



"A HIGH MORTALITY IN NEONATAL MODIFIED BLALOCK TAUSSIG SHUNT, STILL A LIFE SAVIOUR? - A SINGLE CENTRE STUDY."

Cardiology

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ABSTRACT

The Modified Blalock-Taussig shunt, is the most common palliative neonatal closed-heart procedure. Professor Marc de-Leval modified the procedure using the interposition graft between the subclavian artery and the pulmonary artery so was also called as the de-Leval shunt or the Great Ormond Street (GOS) shunt. The mortality rate in neonates is still highest during the first post-operative month. Risk factors, such as low birthweight, shunt size, noncardiac congenital abnormalities, and heterotaxy syndrome, are the important factors for the morbidity and mortality. Perioperative advances still have not shown significant improvements in outcomes. Patients undergoing intervention experienced increased morbidity and mortality¹. Postoperative mortality has been ascribed to many potential factors, with acute or chronic shunt occlusion from shunt thrombosis, shunt stenosis and also the downstream pulmonary artery distortion likely playing a large role in postoperative attrition^{2,6,7}. A retrospective study was thus conducted to determine the factors responsible for the morbidity and mortality in patients with neonatal BT Shunts done during the period of 2010 till 2020.

KEYWORDS

Modified Blalock Taussig Shunt, Neonates, Mortality

INTRODUCTION:

The Modified Blalock-Taussig shunt, is the most common palliative neonatal closed-heart procedure. Professor Marc de-Leval modified the procedure using the interposition graft between the subclavian artery and the pulmonary artery so was also called as the de-Leval shunt or the Great Ormond Street (GOS) shunt. The mortality rate in neonates is still highest during the first post-operative month. Risk factors, such as low birthweight, shunt size, noncardiac congenital abnormalities, and heterotaxy syndrome, are the important factors for the morbidity and mortality. Perioperative advances still have not shown significant improvements in outcomes. Patients undergoing intervention experienced increased morbidity and mortality¹. Postoperative mortality has been ascribed to many potential factors, with acute or chronic shunt occlusion from shunt thrombosis, shunt stenosis and also the downstream pulmonary artery distortion likely playing a large role in postoperative attrition^{2,6,7}.

A retrospective study was thus conducted to determine the factors responsible for the morbidity and mortality in patients with neonatal BT Shunts done during the period of 2010 till 2020.

Patients and methods:

A retrospective cohort study of all neonates (<30 days of age) who underwent S-PA shunt placement at G S Medical college and K E M Hospital Mumbai, was performed from the period of 2010 to march 2020.

Patients with central shunts were excluded from the study. For the purposes of this study, all the cases with Modified Blalock-Taussig shunt (BTS) as the only procedure, staged 1st or 2nd surgery for univentricular hearts, shunts as part of the Norwood procedure for HLHS and variants were considered.

We obtained a detailed information regarding the postoperative course, morbidity, and mortality by review of the hospital medical records, operative reports, cardiac catheterization reports, and echocardiogram reports.

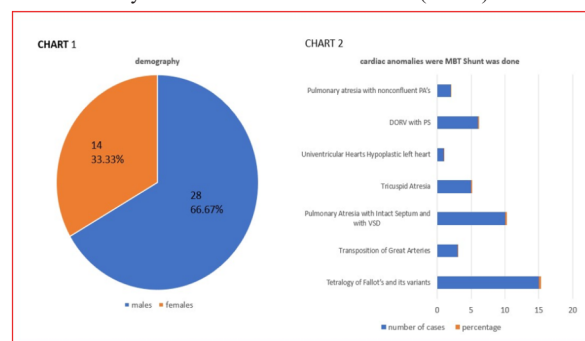
42 neonates were operated during the period of 2010 to 2020. Males (28) predominated the females (14).

Chart 1.

The various cardiac anomalies seen were: Chart 2

1. Tetralogy of Fallot's and its variants: 15 (35.71%)

2. Transposition of Great Arteries: 3 (7.14%)
3. Pulmonary Atresia with Intact Septum and with VSD: 10 (23.80%)
4. Tricuspid Atresia: 5 (11.90%)
5. Univentricular Hearts Hypoplastic left heart: 1 (2.38%)
6. DORV with PS: 6 (14.2%)
7. Pulmonary atresia with nonconfluent PA's: 2 (4.76%)



All the patient's data was analysed taking into consideration of gender, gestational age, birthweight, presence of significant associated cardiac and noncardiac congenital genetic abnormalities, heterotaxy syndrome, underlying cardiac diagnosis at S-PA shunt placement. Gestational age of less than 37 weeks and weight less than 2.5 kg was considered as premature.

The shunt used were majorly PTFE, mothers GSV in some neonates. The mean age was 18.97 days (range: 3-30 days). The mean weight of the babies was 3.22 kgs, the smallest weighed 2.3 kg.

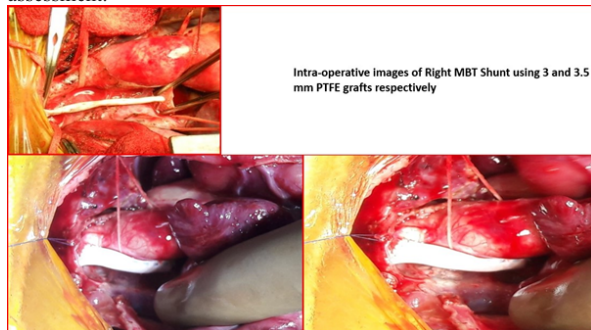
All patients were deeply cyanotic and preoperative prostaglandin E1 was needed in all (42) patients to ensure ductal patency. Preoperative vitals and SPO₂ were studied. The mean arterial SPO₂ was 67% with PGE1 infusion in all patients.

4 (9.52%) Patients with PA and IVS and 1 with hypoplastic left heart were critical with ventilatory and inotropic support.

The mean right and left pulmonary artery sizes were 3.23 mm and 2.73

mm, respectively.

All the patients were operated through median sternotomy and right or left (right aortic arch) modified BT Shunt was done. S-P A shunting was done from the origin of the Innominate to the corresponding pulmonary artery. Shunt size was determined by the weight of the neonate and the intraoperative pulmonary artery and innominate artery sizes. Patients were operated with or without pump support. Ductal ligation was done as per the saturation and intraoperative vital assessment.

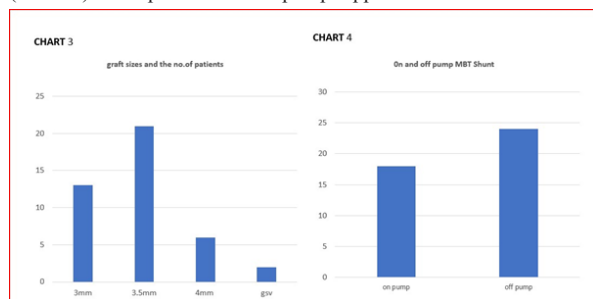


Post operatively heparin infusion (10-20 units/kg/hr) was started in all the patients for at least 48 hrs. Aspirin (1mg/kg) was given orally post operatively.

All patients were shifted on inotropic support mainly adrenaline (0.03 to 0.05 microgram/kg/min) and dopamine was added (3 to 5 microgram/kg/min) as our institutional protocols. Ventilated for 24 to 48 hrs and as per vital conditions, SPO₂ and the renal functions. Post extubation nasal non-invasive ventilation was started in all the cases for at least 48 hrs followed by oxygen hood. Post-operative saturation was monitored strictly and bed side 2D-ECHO was done for shunt functioning at every 48 hours to rule out shunt thrombosis, kinking and distortion of the pulmonary arteries. Depending on which the re-intervention was planned if required.

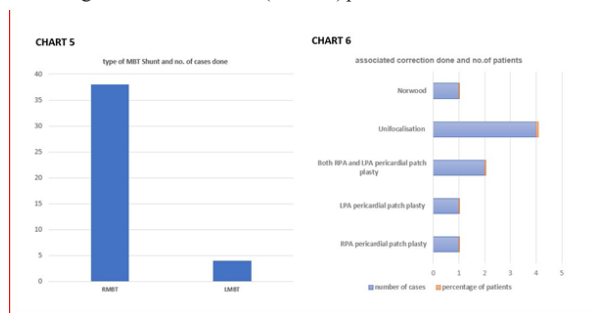
The polytetrafluoroethylene grafts (shunts) sizes used were, 3 mm in 13 patients (30.95%), 3.5 mm in 21 patients (50%), 4 mm in 6 patients (14.28%) and mother's great saphenous vein was used in 2 patients (4.76%). **Chart 3**

18 (42.85%) patients were operated on pump support and others 24 (57.14%) were operated without pump support. **Chart 4**



Right modified BT shunt was done in 38 (90.47%) patients. Includes the one with Right common carotid artery to Right PA were this patient had anomalous origin of right subclavian artery and Left modified BT shunt was done in 4 (9.53%) patients. **Chart 5**

Ductal ligation was done in 28 (66.66%) patients.



The procedures done in association with S-PA shunts were: **Chart 6**

1. RPA pericardial patch plasty – 1 (2.38%)
2. LPA pericardial patch plasty – 1 (2.38%)
3. Both RPA and LPA pericardial patch plasty – 2 (4.76%)
4. Unifocalisation – 4 (9.52%)
 - 1 (2.38%) on pump
 - 3 (7.14%) off pump
5. Norwood procedure – 1 (2.38%)

The mean duration of mechanical ventilation was 4.5 +/- 1.5 days. 4 (9.5%) patients who developed bronchopneumonia needed prolonged ventilation for 14 to 20 days. The mean intensive care unit stay was 11.2 +/- 1.3 days. The mean hospital stay was 15 +/- 2.8 days. 3 (7.14%) patients with sepsis stayed beyond 21 days.

There were no intraoperative deaths. There were 8 (19.04%) deaths with 62.5% (5 patients) of the deaths seen within 48 hrs post-operatively. 7 (16.67%) patients with PA intact IVS were among the deaths and one (2.38%) with associated hypoplastic left heart.

Immediate post-operative low cardiac output and possibly shunt malfunction in 3 (7.14%) these were with low weight 2 cases (4.76%) weight being 2.4 kgs and 1 (2.38%) with Norwood procedure. Bronchopneumonia in 2 (4.7%), shunt thrombosis in 2 (4.7%) and 1 (2.38%) patient had late shunt block. The patients with shunt thrombosis were re-explored and graft was redone. One of these patients developed on table thrombosis. 3 (7.14%) patients developed sepsis and were treated with extended antibiotics and anti-fungal agents. They all recovered well after treatment.

The number of deaths in comparison to the graft sizes were as follows:

- 4 mm – 1 (out of 6 patients) 16.67%
- 3.5 mm – 3 (out of 21 patients) 14.28%
- 3 mm – 3 (out of 13 patients) 23.07%
- GSV – 1 (out of 2 patients) 50%

The patency rates of the grafts were as follows after 1 month.

- 4 mm – 83.33%
- 3.4 mm – 85.72%
- 3 mm – 76.93%
- Mother's GSV – 50%

34 (80%) patients were alive and well at follow-up with a mean oxygen saturation of 83.84%.

All the patients were kept on aspirin. All patients 34 patients were followed every monthly for a minimum of 6 months and later at every 3 months for up to 5 years and then 1 yearly.

Comparison of the pre and post-operative parameters at 6 months, 1 year and 5 years respectively with the percent change/growth in the parameters. Table 1 and **Chart 7**

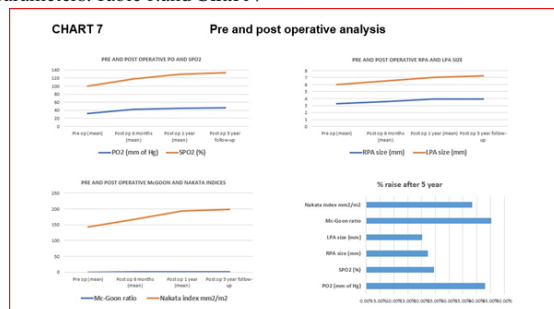


Table 1:

Parameter	Pre op (mean)	Post op 6 months (mean)	Post op 1 year (mean)	Post op 5 year follow-up	% raise after 5 year
PO2 (mm of Hg)	32.54	42.64	45.38	46.54	43.02%
SPO2 (%)	67.00	75.32	83.84	86.76	24.49%
RPA size (mm)	3.23	3.56	3.92	3.95	22.29%
LPA size (mm)	2.73	2.96	3.09	3.28	20.14%
Mc-Goon ratio	1.08	1.32	1.52	1.57	45.37%
Nakata index mm ² /m ²	143	168	193	198	38.46%

Out of 34 patients 6 (17.64%) patients of TOF underwent ICR at age of 2 to 5 yrs. 12 (35.29%) patients underwent BDG as 2nd stage of univentricular heart repair. 16 (47.05%) patients are still waiting for staged completion and out of which 10 patients were lost for follow up.

DISCUSSION:

Modified Blalock Taussig Shunt is the most currently and widely used procedure of choice for palliation of Congenital Cyanotic Heart Diseases. Professor Marc de-Leval modified the procedure using the interposition graft between the subclavian artery and the pulmonary artery so was also called as the de-Leval shunt or the Great Ormond Street (GOS) shunt.

The mortality rate in neonates is still highest during the first post-operative month. Risk factors, such as low birthweight, shunt size, noncardiac congenital abnormalities, and heterotaxy syndrome, are the important factors for the morbidity and mortality^{2,7}. Patients undergoing intervention experienced increased morbidity and mortality¹. Postoperative mortality has been ascribed to many potential factors, with acute or chronic shunt occlusion from shunt thrombosis, shunt stenosis and also the downstream pulmonary artery distortion likely playing a large role in postoperative attrition^{2,6,7}.

The above study also reveals the high mortality rate of 19.04%^{5,6,7,8} and with almost 62.5% deaths within first 48 hrs^{5,8}. 16.67% deaths were seen in patients with PA intact IVS^{6,7} was among the deaths and 2.38% with associated hypoplastic left heart^{6,7,8}.

Immediate post-operative low cardiac output⁷ and possibly shunt malfunction was seen in 7.14% patients and 4.76% with low weight⁷ 2.4 kgs and one patient with associated hypoplastic left heart were Norwood procedure was done⁷. Bronchopneumonia was seen in 4.7% patients requiring >14 days of ventilation, shunt thrombosis in 4.7% cases that was re-explored.

2.38% patients had late shunt block after 1 year and underwent intracardiac repair with transannular patch of Right Ventricular Outflow Tract.

The mean duration of mechanical ventilation was 4.5 +/- 1.5 days^{6,7}. 4 (9.5%) patients who developed bronchopneumonia needed prolonged ventilation for 14 to 20 days. The mean intensive care unit stay was 11.2 +/- 1.3 days⁷. The mean hospital stay was 15 +/- 2.8 days. 7.14% patients with sepsis stayed beyond 21 days^{4,6,7}.

The deaths were not related to the graft size^{5,7,8} and mother's GSV was a good alternative for small sized pulmonary arteries. The patency rates of the grafts were 81% after 1 month, 78% after 6 months and 75% after 5 years^{7,8}.

Also, the 5 years post-operative analysis shows that, there was 45.37% and 38.46% growth in the Mc-Goon and Nakata indices respectively^{5,7,8}. Thus, the patients with MBT shunt can be safely taken for the intracardiac repair or completion of the staged repair for univentricular hearts.

17.64% patients of TOF underwent ICR at age of 2 to 5 yrs. 35.29% patients underwent BDG as 2nd stage of univentricular heart repair. 47.05% patients are still waiting for staged completion and almost 29% patients were lost for follow up

CONCLUSION:

Thus, the mortality rate still remains high after the neonatal modified Blalock-Taussig shunt particularly in the immediate post-operative period of within 48 hrs. And PA with IVS, univentricular hearts and low weight <3 kgs are the predictors of high mortality and morbidity. Shunt thrombosis and occlusion cause sudden deaths in the post-operative period. Still the graft patency rates are good thus increasing the survival of the patients. Might be the recent advances in ECMO and interventional technologies can get down the mortality rates of the neonatal modified BT shunts.

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