นิพนธ์ต้นฉบับ

Early outcome of palliative shunt surgery for cyanotic congenital heart disease in Songklanagarind Hospital

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Abstract:

Early outcome of palliative shunt surgery for cyanotic congenital heart disease in Songklanagarind Hospital

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Songkla Med J 2005;23(3):137-143

The Modified Blalock-Taussig (MBT) shunt provides excellent palliation for patients with cyanotic heart disease with diminution of pulmonary blood flow. This retrospective study reviewed our results as a developing cardiac center, comparing them with those in the literature.

Between July 2001 and June 2003, forty-two patients (21 male and 21 female) underwent 44 MBT shunts in Songklanagarind Hospital. The age ranged from 3 days to 13 years (median=12 months, P_{25-75}= 6-36) and four patients were neonates. Patients' weight ranged from 1.9 to 27 kg (median=8.2 kg, P_{25-75}= 5.5-10.8). Tetralogy of Fallot comprised the

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majority of cases (59.5%). Varying sizes of grafts were used. Acute shunt failure occurred in 2 cases (one case with 3-mm and one case with 6-mm graft). Both received perioperative heparin, and reoperations for contralateral MBT shunts were performed with satisfactory results. The 30-day mortality was 2.4% (1/42) in this study. The increase in oxygen saturation after the procedures was significant (P < 0.001) and there was an increasing trend of early postoperative O_2 saturation difference for patients with lower preoperative O_2 saturation.

In conclusion, the MBT shunt is an acceptable alternative palliative procedure for patients requiring a systemic-pulmonary shunt. This report showed an early morbidity and mortality rate which were comparable to that of other studies..

Key words: *Palliative shunt, cyanotic congenital heart disease*

บทคัดย่อ:

การผ่าตัด Modified Blalock-Taussig shunt เป็นการผ่าตัดรักษาแบบประคับประคองในผู้ป่วยหัวใจพิการแต่กำเนิดชนิดเขียว ช่วยลดปัญหาเรื่องเลือดไปเลี้ยงปอดน้อย ซึ่งนับเป็นการผ่าตัดที่นิยมทำกันมากในผู้ป่วยดังกล่าวในหลายๆ สถาบัน

ในโรงพยาบาลสงขลานครินทร์ ตั้งแต่เดือนกรกฎาคม พ.ศ. 2544 ถึง มิถุนายน พ.ศ. 2546 มีผู้ป่วย 42 ราย ได้รับการผ่าตัดโดยวิธีดังกล่าว (ชาย 21 ราย และหญิง 21 ราย) อายุตั้งแต่ 3 วัน ถึง 13 ปี (มัธยฐาน = 12 เดือน), น้ำหนักผู้ป่วยตั้งแต่ 1.9 ถึง 27 กิโลกรัม (มัธยฐาน = 8.2 กิโลกรัม), โดยส่วนใหญ่เป็นโรค Tetralogy of Fallot, ทั้งหมดใช้หลอดเลือดเทียม ขนาดตั้งแต่ 3-6 มิลลิเมตร ผลการรักษาพบ ภาวะหลอดเลือดเทียมอุดตันเฉียบพลันหลังผ่าตัด 2 ราย, อัตราการเสียชีวิตใน 30 วันแรกคิดเป็น ร้อยละ 2.4 ผลการศึกษาพบว่าผู้ป่วยทุกรายมีค่าออกซิเจนในเลือดเพิ่มขึ้นอย่างมีนัยสำคัญทางสถิติ (P < 0.001) เมื่อเทียบกับค่าออกซิเจนก่อนการผ่าตัด โดยเฉพาะผู้ป่วยที่มีค่าออกซิเจนในเลือดต่ำมากก่อนการผ่าตัด

การผ่าตัดแบบประคับประคองในผู้ป่วยหัวใจพิการแต่กำเนิดชนิดเขียว โดยวิธี Modified Blalock-Taussig shunt เป็นการผ่าตัดที่ได้ผลดีมาก และเพิ่มเลือดไปปอดได้อย่างเหมาะสมมีอัตราการเสียชีวิตภายหลังการผ่าตัดต่ำ ซึ่งเหมาะสมในการรักษาผู้ป่วยภาวะดังกล่าว

คำสำคัญ: *การผ่าตัดประคับประคอง, โรคหัวใจพิการแต่กำเนิดชนิดเขียว*

Introduction

The original Blalock-Taussig shunt was described in 1945 and represented the first direct surgical procedure for the palliative treatment of cyanotic congenital heart disease.[1] It remains the shunt of choice, particularly in neonates who are unsuitable for a total corrective operation.[2-7] Systemic-pulmonary polytetrafluoroethylene (PTFE) grafts, like the modified Blalock-Taussig (MBT) shunts, are of major importance in the alternative management of infants and children with various congenital heart diseases.[8] The modified Blalock-Taussig shunt uses a polytetrafluoroethylene (PTFE) interposition graft between the subclavian artery and the pulmonary artery, and is believed to reduce many of the disadvantages of the so-called classic Blalock-Taussig shunt. The MBT shunt has been adopted by most institutions as the palliative shunt procedure of choice.[2, 8-9] The MBT shunt's main advantage is that it provides the ability to create pressure-and volume-controlled pulmonary perfusion with preservation of distal flow in the subclavian artery.[3, 9-12] The palliative use of the MBT shunt is even greater in developing countries because of lack or limitation of resources, late presentation, and referral of patients. We reviewed our experience of the modified Blalock-Taussig shunt in Songklanagarind Hospital to identify the immediate outcomes after surgery.

Materials and methods

The medical records of patients (n = 42) who underwent a modified Blalock-Taussig (MBT) shunt procedure at Songklanagarind Hospital from July 2001 to June 2003 were reviewed. The modified Blalock-Taussig shunt was performed in patients with cyanotic heart diseases and clinical evidence of cyanotic spells, low oxygen saturation (<85%), or low body weight and small size of pulmonary artery, that were not suitable for total correction. The MBT shunt was performed using a standard posterolateral thoracotomy in the fourth intercostal space. Minimal dissection of the subclavian and pulmonary arteries was performed to allow adequate exposure for partial-occlusive clamping as proximal as possible to the widest part of the anastomosis. Heparin was administered at a dose of 1 mg/kg intravenously before clamping the subclavian artery. A polytetrafluoroethylene (PTFE) tube graft was chosen according to the body weight of the patients, and the MBT shunt was constructed by using continuous 7/0 polypropylene suturing. The diameter of PTFE shunt for surgery was 3 mm in less than 2.5 kg in body weight, 3.5 mm in 2.5-3 kg, 4 mm in 3-5 kg, 5 mm in 5-10 kg, and 6 mm in 10-25 kg.

Baseline characteristics of patients (age, diagnosis, and body weight) and perioperative variables (side of shunt, diameter of graft, postoperative heparin, and inotropic drug administration) were reviewed. Postoperative shunt patency was assessed by detection of a shunt murmur and/or echocardiography. In some cases, postoperative heparin (10 units/kg/hr) was infused in some patients with a small pulmonary artery, and small conduits ≤4 mm). Dopamine (5-7μg/kg min) was used to maintain systolic pressure over 80 mmHg to augment the shunt flowing. The criteria used to define early shunt failure were (1) complete occlusion during the hospitalization period, and (2) needing to return to the operating room for a second shunt operation. Preoperative and postoperative oxygen saturation room air were recorded for all patients.

The statistical analyses were carried out using the STATA statistical package (Version 7.0; College station, TX). Parametric methods were used when appropriate and non-parametric methods otherwise. Quantitative variables that approximated a normal distribution were reported as the mean plus and minus the standard error of the mean, and those that did not approximate a normal distribution as median and interquartile range. The preoperative and postoperative oxygen saturation was compared using the Wilcoxon matched pairs signed-rank test. Trends of oxygen saturation before and after performed modified Blalock-Taussig shunt were analyzed using the standard regression analysis for transformed continuous normalized data. Statistical significance was attained when P-value was < 0.05.

Table 1 Patients' profiles, characteristics, and diagnostics

Diagnosis	Age (months)		Body weight (kg)	
	Median, range	P_{25-75}	Median, range	P_{25-75}
TOF*(n=25)	24 (0.5-156)	(12-84)	10 (2.9-27)	(7.1-14.9)
PA, VSD**(n=7)	6 (0.4-24)	(6-6)	6.6 (3-10.1)	(6.6-6.6)
DORV with PS/PA***(n=4)	21 (1-72)	-	7.5 (1.9-24.4)	-
Tricuspid atresia (n=3)	1 (1-5)	-	3.6 (2.6-5.4)	-
Complex univentricular heart (n=3)	1 (1-108)	-	2.5 (2.2-19.7)	-
Total (n=42)	**12 (0.4-156)**	**6-36**	**8.2 (1.9-27)**	**(5.5-10.8)**

*Tetralogy of Fallot **Pulmonary atresia and ventricular septal defect,
***Double outlet right ventricle with pulmonary stenosis or pulmonary atresia

Results

Preoperative status

The median age of the patients was 12 months (range 3 days to 156 months, P_{25-75}= 6-36). Their median weight was 8.2 kg (range 1.9 to 27 kg, P_{25-75}= 5.5-10.8). Four patients (9.5%) were neonates (<1 month of age).

The diagnoses were grouped into five categories (Table 1). Twenty-five patients (59.5%) were diagnosed with tetralogy of Fallot. By echocardiographic evaluation, the mean size of the pulmonary arterial branch was 6.1 ± 2.0 mm. The mean size of the subclavian artery was 5.3 ± 1.8 mm.

Operative details

The distribution of the size of the PTFE grafts is shown in Figure 1. Thirty-five (83.3%) patients had right-side shunts and seven had left-side shunts. Twenty-three patients (54.8%) had a primary PTFE tube graft size of 5 mm, 12 patients (28.6%) had a tube graft size of 4 mm; 5 patients had size 6 mm; 1 patient each had sizes 3.5 mm and 3 mm.

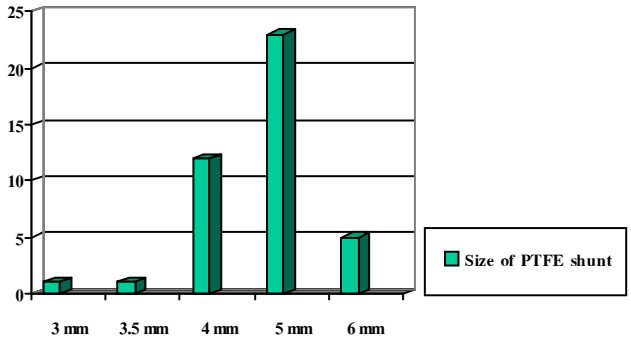

Figure 1 The distribution of sizes of PTFE graft used in this study

Table 2 Preoperative and postoperative oxygen saturation (n = 42)

Variable	Min	P_{25}	Median	P_{75}	Max	N.
Pre op. O_2sat	40	68	74.5	80	0	42
Post op. O_2sat	65	82	85	87	96	42

WILCOXON SIGNED - RANK TEST
Ho: Pre-Op O_2 sat = Post-Op O_2 sat
Z = -5.641 P > lZl = 0.0000

Oxygen saturation

The median postoperative O_2 saturation [85, P_{25-75} (82, 87)] was significantly higher than the preoperative O_2 saturation [74.5, P_{25-75} (68,80)] (Table 2). (Wilcoxon Signed - Rank test P > lZl = 0.0000)

Linear regression of preoperative O_2 saturation (pre op. O_2sat) and difference of post and preoperative O_2 saturation (ΔO_2sat) are shown in Table 3. Both independent and dependent variables were transformed to meet regression assumptions and regression diagnostic tests. The final model of equation of difference of preoperative and postoperative O_2 saturation was established and shown in Table 3. The trends of oxygen saturation before and after the modified Blalock-Taussig shunt procedure are shown in Figure 2. There is an increasing trend of early postoperative O_2sat difference for patients with lower preoperative O_2sat.

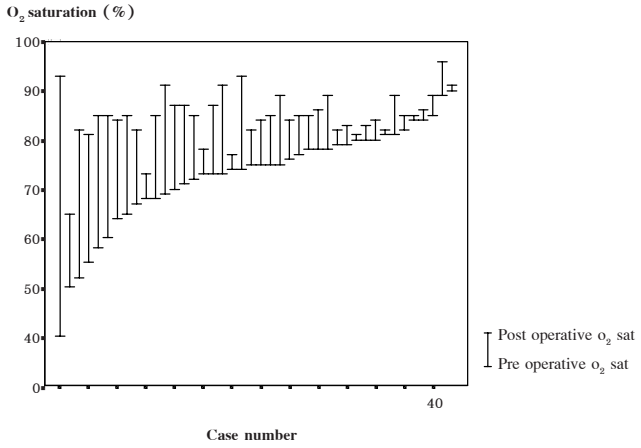

Figure 2 Relationship of preoperative O_2 saturation and difference of post & preoperative O_2 saturations

Early shunt failure

Acute shunt thrombosis occurred in 2 cases. The first was a neonate, weight 2200 g with a 3 mm diameter pulmonary branch with univentricular heart repaired with a 3-mm graft. The shunt became blocked 24 hours after the procedure. The second patient, age 6 years, weight 24 kg, with a 9 mm diameter pulmonary branch was double outlet right ventricle (DORV) with pulmonary stenosis (PS) repaired with a 6-mm graft. Echocardiography revealed no shunt flowing within the first week after surgery. Both patients were reoperated on and contralateral MBT shunts were performed, following which

both had an uneventful recovery. Postoperative echocardiography demonstrated shunt patency in both patients. Six (14.3%) patients needed postoperative inotropic drug support to maintain systolic blood pressure over 80 mmHg for augmentation of forward flow through the prosthetic shunt and postoperative heparin (10 units/kg/hr) was infused in 17 (40.5%) patients.

Early mortality (within 30 days)

There were no operative deaths. Of the forty-two patients, 30-day mortality occurred in only one case (2.4%). She had been diagnosed with TOF with poor biventricular function. Twelve hours after the MBT shunt had been performed she developed metabolic acidosis with a clinical manifestation of low cardiac output and died. An echocardiography revealed poor biventricular function but good functioning of the shunt.

Overall mortality was 4.7% (2/42). Another patient died 1 year after surgery of a non-cardiac related cause.

Discussion

Palliative shunt surgery for cyanotic congenital heart disease in our institution uses the modified Blalock-Taussig (MBT) shunt. An ideal shunt should (1) provide adequate pulmonary blood flow, (2) allow shunt flow to increase with growth, (3) be reliable in its early and late flow characteristics, (4) provide bilateral pulmonary arterial flow, (5) avoid distortion of the pulmonary arterial anatomy, and (6) be simple to construct and take down for total corrective procedure.[3, 6] We chose the modified rather than the classical shunt in all our patients for the following reasons: technical ease, a wide proximal and distal anastomosis guaranteed, and preservation of the distal subclavian flow, thus eliminating the danger of forearm ischemia.[8-11] More than of 50% of our patients were diagnosed with tetralogy of Fallot, a condition in which the management is controversial.[13] Total correction of cyanotic heart disease is increasingly replacing two-stage procedures in most medical centers, although there are still those who advocate early palliation. In our recently established unit, a two-stage procedure is the safer option.

Table 3 Results of linear regression analysis with transformed preoperative O_2sat (pre.op O_2sat^t) as independent variable and transformed "Difference of preoperative and postoperative O_2 saturation (ΔO_2sat^t)" as dependent variable

Source	ss	df	MS			
				Number of obs	=	42
				F (1 , 40)	=	96.05
Model	105.369213	1	105.369213	Prob > F	=	0.0000
Residual	43.8796851	40	1.09699213	R-squared	=	0.7060
				Adj R-squared	=	0.6986
Total	**149.248898**	**41**	**3.64021703**	Root MSE	=	1.0474

ΔO_2sat^t	Coef.	Std. Err.	t	P> |t|	[95% Conf. Interval]	
pre.op O_2sat^t	-.000455	.0000464	-9.80	0.000	-.0005488	.0003612
_cons	9.310301	.5971085	15.59	0.000	8.1035	10.5171

and final model is: O_2 saturation different

$= e^{1.7737}$ In [-0.000455 $(PREOP_{O_2}sat)^{2.19277}$+9.310301]

The median patients' age in this study was higher than patients described in other reports,[3-7, 14-16] which may be rlelated to the fact that there are only a few pediatric cardiologists working in southern Thailand. Pediatricians should increase their awareness of congenital heart disease in children in order to detect and refer them for early correction before clinical deterioration occurs.

The overall incidence of early shunt failure in the pediatric group in Thailand is not known. Two patients (4.7%) of our series suffered shunt thrombosis. This complication may have been due to the small size of the pulmonary artery and/or competitive flow from the patent ductus arteriosus (PDA) because they occurred early in our experience, and the other was a small graft (3 mm) with a large PDA. We now advocate ligating a large functioning ductus in neonates after shunt construction since the sudden increase in pulmonary flow and competitive flow between the shunt and the ductus arteriosus seems to induce pulmonary edema and early shunt thrombosis. This method may prevent early shunt failure and/or postoperative pulmonary edema.[12, 16] Two of our patients had shunt thrombosis but only one of them had a 3-mm shunt, so shunt size alone was not the risk determinant of shunt thrombosis. We speculate that postoperative shunt thrombosis is more likely related to intraoperative technical difficulties or extremely small pulmonary artery size. Risk factors for determining patency of the MBT shunt are still controversial and need further study.[15-16] Our study found that the increase in oxygen saturation after the procedures was significant and is inversely related to preoperation O_2 saturation. The relation of preoperative O_2 saturation and difference of post- and preoperative O_2 saturation are shown in Figure 2. Further studies relating risk factors to outcome are required. Reported complications of the MBT shunt are thrombosis, infection, and pseudoaneurysm of the graft.[7, 15-16] None of our patients had graft-related infections. An unusual and infrequently reported complication of the PTFE graft is a perigraft seroma.[17-18] One patient in our series came down with this complication and was treated by wrapping the PTFE graft with a Dacron patch and oxidized regenerated cellulose.[18-19] This method gave an excellent result in the immediate and midterm period. Our experience confirms that the MBT shunt provides satisfactory early palliation: the early occlusion rate is low and comparable to other series, excessive pulmonary blood flow is extremely rare, complications are infrequent (serous leakage and seroma formation have been reported but are unusual), and take-down of the shunt at the time of complete repair is easy, particularly when a right-sided MBT shunt has been used.

Our study again confirms the excellent early results achieved with this procedure. There were no operative mortalities and the 30-day mortality was only 2.4%, which is comparable to those in other series.[3-4, 14-15] Overall mortality in this series was 2/42 (4.7%).

Conclusion

This review highlights some of the palliative shunt procedures in pediatric cardiac surgery in developing cardiac center. We hope that by pointing out these problems and the possible solutions will result in improvement of morbidity and mortality. The MBT shunt is an excellent alternative palliative procedure for patients requiring a systemic-pulmonary shunt. This series showed an early morbidity and mortality rate which were comparable to that of other studies.

Acknowledgement

The authors wish to thank Dr. Vorapong Chowchuvech for his help with the statistical analysis.

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