SURGICAL RESULTS OF ARTERIAL SWITCH OPERATION FOR TAUSSIG-BING ANOMALY AT VIETNAM NATIONAL CHILDREN'S HOSPITAL

Nguyen Tuan Mai, Nguyen Ly Thinh Truong, Et al, Viet Nam
National children's Hospital

Ho Chi Minh City, November 16, 2023

Historical Perspectives

Igor E. Konstantinov, MD, PhD

Taussig-Bing Anomaly

From Original Description to the Current Era

Taussig-Bing anomaly is a rare congenital heart malformation that was first described in 1949 by Helen B. Taussig (1898–1986) and Richard J. Bing (1909–). Although substantial improvement has since been achieved in surgical results of the repair of the anomaly, management of the Taussig-Bing anomaly remains challenging. A history of the original description of the anomaly, the life stories of the individuals who first described it, and the current outcomes of its surgical management are reviewed herein. ***(Tex Heart Inst J 2009;36(6):580-5)***

How is one to judge one's past? Many would rate it by honors received, societies elected to, or fortune amassed. I judge my life by the degree of happiness I have received from my work. . . .
— Dr. Richard J. Bing[1]

A heart malformation known as Taussig-Bing anomaly (also called Taussig-Bing syndrome, heart, or malformation) consists of transposition of the aorta to the right ventricle and malposition of the pulmonary artery with subpulmonary ventricular septal defect (VSD) (Fig. 1). Although this cardiac malformation was first described 60 years ago,[1] its management still presents a challenge to cardiologists and cardiac surgeons. A history of the original description of the anomaly, life stories of the individuals behind the description of the anomaly, and the current outcomes of its surgical management are reviewed herein.

The anomaly bears the names of 2 outstanding physicians, Dr. Helen Taussig and Dr. Richard Bing, who worked together at The Johns Hopkins Hospital in Baltimore.

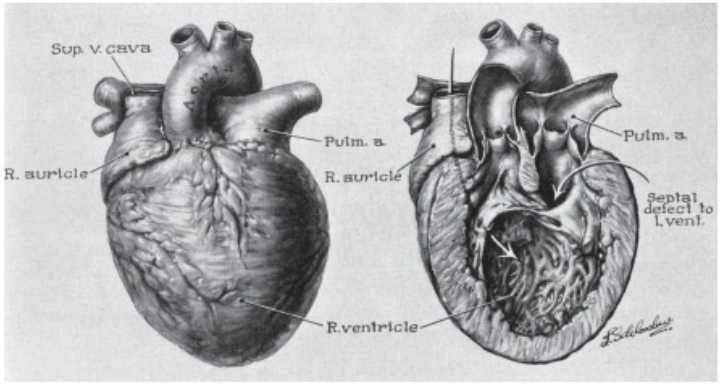


Fig. 1 *Original drawing of the heart shows the size and position of the aorta and pulmonary artery and their relation to the septal defect. Reprinted from Taussig HB, Bing RJ. Complete transposition of the aorta and a levoposition of the pulmonary artery. Am Heart J 1949;37(4):551-9, with permission from Elsevier.*

- Definition: Taussig-Bing anomaly include:DORV, a large subpulmonary VSD, aorta arising completely from the RV, and at least 50% of PA arising from the RV
- with a bilateral conus (pulmonary– mitral continuity is absent, subaortic RVOT obstruction is found in 50% to 60%, RV hypertrophy .
- Aortic arch obstruction is common and present in more than 50% of cases

Fig. 2 *Helen Brooke Taussig (1898–1986). Courtesy of An N. Redington, Hospital for Sick Children, Toronto, Canada.*

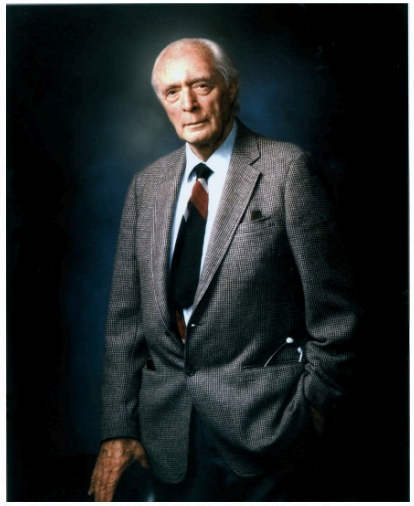


Fig. 3 *Richard John Bing (1909–). Courtesy of Richard J. Bing.*

Late outcomes after arterial switch operation for Taussig-Bing anomaly

Mathieu Vergnat, MD,[a] Alban-Elouen Baruteau, MD,[a,b] Lucile Houyel, MD,[a] Mohamedou Ly, MD,[a] Régine Roussin, MD,[a] André Capderou, MD, PhD,[b,c] Virginie Lambert, MD, PhD,[a,c] and Emre Belli, MD[a]

Objective: To assess the long-term results of the arterial switch operation (ASO) for Taussig-Bing Anomaly (TBA) and identify risk factors affecting outcomes.

Methods: Retrospective review and late follow-up was performed for all TBA patients from 1997 to 2010 (follow-up >3 years). Selection criteria included the absence of mitro-pulmonary continuity.

Results: Sixty-nine children underwent ASO at a median age of 24 days (interquartile range [IR] 11-125), with concomitant repair of aortic arch obstruction in 26 (37.7%). Complex coronary anatomy (n = 38; 55.0%) was common. Nine (13.0%) patients had staged repair. Hospital mortality was 5.8% (95% confidence interval [CI], 1.6%-14.2%; n = 4). Median follow-up was 11.2 years (IR 7.2-13.8). Subsequent mortality was confined to the first postoperative year (n = 5, 86% [95% CI, 78%-95%]), 1-, and 10-year survival). Overall mortality was related to coronary pattern (Yacoub types C and E vs A and D, multivariate, hazard ratio [HR] 12.2 [95% CI, 1.2-122.1], $P = .03$). At latest follow-up, 96% of the survivors are asymptomatic, with normal ventricular function. Cumulative incidence of reintervention at 10 years was 53% (95% CI, 28%-77%). Concomitant aortic arch obstruction was a predictor of reintervention (multivariate, HR 2.9 [95% CI, 1.1-7.4], $P = .03$). No mortality occurred upon reinterventions.

Conclusions: In the largest series to date of ASO for TBA, mortality is confined to the first postoperative year, and related to coronary artery pattern. Beyond the first year, needed reinterventions are frequent, but with sustained functional status and no mortality over >10 years follow-up. Aortic arch obstruction is the main predictor for reintervention. Despite a significant rate of early events, favorable long-term outcomes argue for use of the ASO in TBA patients. (J Thorac Cardiovasc Surg 2015;149:1124-32)

Primary Arterial Switch Operation as a Strategy for Total Correction of Taussig–Bing Anomaly

A 21-Year Experience

Denise A. Hayes, MD; Sophie Jones, MD; Jan M. Quaegebeur, MD, PhD; Marc E. Richmond, MD, MS; Howard F. Andrews, PhD; Julie S. Glickstein, MD; Jonathan M. Chen, MD; Emile Bacha, MD; Leonardo Liberman, MD

Background—Studies of the arterial switch operation for Taussig–Bing anomaly demonstrate significant rates of reintervention and mortality, particularly after initial palliation to delay complete repair. We aimed to describe the long-term outcomes of our 21-year practice of single-stage arterial switch operation for all patients with Taussig–Bing anomaly.

Methods and Results—A retrospective study was performed, and 43 patients with Taussig–Bing anomaly were identified between 1990 and 2011. Median age at arterial switch operation was 7 (range, 2–192) days, and median operative weight was 3.2 (1.4–6.2) kg. Aortic arch obstruction was present in 30 patients (70%). Hospital mortality was 7% (n=3). Follow-up was available for 37 hospital survivors at a mean of 8.1 (±6.3) years. Late mortality was 2% (n=1). At follow-up, all patients were in New York Heart Association functional class I. Freedom from transcatheter or surgical reintervention was 73% at 1 year, 64% at 5 years, and 60% at 10 years. Eleven patients underwent 13 catheter reinterventions on the pulmonary arteries (n=8) or aortic arch (n=5). Seven patients underwent 11 reoperations, including relief of right ventricular outflow tract obstruction (n=5), pulmonary arterioplasty (n=3), recoarctation repair (n=2), and tricuspid valve repair (n=1). By multivariate analysis, a preoperative aortic valve annulus z score of ≤−2.5 was associated with reintervention (hazard ratio, 7.66 [95% confidence interval, 1.29–45.6], P=0.03).

Conclusions—Although reintervention is common, primary correction of Taussig–Bing anomaly with arterial switch operation can be achieved in all patients with low mortality and good long-term outcomes. (***Circulation*. 2013;128[suppl 1]:S194-S198.**)

- ASO with VSD closure has become the best choice for Taussig-Bing anomaly.
- One-stage repair in Taussig-Bing anomaly with AAO might provide better outcomes at experienced centers (the lengthy surgery includes ASO, aortic arch repair with VSD closure, compounded by complex coronary anatomy, presence of sub-aortic obstruction which can be complex, can be challenging)
- The overall survival rate of ASO for TBA is typically excellent and varies, early mortality according to recent published literature, is from 5.3% to 11%. 85% survival rate at 10 years

ATCSA2023
Ho Chi Minh city, Vietnam

Outcomes of the Arterial Switch Operation in Patients With Taussig-Bing Anomaly

Natalie Soszyn, BMedSci, Tyson A. Fricke, BMedSci, Gavin R. Wheaton, MBBS, James M. Ramsay, MBBS, Yves d'Udekem, MD, PhD, Christian P. Brizard, MD, and Igor E. Konstantinov, MD, PhD

Department of Cardiac Surgery, Royal Children's Hospital, Department of Paediatrics, The University of Melbourne, and the Murdoch Children's Research Institute, Melbourne; Department of Cardiology, Women's and Children's Hospital, Adelaide; and Department of Cardiology, Princess Margaret Hospital for Children, Perth, Australia

Background. The arterial switch operation (ASO) is associated with poorer outcomes in patients with Taussig-Bing anomaly (TBA) compared with transposition of the great arteries (TGA). We describe the outcomes after ASO in patients with TBA at a single institution.

Methods. Between 1983 and 2009, 57 patients with TBA underwent the ASO at the Royal Children's Hospital in Melbourne.

Results. Hospital mortality was 5.3% (3 of 57). Larger weight at operation ($p = 0.015$), pulmonary artery banding prior to ASO ($p = 0.049$) and concurrent pulmonary artery banding ($p = 0.049$) were risk factors of early death. Actuarial survival was 94% at 15 years. Follow-up was 84% complete with a mean follow-up of 9.8 ± 6.7 years (range, 6 days to 19.1 years). There was no late mortality. Reintervention was required in 24.4% (11 of 45). Longer cross-clamp time ($p = 0.027$) was a risk factor for reintervention. Freedom from reintervention was 75.3% at 15 years. After ASO, 2.2% (1 of 45) presented with sub-neopulmonary obstruction and 13.3% (6 of 45) had moderate or more neoaortic insufficiency (neo-AI). Surgery prior to ASO was a risk factor for sub-neopulmonary obstruction ($p = 0.049$) and moderate or more neo-AI ($p = 0.016$). Freedom from moderate or more neo-AI was 91.1% at 10 years.

Conclusions. Early mortality has improved over time with no mortality occurring in the last decade. Although patients are doing well on late follow-up, many patients require reintervention and show progression of neo-AI. Close long-term follow-up is warranted as patients are likely to require further reintervention in the second decade after TBA repair.

(Ann Thorac Surg 2011;92:673–9)

Arterial switch operation in patients with Taussig–Bing anomaly – influence of staged repair and coronary anatomy on outcome☆

Massimo Griselli, Simon P. McGuirk, Chung-Sen Ko, Andrew J.B. Clarke, David J. Barron, William J. Brawn*

Department of Paediatric Cardiac Surgery, Diana, Princess of Wales Children's Hospital, Steelhouse Lane, Birmingham B4 6NH, United Kingdom

Received 21 August 2006; received in revised form 13 November 2006; accepted 20 November 2006; Available online 12 January 2007

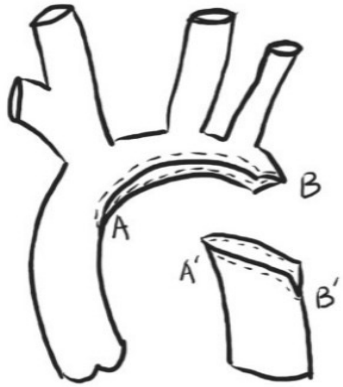
Abstract

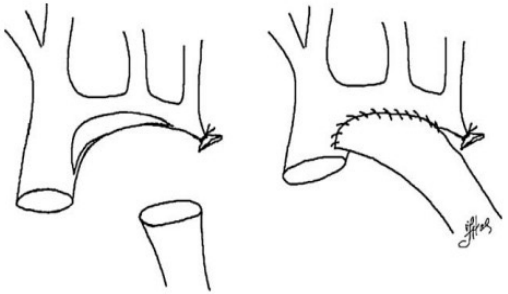
Objective: This study evaluated the results of arterial switch operation and closure of ventricular defects (ASO + VSDc) for double outlet right ventricle with sub-pulmonary ventricular septal defect (Taussig–Bing anomaly). **Methods:** Between 1988 and 2003, 33 patients (25 male, 76%) with Taussig–Bing anomaly underwent ASO + VSDc (median age 39 days, 1 day–2.1 years). The relationship of the great arteries was antero-posterior (Group I, $n = 19$) or side-by-side (Group II, $n = 14$). Coronary anatomy (Yacoub's classification) was exclusively type A or D in Group I and predominantly type D or E in Group II (64%). Incidence of sub-aortic obstruction and aortic arch obstruction was similar in Group I and II (37% vs 57%, $p = 0.25$ and 84% vs 79%, $p = 0.98$, respectively). Twenty-five patients (76%) had one-stage total correction. Risk factors were analysed using multivariable analysis. Follow-up was complete (median interval of 6.2 years; range, 0.6–15.2 years). **Results:** There were three early (9%) and one late death. Actuarial survival was 88 ± 6% at 1 and 10 years. There were two early and four late re-operations. Freedom from re-operation was 90 ± 5% and 75 ± 9% at 1 and 10 years. Four patients required cardiological re-interventions. Freedom from re-intervention at 5 and 10 years was 79 ± 9%. On multivariable analysis, complex coronary anatomy (type B and C) was a risk for early mortality ($p < 0.001$) but all other anatomical variables and staged strategy did not influence early or actuarial survival. **Conclusions:** The ASO + VSDc approach can be applied to Taussig–Bing anomaly with acceptable mortality and morbidity and it is the procedure of choice at our institution. Anatomical variables did not influence outcomes with this strategy. A staged strategy is still appropriate in complex cases.

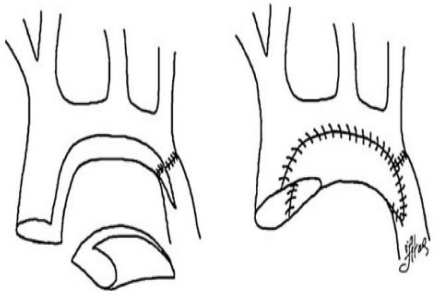
- Risk factors of early mortality: increased weight at operation, PAB prior to ASO, concurrent PAB, coronary artery anatomy
- Risk factors of re-operation or re-intervention: side by side great vessels, subaortic obstruction and aortic arch abnormalities.

Methods

- Retrospective study, from 2/2010 to 10/2021 at Vietnam National Children's Hospital
- Patients: There were 99 patients with Taussig-Bing anomaly with or without arch obstruction which were performed ASO
- Single-stage repair for ASO with aortic arch reconstruction: (Avoid DHCA, using regional cerebral perfusion combined with NIRS for cerebral oxygenation monitoring, Aortic arch reconstruction by extensive dissection, extended end-to-end/side anastomosis, using autologous native tissue)

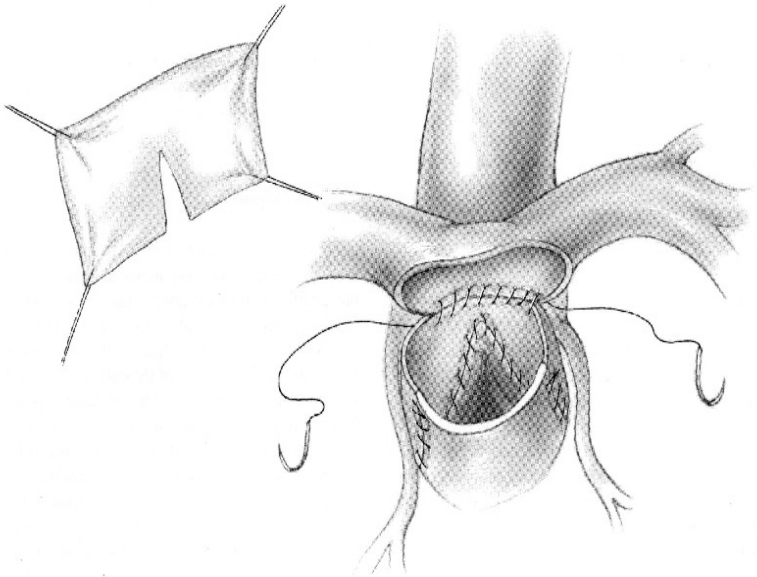






Methods

- Lecompte maneuver in all cases, relocated the distal neo-pulmonary to the right PA for side-by-side great arteries relationship
- Always inspect the sub-aortic RVOT muscle and resectior
- Right atrial approach for VSD closure
- Coronary re-implantation by closed technique, minimize the trapdoor
- Neo-PA reconstruction: Fresh autologous pericardial patch: The height of the patch is crucial to avoid left and right PA torsion



Results

Demographic and Anatomic Characteristics	n (%), mean (SD), or median (IQR)
Male/Female	78/21
Age at surgery (days)	55(83)
Weight at surgery (kg)	3,7(1,25)
Prenatal diagnosis	13 (13,1%)
Pre-operation ventilator	27(27,3%)
Coronary patterns (Leiden classification)	
1L2RCx	21(21,2%)
1LCx2R	32 (32,3%)
1LCxR	6 (6,1%)
1LR2Cx	5 (5,1%)
2LCxR	21(21,2%)
1R2LCx	12 (12,1%)
1RCx2L	1(1%)
1Cx2RL	1(1%)
Intramural coronary artery	7 (7,07%)
Aortic arch obstruction	52(52,5%)
Coarctation of aorta/ Hypoplastic aortic arch	46(46,4%)
Interrupted aortic arch	6(6,1%)
Native PA–aorta diameter ratio ≥2	78(78,8%)
Commissural malalignment	23(23,2%)
Subaortic RVOTO	84(84,8%)

Results

Operative data	n (%), mean (SD), or median (IQR)
Operating time (min)	330(90)
Bypass time (min)	214(69)
Ao cross clamp time (min)	158(39)
Regional cerebral perfusion time (min)	26(21,5)
Additional operative procedures with ASO + VSD closure	
Concomitant Aortic arch repair	50(50,5%)
Coarctation repair and PAB Previous procedures	2(2,1%)
LVOT (subneoaortic) resection	6(6,1%)
RVOT (subneopulmonary) resection	84(84,8%)
Native pulmonary root reduction	44(44,4%)
Pulmonary bifurcation translation to the right PA	44(44,4%)
Unroofing the intramural coronary artery	7(7,1%)
Concomitant PA banding (leave VSD)	8(8,1%)

Results

Early Postoperative Data	n (%), mean (SD), or median (IQR)
Mechanical ventilation time (hours)	90(52,5)
Length of postoperative hospital stay (days)	21(14)
Delayed chest closure or reopening	32(32,3%)
Wound infection	15(15,2%)
Sternal infection	2(2,1%)
Respiratory infection	23(23,2%)
Sepsis infection	8(8,1%)
Diaphragm paralysis	2(2,1%)
Peritoneal dialysis	27(27,3%)
Neurological abnormalities or seizures	3(3,1%)
ECMO	1(1%)
Exploration for bleeding	1(1%)
Post-operative Arrhythmia	45(45,5%)
Sinus node dysfunction requiring permanent pacemaker	1(1%)

Results

❖Early mortality : 13(13,1%)

✓6 patients died of hospital-acquired infection
✓2 patients died of myocardial ischemia
✓5 patients died related to suspected mixed cardiac failure or respiratory failure

❖Late death : 2(2,1%)

❖15(15,2%) patients needed 19 Cardiac reoperation:

✓6 patients had VSD closure and debanding of the PA

✓3 patients needed 5 reoperations for RVOT obstruction

✓3 patients needed reoperations for recurrent coarctation and ascending aorta stenosis

✓1 patient required pacemaker implantation due to sinus node dysfunction

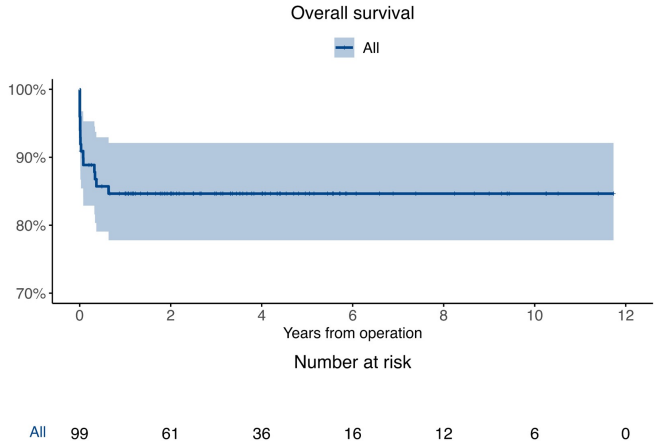
✓2 patients needed reoperations for LVOT obstruction

✓4 patients needed put BT shunt

❖Catheter reintervention : 4(4%)

✓2 patients with Blalock-Taussig shunt occlusion

✓2 patients with balloon angioplasty for recurrent coarctation



Results

- Multivariate Cox regression showed secondary aortic cross-clamping (HR 4,42, 95% CI, 1,18–16,54; p = 0,028) was a risk factor for overall mortality

Results

- Median follow-up of 3.8 years
- 5 patients was lost follow up
- Aortic regurgitation: no 51(64,6%), trivial-mild 28(35,4%), moderate and severe (no patients)
- Postoperative echocardiography at the last follow-up for the patients required arch repair: PG across the arch: 9,5(3,5) mmHg

Conclusions

- The surgical results of Taussig-Bing anomaly were satisfactory at Vietnam national children's Hospital
- Performing extensive septoparietal trabeculation division might reduce the reintervention rate for RVOTO

THANK YOU!