CARDIOVASCULAR COMPLICATIONS OF ENTERIC FEVER

S. Singh
S. Singhi

The clinical presentation of enteric fever in children is different from that in adults(1-4). Pulmonary, neurological and other extra-abdominal manifestations are relatively frequent, while gastrointestinal complications are less common(2-4). Cardiovascular complications (clinical and sub-clinical) occur in 1 to 80% of cases. In this review we have focused on the cardiovascular complications with special emphasis on the diagnostic features and treatment. The various cardiovascular complications are listed in *Table I.*

Myocarditis

Myocarditis usually occurs in the late second or early third week of the illness. The incidence of clinically manifest disease is about 1-2%(5), but ECG changes of myocarditis are reported in 30-80% patients(5-7). Children are affected more often than adults. Rowland(8) found clinical myocarditis in 9(1.7%) of 530 patients of enteric fever; 6 of these were children below 12 years.

Tachycardia is usually the first sign of myocarditis. The first heart sound may be muffled during the active stage of the disease, without accompanying congestive cardiac failure(CCF) or a gallop rhythm. The diagnosis should be suspected if there is tachycardia, weak pulse and muffled heart sounds. Hypotension, venous engorgement and frank congestive failure may be occasionally present(8). However, appearance of signs of congestive heart failure early or late in the course of the disease should always arouse the suspicion of myocarditis.

Isolated blood pressure changes may occur without myocarditis(9) Stuart and Pullen, in a study of 360 cases of enteric fever which included 37% children, found a gradual and consistent fall usually up to 20 mm Hg systolic and 15 mm Hg diastolic. Drop as great as 40 mm systolic and 30 mm diastolic, without evidence of contributory complicating factors, were observed in a few instances(9). We have recently seen 2 cases of resistant typhoid fever with hypotension. The blood pressure did not increase with fluid replacement and returned to normal only after 2 weeks of antibiotic therapy.

The ECG criteria for diagnosis of myocarditis include a prolonged PR interval, lengthening of Q-Tc, conduction defects, ST and T-wave changes(5,6,9). Most of the authors have reported low voltage complexes and flattened or inverted T-waves along with clinical myocardial dysfunction.

The ECG changes do not bear any re-

From the Department of Pediatrics, Postgraduate Institute of Medical Education and Research, Chandigarh 160 012.

Reprint requests: Dr. Sunit Singhi, Additional Professor, Department of Pediatrics, PGIMER, Chandigarh 160 012.

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TABLE I–*Cardiovascular Complications of Enteric Fever*

Manifestations	Percentage	References
ECG changes	40-80	(7)
Myocarditis (Clinical)	1-2	(5,8)
Endocarditis	Rare, exact incidence not known	(4,14)
Pericarditis	Rare, exact incidence not known	(4,12)
Arterial thrombosis	Case reports only	(9,20)
Venous thrombosis	0.83	(9)
Arrhythmias	Rare, case reports only	(17,18,19)

lationship with clinical toxicity or higher agglutinin titre; gross cardiac failure may be present with minimial ECG alternations(5). On the other hand, ECG may show considerable change with little cardiac enlargement or other abnormal signs.

A significant rise in SGOT (oxalacetic transaminase) was observed only in 30% of enteric myocarditis by Khosla *et al.*(10). The rise in the transaminases had no correlation with the ECG findings and clinical picture of myocarditis. The level took two weeks to return to normal.

Oral administration of digitalis is indicated only in presence of congestive cardiac failure. The drug should be given cautiously because of increased sensitivity of myocardium. At least one adult study suggests that digitalis and diuretic therapy needs to be maintained for a longer period than the clinical picture would suggest(11). Once clinical myocarditis is present the prognosis is poor; mortality as high as 77% has been reported(8). It has been recently suggested that children with typhoid myocarditis may develop cardiomyopathy as a long tumor sequelae(12).

Isolated ECG Abnormalities (Table II)

The frequency with which ECG abnormalities are reported has varied from author to author(6,7,13); the incidence directly related to the frequency with which tracings were obtained during the illness.

The ECG changes appear at the height of pyrexial illness, commonly between first and second week but can occur early or during early convalescence(6,7). The changes are not necessarily associated with any clinical sign of cardiovascular disease.

Similar changes in ECG can be caused by electrolyte abnormalities, severe anemia, and vitamin B complex deficiency. A study in 1948 on adult patients demonstrated normalization of ECG in 23 out of 35 patients with T-wave changes following daily administration of 300-500 mg niacin(13). Similar ECG changes including decreased amplitude of QRS complexes, flat or inverted T-waves, and ST elevation may occur with fever of any etiology; conduction defects are, however, not reported.

Endocarditis

Endocarditis is very rare in enteric fever. It occurs more often in patients with pre-existing valvular heart disease, than in those with a previously normal heart(4,14). The patient is usually sick, febrile and in congestive cardiac failure. There is cardiomegaly, changing systolic murmurs and

TABLE II—*EKG Abnormalities Reported in Enteric Fever*

	Incidence	Changes	Pathogenesis
1. QRS complex	11%-25% (6,13)	Low voltage graphs, improves with therapy	Possibly due to myocarditis(6)
2. QT_c interval	0-45% (7,13)	Prolongation with myocardial involvement; myocardial failure(6)	Related to loss of K^+ from myocardial cells due to tissue anoxia(6)
3. ST segment and T wave	45%-55% (6)	Flat, diaphasic of inverted; depression of ST segment	Myocardial damage; low voltage T waves suggest damage; takes longer time to revert to normal
4. P-R interval	26%-50% (6,13)	Prolongation	Effect of toxins on conducting tissue. Recovery attributed to opening up of collaterals and disappearance of toxemia(6)

evidence of left ventricular failure. Leucocytosis and persistent fever in a patient with previous valvular heart disease, during course of enteric fever, indicates a possibility of endocarditis.

Pericarditis

While pericarditis is considered rare(15,16), in a recent report, Majumder(12) noted overt pericardial involvement in 2 cases out of 96 hospitalized children. Mokhobo(16) reported two children who had a clinical presentation exactly like rheumatic carditis and were treated for two months before blood culture grew *S. typhi.* These patients presented with high fever, tachycardia and CCF, had pericardial rub and changing apical systolic murmur. The chest roentgenogram showed cardiomegaly and ECG showed nonspecific changes of myocardial damage.

Arrhythmias

Various arrhythmias that have been described in enteric fever include (*i*) complete atrio-ventricular (AV) and sino-atrial block(17); (*ii*) Wenckebach phenomenon(18); (*iii*) Transient incomplete right bundle branch block(5); (*iv*) Ventricular ectopic beats(6); and (*v*) Ventricular arrhythmia with prolonged Q-Tc(19).

Arteritis/Thrombosis

Arteritis is very rare in enteric fever(20). In all the reported instances lower limb vessels were affected, either because of involvement of femoral or popliteal artery or bifurcation of aorta. Gangrene of the limbs may occur as a consequence. The clinical presentation is similar to arteritis of any etiology.

Various mechanisms like *Salmonella* arteritis (infective or toxic), embolization from mural thrombus or thrombogenic situations like dehydration, hypotension, septicemia are implicated in the causation of arterial thrombosis. Early recognition and prompt treatment is necessary to save the organ affected by thrombosis.

Venous thrombosis

Venous thrombosis was a common complication before the antibiotic era, and often occurred in the fourth week of the ill-

ness(1). The major veins affected were saphenous and femoral. The condition was characterized by sudden appearance of pain and swelling of affected limb, secondary rise in temperature, marked tenderness and cord like thickening of the affected vein. Dehydration and prolonged lying in bed were blamed for causing thrombosis, but in some cases *Salmonella typhi* were isolated from the clot. The complication should be treated as any other venous thrombosis along with specific antibiotics.

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