

We should, therefore, consider an expansion of the surgical indications for IE. In general, the surgical indications for IE are: 1) appreciable or worsening congestive heart failure, 2) infections uncontrollable by antibiotics, particularly fungal, gram negative bacillary or staphylococcal infections, 3) recurrent embolization, 4) progressive spread of intracardiac infections, as manifested by conduction system disturbances, aneurysm, fistula formation or suppurative pericarditis, and 5) prosthetic valve endocarditis.¹¹⁻¹³ In addition to conventional indications, we recommend surgical intervention in cases where there is huge vegetation with animated movability in the heart and vessels. The prophylaxis of IE is extremely important for patients with predisposing factors. According to the new revision of the prophylactic regimen for IE issued by the American Heart Association,¹⁴ the cardiologist as well as the general practitioner should make every effort to reduce the risk of IE by means of the proper prescription of antibiotics.

REFERENCES

1. JOHNSON DH, ROSENTHAL A, NADAS AS: A forty-year review of bacterial endocarditis in infancy and children. *Circulation* 51: 581, 1975
2. CALDWELL RL, HURWITZ RA, GIROD DA: Subacute bacterial endocarditis in children. *Amer J Dis Child* 122: 312, 1971
3. JOHNSON CM, RHODES KH: Pediatric endocarditis. *Mayo Clin Proc* 57: 86, 1982
4. STANTON BF, BALTIMORE RS, CLEMENS JD: Changing Spectrum of infective endocarditis in Children analysis of 26 cases, 1970-1979. *AJDC* 138: 720, 1984
5. TAKAMIZAWA K: A clinical study of infective endocarditis in children. *J Tokyo Wom Med Coll* 51: 399, 1981
6. MINTZ GS, KOTLER MN, SEGAL BL, PARRY WR: Comparison of two-dimensional and M-mode echocardiography in the evaluation of patients with infective endocarditis. *Am J Cardiol* 43: 738, 1979
7. STROM J, BECKER R, DAVIS R, MATSUMOTO M, FISHMAN W, SONNENBLICK EH, FRATER RWH: Echocardiographic and surgical correlations in bacterial endocarditis. *Circulation* 62(Suppl 1): I-164, 1980
8. GILBERT BW, HANEY RS, CRAWFORD F, MCCLELLAN J, GALLIS HA, JOHNSON ML, KISSLO JA: Two-dimensional echocardiographic assessment of vegetative endocarditis. *Circulation* 55: 346, 1977
9. BERGER M, DELEFIN LA, JELVEH M, GOLDBERG E: Two-dimensional echocardiographic findings in right-sided infective endocarditis. *Circulation* 61: 855, 1980
10. GERSONY WM, HORDOF AJ: Infective endocarditis and diseases of the pericardium. *Pediatr Clin North Am* 25: 831, 1978
11. PAPAPORT E: The changing role of surgery in the management of infective endocarditis. *Circulation* 58: 598, 1978
12. STINSON EB: Surgical treatment of infective endocarditis. *Prog Cardiovasc Dis* 22: 145, 1979
13. MCANULTY JH, RAHIMTOOLA SH: Surgery for infective endocarditis. *JAMA* 242: 77, 1979
14. SHULMAN ST et al: Special statement: Prevention of bacterial endocarditis. *Pediatrics* 75: 603, 1985