

# Blalock-Taussig anastomosis in 126 patients with Fallot's tetralogy

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The long-term results of Blalock anastomosis in 126 patients (1954-71) for Fallot's tetralogy are presented. The operative mortality was 10% and the overall mortality 38%. The 78 survivors were reviewed after periods of surveillance ranging from six months to 17 years. Complications were few.

It is concluded that although total correction as a primary procedure has become the treatment of choice in most, it may in some instances never be technically feasible because of extreme underdevelopment of the right ventricular outflow tract. In the very young with urgent symptoms and rapid deterioration total correction would be considered hazardous. In the infant a high operative mortality reflected the inadequate calibre of the vessels used in the shunt operation.

Blalock and Taussig (1945) introduced the first effective palliative procedure for the relief of Fallot's tetralogy by anastomosing the right subclavian artery to the corresponding pulmonary artery. Subsequent palliative operations have either anastomosed the aorta to a pulmonary artery (Potts, Smith, and Gibson, 1946; Waterston, 1962) or aimed to relieve the right ventricular outflow tract obstruction (Brock, 1948, 1952).

During 17 years we have employed almost exclusively the Blalock-Taussig anastomosis for all patients over the age of 1 year with Fallot's tetralogy demanding urgent surgical intervention because of increasing disability. We present an assessment of the results of operation and of the subsequent progress of these patients.

## CLINICAL MATERIAL

Between April 1954 and April 1971 a Blalock-Taussig shunt was created in 126 patients as a primary procedure for Fallot's tetralogy. Sixty-six patients were male and 60 female. The age at operation ranged from 6 weeks to 24 years; 68% (86) were under 3 years of age. The four patients aged 10 years and over occurred early in the series; had they presented in more recent years primary total correction would certainly have been performed by choice. All the patients were severely disabled, pronounced cyanosis and breathlessness being the commonest presenting symptoms, while in the most severely affected children cyanotic attacks accompanied in some instances

by loss of consciousness were frequently reported. The survivors were reviewed finally in December 1971.

## RESULTS

Deaths at operation (Table I) numbered 13 (10%), eight of which occurred among the 20 patients under 1 year of age.

TABLE I  
126 PATIENTS WITH FALLOT'S TETRALOGY WHO UNDERWENT BLALOCK-TAUSSIG SHUNT

	Age					
	0-6 mth	7-11 mth	1-3 yr	4-10 yr	11-20 yr	> 20 yr
Number	12	16	58	36	3	1
Early deaths	5	3	3	2	0	0

Early mortality = 13 of 126 (10.3%) (under 1 year 8 deaths out of 28 = 28%). Late deaths 35 of 113 (31%). Total mortality = 35 + 13 = 48 out of 126 = 38%.

COMPLICATIONS AND LATER DEATHS All 113 patients who survived operation continued under outpatient supervision for periods ranging from eight months to 17 years. Eight patients developed major complications, namely cerebral abscess in five with two deaths, cerebral thrombosis in two, and bacterial meningitis in one. Bacterial endocarditis was not encountered. The two who survived a cerebral thrombosis had a permanent hemiparesis.

TABLE II  
35 LATE DEATHS IN 113 SURVIVORS (31%)

Related to Further Surgery			Cerebral Abscess	Cardiac Failure	Unknown (at home)	Hepatitis
Total Correction	Waterston Shunt	Pulmonary Valvotomy				
21	5	1	2	2	3	1

There were 35 late deaths giving a total mortality of 38%. Twenty-seven of these deaths resulted from further surgical treatment, two from unexpected cardiac failure, and one from hepatitis; three occurred at home without a clearly identified cause and two were from cerebral abscess as already mentioned (Table II). The formidable mortality with which complete repair after a Blalock-Taussig anastomosis was initially associated declined sharply in later years.

Of the 113 survivors of the first operation, 54 had a total of 57 additional surgical procedures. These were pulmonary valvotomy or infundibulectomy in 15, of whom three subsequently underwent total correction, a Waterston shunt in 13 infants or small children with unsatisfactory Blalock-Taussig shunts, and total correction in 29. The time interval between the Blalock-Taussig anastomosis and further surgical intervention was from two months to 14 years (mean 5.7 years). In only 10 patients was the second operation undertaken within three years of the first. Six of these were infants who underwent a Waterston anastomosis some months after an unsuccessful Blalock and of whom three died, emphasizing the desperate plight of those with

a severely obstructed right ventricular outlet. The remainder (47) underwent further surgery at intervals of three to 12 years after their shunt operation.

**LONG-TERM FOLLOW-UP** For the consideration of late results the original 126 patients were divided into three groups (Fig. 1).

**Group 1** This comprised 54 patients operated on more than nine years previously of whom six died at operation, 24 died during follow-up, and 24 were still alive at review in December 1973. Thus 50% of those who survived operation were alive and well more than nine years after operation. Of these, 11 have had no further surgery while 13 had either pulmonary valvotomy or total correction. Nine had survived for more than 10 years after operation.

**Group 2** This comprised 52 patients operated on three to nine years previously among whom there were seven operative deaths and 11 late deaths leaving 34 (75% of the survivors of operation) alive and well.

**Group 3** This comprised 20 patients operated on within the previous three years. All were alive and well.

#### PRESENT STATUS OF SURVIVORS

Of the original 126 patients, 78 (62%) survived. Twenty-seven had undergone further surgical treatment (three patients each underwent two further surgical procedures). A clinical assessment of those patients is outlined in Table III. Of the 51 who had had no further surgical treatment 44 had evidence of a functioning anastomosis and showed no sign of deterioration. In 11 there had been some deterioration; one patient had declined further surgical treatment, two were awaiting total correction, and eight were awaiting preoperative reassessment by cardiac catheterization. Thirty-one patients underwent cardiac catheterization and angiocardiology at varying intervals after their initial anastomosis; in none was there evidence of pulmonary hypertension.

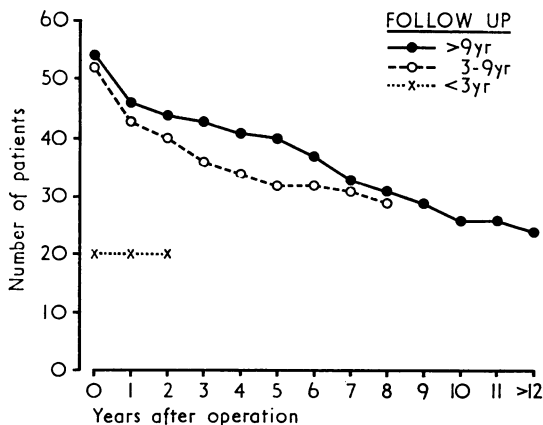


FIG. 1. Late results in three groups showing numbers alive at follow-up: ●—● follow-up >9 years; ○—○ follow-up 3-9 years; ×—× follow-up <3 years.

TABLE III  
CLINICAL STATUS OF 78 SURVIVORS

14 with pulmonary valvotomy	11 improved (may be suitable for correction later)
8 total correction	3 had subsequent total correction
8 Waterston	5 symptom-free. No cardiomegaly
	3 with grade I dyspnoea and cardiomegaly
	All improved. Calibre of pulmonary arteries in 5 so small that further correction seems remote
51 with no further surgery	21 Blalock-Taussig shunt 1-3 years ago. Too early for reassessment. Clinically well
	6 either mongolism or hemiplegic. No further surgery proposed
	6 moved elsewhere. Generally well
	8 awaiting cardiac catheterization + angiography for assessing possibility of correction
	2 awaiting correction
	7 well, no further action meantime (includes 4 who had Blalock-Taussig shunt 14 years ago)
	1 deteriorating. Further investigation and surgery refused

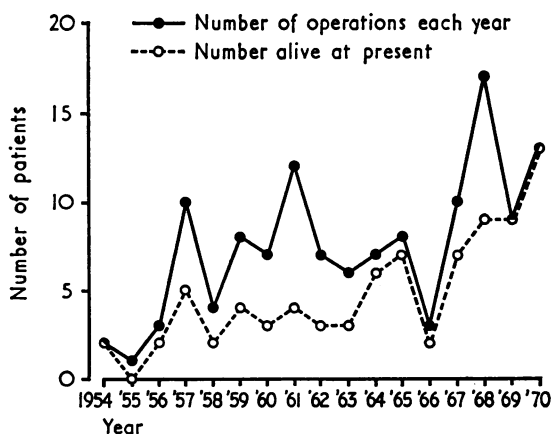


FIG. 2. Number of patients alive in December 1971 in relation to time since Blalock-Taussig shunt.

Figure 2 represents in graphic form the number of patients alive at the end of 1971 related to the year in which their Blalock-Taussig anastomosis was performed. The two patients operated on in 1954 were alive and well. Of the 12 operated on in 1961 only four were alive at the close of the study; this was related to a transiently high surgical mortality associated with early experience in total correction as a second-stage procedure.

#### DISCUSSION

The 10% surgical mortality in our series was identical with that observed in previous reports (White, McNamara, Bauersfeld, and Taussig, 1956; Deuchar, Bescos, and Chakorn, 1972). The high mortality in infants was considered to be a reflection of the greater severity of the right ventricular outflow obstruction in those presenting early in urgent need of surgical relief.

Indeed this high mortality is largely an indication of failure to establish a large enough anasto-

mosis between the small vessels presented at operation. In this context the introduction of an anastomosis between ascending aorta and right main pulmonary artery (Waterston, 1962) has provided for the infant a more adequate palliative shunt and this we employed in the latter part of our series.

Late complications were few, the commonest being cerebral abscess. Bacterial endocarditis, quite frequently encountered by Deuchar *et al.* (1972), was not proven in any of our patients, but it could not be entirely ruled out in five patients who died at home, three from an unknown cause and two in cardiac failure.

The apparent absence of pulmonary hypertension after the shunt operation was in keeping with the findings of Deuchar *et al.* (1972). The subclavian artery to pulmonary artery anastomosis carries a much lower risk of pulmonary hypertension than a direct anastomosis between aorta and pulmonary artery. The reason for this complication is an excessively large pulmonary blood flow (Paul, Miller, and Potts, 1961; McGaff, Ross, and Braunwald, 1962; Cole, Muster, Fixler, and Paul, 1971), and a practical consequence is that the timing of corrective surgery may become a matter of urgency when the anastomosis is between these major arteries (Bernuth *et al.*, 1971).

Campbell (1972) estimated that the average life span in Fallot's tetralogy without operation was 15 years. The outlook has been improved both with the earlier palliative procedures and more recently with total correction. Taussig (1972) reported long-term survival in a patient who was well and active 24 years after a Blalock-Taussig anastomosis. The same author, analysing results in 500 patients who had undergone a Blalock-Taussig anastomosis, found that after five years 67% had still maintained their improvement (White *et al.*, 1956). Ten to 13 years after operation more than 40% were still well and active (Taussig, Crawford, Pelargonio, and Zachariou-

dakis, 1962). Of 45 of our patients who had undergone their shunt operation three to nine years earlier 75% (34) were alive and well. Among 48 operated upon nine to 17 years before, 50% (24) were alive and well, although 13 had required a subsequent operation. These figures and those of Taussig show close similarity.

Total correction is now the treatment of choice, but the mortality remains in the region of 10% (Kirklin, Wallace, McGoon, and DuShane, 1965; Malm *et al.*, 1966) and may be even greater in patients who have had a previous operation. More recent experience with improved techniques have produced better results (Goldman, Mustard, and Trusler, 1968). In certain very severe cases of right ventricular outflow tract obstruction, total correction may not be a practicable undertaking. In these circumstances either a Blalock-Taussig anastomosis or in infants a Waterston shunt (Waterston, 1962) can be relied upon to bring about a degree of improvement in symptoms maintained over several years. Our present policy is to avoid where possible the greater risks attached to a double operative procedure, palliative followed by radical, and to proceed directly to the latter. Where, however, the patient has had a shunt operation because of the early onset of acute symptoms we do not consider that radical surgical treatment is urgently needed unless there are increasing symptoms, a rising haematocrit, a disappearing shunt murmur, or an increasing incidence of cyanotic attacks. Where there is no urgency we recommend the corrective operation before the end of the first decade.

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