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CURRENT TOPICS REVIEW ARTICLE

Current status of cardiovascular surgery in Japan, 2015 and 2016: a report based on the Japan Cardiovascular Surgery Database. 1—congenital heart surgery

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Abstract

Objectives We analyzed the mortality and morbidity of congenital heart surgery in Japan by using Japan Cardiovascular Surgery Database (JCVSD).

Methods The data on congenital heart surgery performed between January 2015 and December 2016 were obtained from JCVSD. From the data obtained, the most frequent 20 procedures were selected, and the mortalities and major morbidities were analyzed. In addition, the institutions were classified into three groups according to the number of cardiopulmonary cases for a year, and the distribution of the major operations was calculated.

Results The mortality of ASD repair and VSD repair was under 1% and the mortality of TOF repair, complete AVSD repair, Rastelli operation, CoA complex repair, bidirectional Glenn and TCPC was 2–3%. The mortality of Norwood procedure and TAPVC repair were over 10%. These difficult operations were mainly performed at relatively high-volume institutions.

Conclusion Using the data from JCVSD, the national data of congenital heart surgery, including postoperative complications, were analyzed. Neonatal surgery still has considerable complication rates and further improvement is desired. In addition, it was shown that complicated operations tended to be performed at large volume institutions.

Keywords Japan Cardiovascular Surgery Database (JCVSD) · Congenital heart surgery

Abbreviations

VSD	Ventricular septal defect
ASD	Atrial septal defect
PDA	Patent ductus arteriosus
TCPC	Total cavopulmonary connection
TOF	Tetralogy of Fallot
CoA	Coarctation of the aorta
TAPVC	Total anomalous pulmonary venous connection
AVSD	Atrioventricular septal defect
PA	Pulmonary artery
PAVSD	Pulmonary atresia and ventricular septal defect

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Introduction

Since the Congenital Section of Japan Cardiovascular Surgery Database (JCVSD) began registration in 2008, the number of participating institutions has increased to 120 and covers almost all the institutions in the whole country.

In this paper, we analyzed the mortality and major complications of 20 surgical procedures of congenital heart disease performed in Japan in 2015 and 2016.

In addition, the institutions were classified into three groups according to the number of cardiopulmonary cases per year, and the distribution of the major operations was calculated.

Methods

From January 2015 to December 2016, data on congenital heart surgeries performed in Japan were extracted from JCVSD and analyzed. If multiple surgical procedures are performed in a single surgical operation, a surgical operation No. 1 (the most relevant operation technique) is selected and there is no double count.

A total of 20 procedures, including VSD repair, ASD repair, PDA closure, systemic to pulmonary shunt, pulmonary artery banding (PA banding), TCPC (Fontan), TOF repair, Bidirectional Glenn, CoA repair (including + concomitant PA banding), TAPVC repair, arterial switch operation, arterial switch operation + VSD closure, complete AVSD repair, CoA complex repair (including IAA repair/aortic arch repair), PA plasty, pulmonary valve replacement, Rastelli operation/PAVSD repair, mitral valvuloplasty, Norwood procedure (including Norwood-Glenn) and pulmonary venous stenosis repair, were selected. PA banding performed with the diagnosis with HLHS was excluded, because in these cases, PA banding was almost always bilateral PA banding, not main PA banding.

In the previous report [1], we adopted 90 days' death from the operation date; however, we selected '90 days' death or in-hospital death' as the definition of surgical death because in congenital and pediatric cardiac surgery, the number of deaths after 90 days is not ignorable [2]. We showed both 90-days mortality and 90-days or in-hospital mortality on the table so that they can be compared to the previous report.

Major complications include unplanned cardiac reoperation (exclusive of reoperation for bleeding), arrhythmia requiring permanent pacemaker implantation, chylothorax, wound infection (deep wound infection or mediastinitis), phrenic nerve paralysis, and neurological deficit persisting at discharge.

In addition, the institutions were classified into three groups according to the number of cardiopulmonary bypass cases (CPB cases) per year (under 50 CPB cases/year, over 50 CPB cases/year, over 100 CPB cases/year), and the distribution of the major operations (PDA closure, ASD repair, VSD repair, TOF repair, systemic to pulmonary shunt, complete AVSD repair, arterial switch operation, TAPVC repair, CoA complex repair, TCPC(Fontan), Rastelli operation, Norwood procedure) was calculated.

Results

Table 1 shows the number of cases, mortalities and complications for each procedure. Of the 110 institutions, 61 institutions performed less than 50 CPB cases per year, 31 institutions performed 50–99 CPB cases/year and 18 institutions performed over 100 CPB cases/year. Figure 1 shows the distribution of the various types of operations performed by three groups of institutions.

Mortality rate

The mortality rates of ASD repair and VSD repair were 0.1% and 0.3%, respectively. The mortality of PVR was 1.2%. The mortality rate of TOF repair, Rastelli operation, CoA repair, CoA complex repair, complete AVSD repair, bidirectional Glenn, TCPC was under 3%. The procedures with high mortalities included Norwood procedure (16.0%), TAPVC repair (13.8%), arterial switch operation with VSD repair (9.8%), pulmonary venous stenosis repair (8.9%), mitral valvuloplasty (8.4%), arterial switch operation (6.4%) and PA banding (5.7%).

Complications

Unplanned cardiac reoperation

Norwood procedure (14.1%), arterial switch operation with VSD closure (10.7%), TAPVC repair (9.9%), systemic to pulmonary artery shunt (9.8%), mitral valvuloplasty (9.2%), PA plasty (8.0%) and arterial switch operation (7.6%) had relatively high reoperation rate. The procedures with high postoperative mortality tended to have higher unplanned reoperation rate.

Arrhythmia requiring permanent pacemaker implantation

The rate of postoperative permanent pacemakers for VSD was 0.2%. The procedures with more than 1% incidence included TCPC (2.3%), complete AVSD repair (1.8%), arterial switch with VSD repair (1.8%), mitral valvuloplasty (1.7%), pulmonary venous stenosis repair (1.7%), Norwood procedure (1.5%) and Rastelli operation (1.1%).

Chylothorax

Norwood procedure (10.6%), TCPC (10.3%), arterial switch with VSD repair (9.8%), coarctation complex repair (9.7%), complete AVSD repair (8.7%) and TAPVC repair (8.5%) had relatively high rates of postoperative chylothorax.

Wound infection (deep wound infection and mediastinitis)

The rate of deep infection including mediastinitis was approximately 1–2% in any type of operation. Norwood procedure had high rate of incidence (4.6%).

Table 1 Mortality and major complications of 20 major procedures of congenital heart surgery in Japan (2015 and 2016)

	Total	Death (90 days or in-hospital)		Death (90 days)		Unplanned cardiac reoperation exclusive of reoperation for bleeding		Arrhythmia necessitating permanent pacemaker		Chylothorax		Wound infection (mediastinitis/deep wound infection)		Phrenic nerve injury		Neurological deficit, neurological deficit persisting at discharge	
VSD repair	3210	10	0.3%	7	0.2%	40	1.2%	8	0.2%	46	1.4%	16	0.5%	6	0.2%	5	0.2%
ASD repair	1583	2	0.1%	1	0.1%	9	0.6%	3	0.2%	5	0.3%	3	0.2%	2	0.1%	1	0.1%
PDA closure	1259	49	3.9%	29	2.3%	17	1.4%	4	0.3%	23	1.8%	0	0.0%	3	0.2%	17	1.4%
Systemic to pulmonary shunt	1179	56	4.7%	49	4.2%	115	9.8%	1	0.1%	45	3.8%	12	1.0%	20	1.7%	10	0.8%
Pulmonary artery banding	1115	63	5.7%	39	3.5%	65	5.8%	3	0.3%	35	3.1%	9	0.8%	7	0.6%	5	0.4%
TCPC (Fontan)	776	20	2.6%	17	2.2%	50	6.4%	18	2.3%	80	10.3%	11	1.4%	13	1.7%	5	0.6%
TOF repair	593	12	2.0%	10	1.7%	19	3.2%	2	0.3%	19	3.2%	3	0.5%	8	1.3%	6	1.0%
Bidirectional Glenn	721	18	2.5%	12	1.7%	41	5.7%	5	0.7%	41	5.7%	16	2.2%	25	3.5%	2	0.3%
CoA repair	400	12	3.0%	9	2.3%	25	6.3%	0	0.0%	31	7.8%	3	0.8%	15	3.8%	3	0.8%
CoA complex repair	247	6	2.4%	6	2.4%	15	6.1%	2	0.8%	24	9.7%	3	1.2%	6	2.4%	4	1.6%
TAPVC repair	354	49	13.8%	38	10.7%	35	9.9%	1	0.3%	30	8.5%	6	1.7%	9	2.5%	4	1.1%
Complete AVSD repair	334	9	2.7%	9	2.7%	22	6.6%	6	1.8%	29	8.7%	1	0.3%	1	0.3%	4	1.2%
PA plasty	251	8	3.2%	5	2.0%	20	8.0%	0	0.0%	8	3.2%	7	2.8%	8	3.2%	4	1.6%
Valve replacement (PVR)	337	4	1.2%	4	1.2%	11	3.3%	1	0.3%	3	0.9%	3	0.9%	0	0.0%	4	1.2%
Rastelli operation	233	5	2.1%	5	2.1%	10	4.3%	2	0.9%	8	3.4%	2	0.9%	4	1.7%	1	0.4%
Mitral valvuloplasty	239	20	8.4%	16	6.7%	22	9.2%	4	1.7%	8	3.3%	2	0.8%	1	0.4%	3	1.3%
Norwood procedure	263	42	16.0%	32	12.2%	37	14.1%	3	1.1%	28	10.6%	12	4.6%	13	4.9%	8	3.0%
Arterial switch operation (ASO)	236	15	6.4%	12	5.1%	18	7.6%	0	0.0%	18	7.6%	1	0.4%	10	4.2%	2	0.8%
ASO with VSD repair	112	11	9.8%	9	8.0%	12	10.7%	2	1.8%	11	9.8%	2	1.8%	3	2.7%	2	1.8%
Pulmonary venous stenosis repair	135	12	8.9%	6	4.4%	10	7.4%	2	1.5%	5	3.7%	3	2.2%	4	3.0%	1	0.7%

VSD ventricular septal defect, *ASD* atrial septal defect, *PDA* patent ductus arteriosus, *TCPC* total cavopulmonary connection, *TOF* tetralogy of Fallot, *CoA* coarctation of the aorta, *TAPVC* total anomalous pulmonary venous connection, *AVSD* atrioventricular septal defect, *PA* pulmonary artery, *PAVSD* pulmonary atresia and ventricular septal defect

Phrenic nerve paralysis

Norwood procedure (4.9%), arterial switch operation (4.2%), CoA repair (3.8%), bidirectional Glenn (3.5%), PA plasty (3.2%), pulmonary venous stenosis repair (3.0%), PA plasty (2.7%), arterial switch with VSD repair (2.7%), TAPVC repair (2.5%) and CoA complex repair (2.4%) had high rates of phrenic nerve paralysis.

Neurological deficit persisting at discharge

Norwood procedure had 3.0% of neurological deficit at discharge. Other procedure had less than 2% neurological deficit persisting at discharge.

Discussion

Mortality rate

The mortality rates of ASD repair and VSD repair were very good, 0.1% and 0.3%, respectively. This is same as the annual reports by the Japanese Association for Thoracic and Cardiovascular Surgery [3], and in recent years it has been stable with almost no change. Moreover, the mortality rates of TOF repair, complete AVSD repair, CoA repair, CoA complex repair, bidirectional Glenn and TCPC are under 3%. From the data from STS database, the mortality rate (30 days or in-hospital death) of VSD repair, TOF repair, complete AVSD repair, bidirectional

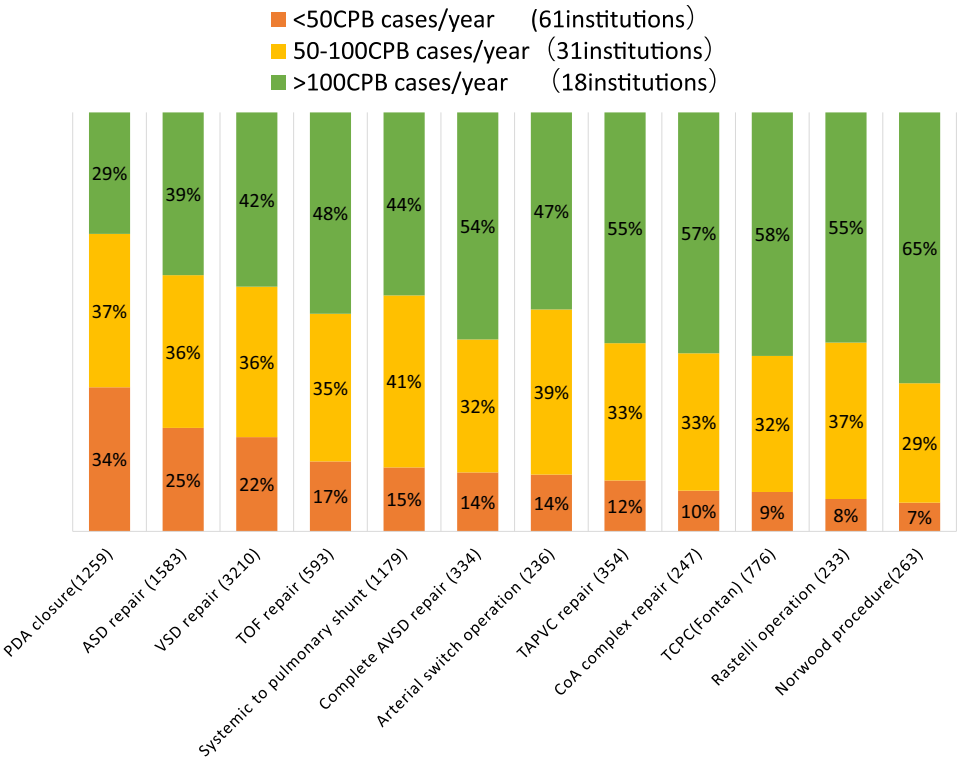

Fig. 1 The distribution of various types of operations performed by three groups of institutions (grouped by cardiopulmonary bypass cases per year)

Glenn and TCPC are 0.6%, 1.1%, 2.7%, 2.1% and 1.1%, respectively, and our data are considered to be comparable. The mortality of Norwood procedure (including Norwood–Glenn) was 15.8% for STS Database and 16.0% in our data and it is considered to be a good result as a national data. However, in Japan, bilateral PA banding is often performed as the first surgery for the HLHS and its variant until the Norwood procedure or Norwood–Glenn procedure are performed. There are patients who die between the bilateral PA banding and next procedure, so it is necessary to pay attention to the interpretation of mortality of Norwood procedure in comparison with other countries. For arterial switch operation and arterial switch operation with VSD closure, mortality was 6.4% and 9.8%, respectively. As shown in the annual report by the Japanese Association for Thoracic Surgery [3], the mortality of arterial switch operation and arterial switch operation with VSD closure was 7.5% and 10.5% in 2003, respectively, and there is no significant improvement in the mortality in this group recently. Therefore, further improvement is desired for this patient cohort.

Complications

One of the advantages of the data in JCVSD is that the database includes complications data and the previous report was the first report to cover nationwide data [1]. In the current report, there was no big change from the previous report. The rates of serious complication like unexpected reoperation, chylothorax, phrenic nerve palsy are high in Norwood operation, TAPVC repair, and arterial switch operation. Further effort to decrease these morbidities is desired. Regarding the neurological abnormality that persists at discharge, it was found relatively frequently: 8.3% in the arterial switch operation and 2% in the TOF repair in the previous report, but in this report, it was decreased to 1.8%, 1.0%, respectively. Although the cause is unknown, further observation is desired.

Distribution of types of operation by institutional volume

Relatively simple operations such as PDA, ASD, and VSD are often performed in small volume institutions. However, more complicated cases like TAPVC repair, Norwood procedure, were performed at large volume institutions. In addition, although the mortality rates were low in Rastelli operation and TCPC, these operations were also tended to be performed at large volume institutions. In the case of TCPC, almost all cases reach TCPC after bidirectional Glenn operation through neonatal palliations including systemic to pulmonary shunts, pulmonary banding or Norwood procedures. Likewise, in the cases of a Rastelli operation, palliative operations are performed in the neonatal or infant period. As a result, it is considered that these operations also tended to be performed at large volume institutions.

Conclusion

From the JCVSD data, the mortalities and morbidities of major operations in Japan were revealed. Neonatal surgery still has considerable complication rates, and further improvement is desired. In addition, it was shown that complicated operations tended to be performed at large volume institutions.

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