

Short-term results of neonatal arterial switch operation for simple and complex transposition of the great arteries. A single centre experience



Wczesne wyniki korekcji anatomicznej przełożenia wielkich pni tętniczych u noworodków po operacji Jatene'a – doświadczenia własne

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Abstract

Introduce: In 1975 Jatene and colleagues described the first successful arterial switch operation (ASO) for transposition of the great arteries (TGA), and practised it for more than thirty years.

The ASO has become the treatment of choice in many centres. The purpose of this study was to assess short-term results after neonatal ASO.

Aim: The aim of this study was to assess early and mid-term results of ASO in a single centre.

Material and Methods: Between December 1997 and June 2009 at our centre 150 ASO were performed by one surgeon. Patients' charts, surgical reports and echocardiograms were retrospectively reviewed. Patients were divided into three groups according to years – first 4 years, second 4 years, and third 4 years – and each group was divided into two subgroups A and B, subgroup A consisting of simple TGA with intact ventricular septum (IVS), and subgroup B consisting of patients with complex heart defects: TGA with ventricular septal defect (VSD), TGA with hypoplastic aortic arch or coarctation of aorta and Taussig-Bing heart. Group I consisted of 54 patients, group II 38, and group III 58.

Results: Our study shows that 30-day mortality was higher in the first group. It is also noticeable that complex TGA confer elevated risk for early mortality. Coronary artery anatomy was not identified as a risk factor.

Conclusions: Despite risks, the study shows that neonatal ASO can be performed with acceptable morbidity and mortality even in patients with complex heart defects.

Key words: transposition of the great arteries (TGA), complex TGA, simple TGA, arterial switch operation (ASO), neonates.

Streszczenie

Wstęp: W roku 1975 Jatene i współpracownicy przeprowadzili pierwszą operację korekcji anatomicznej przełożenia wielkich naczyń (ASO) zakończoną sukcesem. Procedura ta stała się z biegiem czasu leczeniem z wyboru w wielu ośrodkach.

Cel: Celem pracy jest ocena wczesnych wyników leczenia ASO w jednym ośrodku.

Materiał i metody: Między grudniem 1997 a czerwcem 2009 roku w naszym ośrodku zostało wykonanych 150 zabiegów ASO przez jednego chirurga. Poddano analizie dane pacjentów, protokoły operacyjne oraz wyniki badań echokardiograficznych. Pacjenci zostali podzieleni na trzy grupy: operowanych w latach 1997–2001, 2001–2005 i 2005–2009. Każdą grupę podzielono ze względu na anatomię wady: grupa A – proste przełożenie wielkich naczyń (TGA), grupa B – złożone TGA z ubytkiem w przegrodzie międzykomorowej, hipoplazją łuku aorty, koarktacją aorty czy zespołem Taussinga-Binga. W grupie I było 54 pacjentów, w II – 38 i III – 58.

Wyniki: Najwyższą wczesną śmiertelność zanotowano w pierwszej grupie pacjentów. Istotny czynnik ryzyka stwierdzono u pacjentów ze złożonym TGA. Anatomia naczyń wieńcowych nie stanowiła czynnika ryzyka.

Dyskusja: Pomimo powyższego czynnika ryzyka wykazano, że korekcja TGA w okresie noworodkowym może być przeprowadzona z akceptowalną śmiertelnością nawet u pacjentów ze złożonymi postaciami wady.

Słowa kluczowe: przełożenie wielkich naczyń, korekcja anatomiczna, proste TGA, złożone TGA, noworodki.

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Introduction

The aim of this study was to assess early and mid-term results of ASO in a single centre.

Transposition of the great arteries is one of the cyanotic congenital heart defects that can be treated successfully by a surgical approach. Frequency of TGA is around 5-7% of all CHD. In earlier years for treatment of TGA an atrial switch procedure was used (Mustard or Senning operation). Later this procedure was complicated with systemic vein obstruction, arrhythmias, and right ventricular insufficiency. In 1975, Jaten and colleagues [1] introduced the first arterial switch operation (ASO). Subsequently ASO became the treatment of choice in many centres for simple and complex TGA. Advantages of ASO instead of the atrial switch are that the left ventricle works in the systemic circulation and there are fewer problems with late arrhythmias [2-4]. Nevertheless, the ASO remains a complex surgical procedure with possible short- and long-term complications.

Material and Methods

Patients

From December 1997 to June 2009, 150 neonates (68 females, 82 males) underwent an ASO at our centre. Patients' surgical reports and charts were retrospectively reviewed. Patients were divided into three groups for analysis according to the operation years.

Group I consisted of 54 patients from 1997/12 to 2001/12, Group II of 38 patients from 2001/12 to 2005/12, and group III of 58 patients from 2005/12 to 2009/06. In each group we calculated body weight, body surface area, aortic cross-clamp time, age, CPB time, coronary anatomy and thirty-day mortality; they are shown in Table I, Fig. 1 and Fig. 2.

Fig. 1 shows the thirty-day mortality in each group and Fig. 2 shows coronary anatomy following Leiden classification [5] in the mortality group.

Subsequently each group was divided into two subgroups A and B. Subgroup A consists of patients with simple TGA and an intact ventricular septum and subgroup B consists of patients with complex TGA: TGA/+VSD: CoA; HAA; Taussig-Bing heart.

Fig. 3. shows the thirty-day mortality in every subgroup.

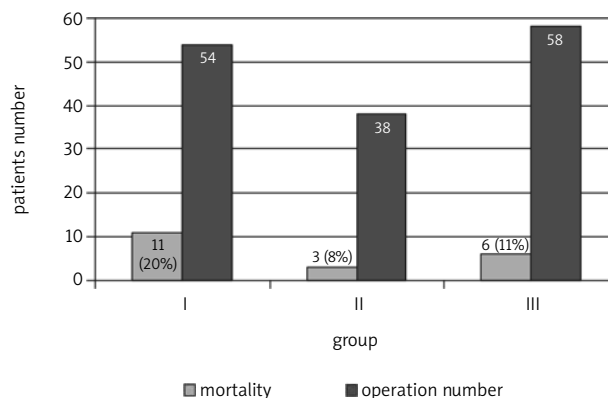


Fig. 1. Total mortality in each group

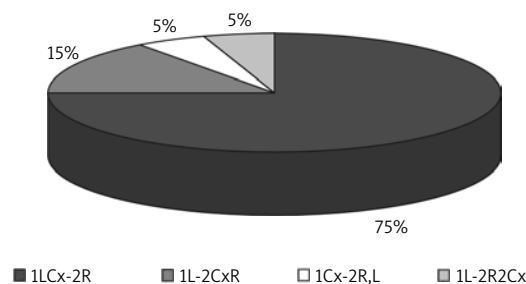


Fig. 2. TC coronary pattern in mortality group

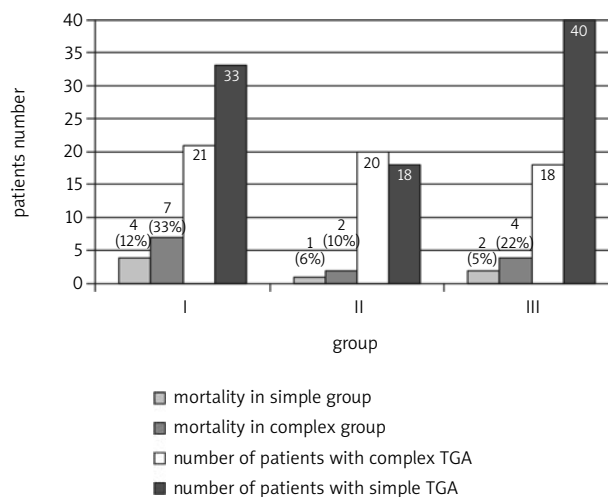


Fig. 3. Mortality in subgroups

Tab. I. Patients with simple and complex TGA having undergone arterial switch operation: median parameters at time of operation

Group	I (54)	II (38)	III (58)	Total (150)	p value
Median weight (kg)	3.55 ± 0.79	3.54 ± 0.42	3.42 ± 0.48	3.41 ± 0.46	> 0.05
Median age (days)	8 ± 4	9 ± 5	8 ± 4	8 ± 5	> 0.05
Median BSA (m ²)	0.22 ± 0.03	0.25 ± 0.12	0.22 ± 0.02	0.23 ± 0.06	> 0.05
Aortic cross-clamping (min)	79 ± 17	92 ± 19	85 ± 26	84 ± 21	< 0.001
CPB time (min)	180 ± 38	214 ± 66	181 ± 46	185 ± 48	0.002
Mortality (n)	11 (20%)	3 (8%)	6 (11%)	20 (13%)	> 0.05

Preoperative management

After admission and diagnosis continuous intravenous prostaglandin infusion was administered to all patients. Rashkind procedure was performed if it was necessary.

Surgical technique

After standard anaesthesia surgery for ASO was performed with systemic hypothermia (24°C) modified ultra-filtration and low flow. Complete circulatory arrest was used selectively, in patients with aortic arch problems. For coronary transfer the trapdoor technique was mainly used [6]. Reconstruction of the pulmonary artery was done with a quadrangular autologous pericardial patch.

Statistics

For check normal distribution was used the Shapiro-Wilk test. Parametric Student t tests were used for variables with a normal distribution. Otherwise, variables were tested by the U test (Mann-Whitney test). Nominal variables were evaluated by Fisher's exact test. The following parameters were compared between groups: age, weight, body surface area, aortic crossclamp time, mortality. Values of p less than 0.05 were considered significant.

It was checked correlation between patients BSA, age, crossclamp time and mortality in our data. For statistical research depend of following paramters used test analisys tables time of life. Above tests needn't normal distribution data. The results of survival rate show graphs. Statistic description results done with Statistica 7.0 (StatSoft).

estimation the smallest square function of survival model: exponential

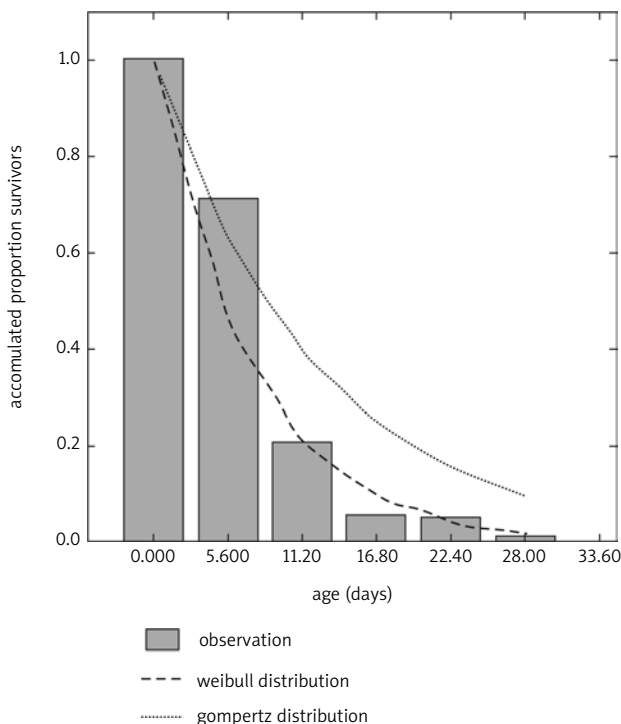


Fig. 4. Survival function for age

estimation the smallest square function of survival model: exponential

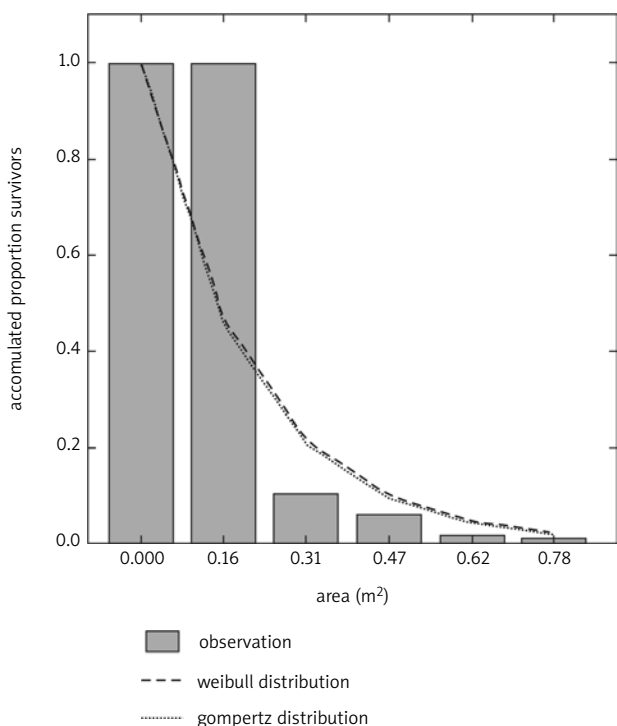


Fig. 5. Survival function for area

estimation the smallest square function of survival model: exponential

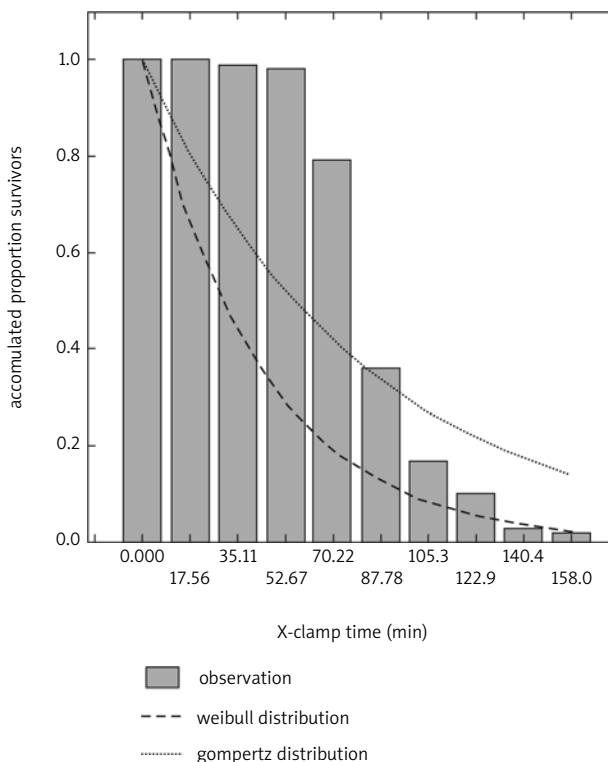


Fig. 6. Survival function for cross-clamp time

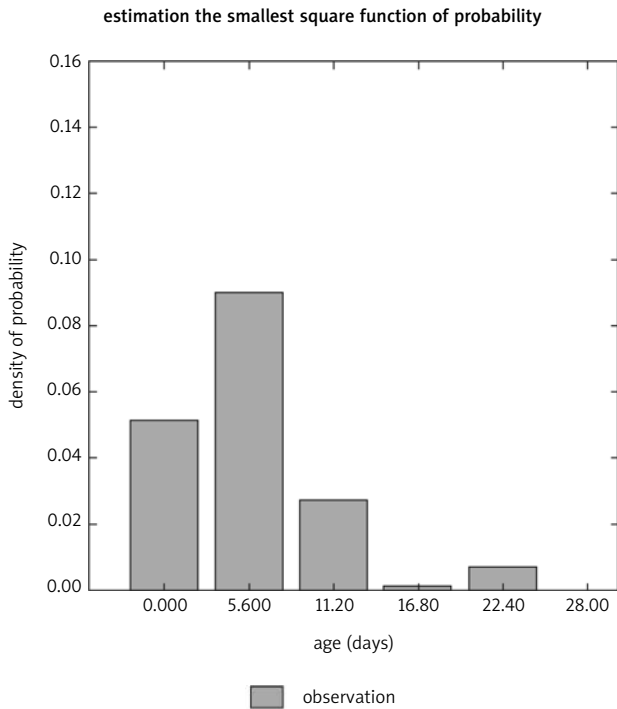


Fig. 7. Probability density for age

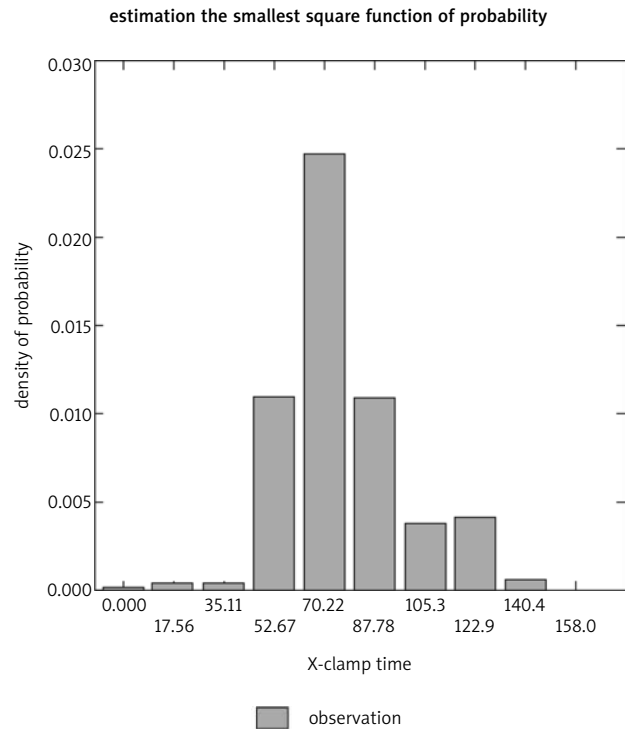


Fig. 8. Probability density for cross-clamp time

Results

Total thirty-day mortality in group I was 20% (11), and in subgroups A and B was 12% (4) and 33% (7) respectively. In group II total mortality was 8% (3), and in subgroups A and B 6% (1) and 10% (2) respectively. In group III total mortality was 11% (6), and in subgroups A and B 5% (2) and 22% (4) respectively.

The majority of our patients were operated on before the 14th day of life. Regarding Fig. 2, in our study coronary anatomy was not considered as elevating risk. Higher risk for early mortality was associated with complex anatomy in other studies [7, 8], because of prolonged aortic cross-clamp time (Table II). Also it is noticeable that coronary transfer is the most important part of ASO. Failure of an anastomosis can induce myocardial infarction [9], resulting in death. Early post-operative follow-up showed good function of neo-aorta and no significant PA stenosis.

Discussion

Our study has shown that the arterial switch operation (ASO) can be performed safely in patients with simple TGA, regardless of associated intra- or extracardiac defects. This study is in agreement with previously published findings on ASO studies [10]. Our 30-day mortality in the last two groups is around 5% for simple TGA and compares favourably with other published large series, where an early mortality rate between 1.6% and 11% of the ASO has been reported [11]. However, the presence of

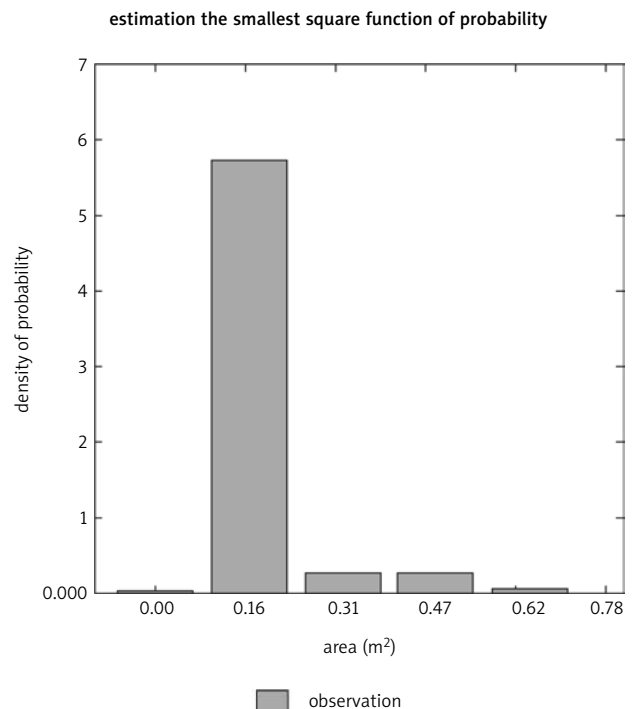


Fig. 9. Probability density for area

a VSD, aortic arch obstruction and complicated coronary anatomy has been described as a significant risk factor. We did not observe differences in outcome regarding the coronary pattern. This might be due to improved surgical skills, progress in cardio-pulmonary bypass and cardiac intensive care.

Tab. II. Median parameters in mortality group

Group	I (11)	II (3)	III (6)	Total (20)	p value
Median weight (kg)	3.41 ± 0.79	3.24 ± 0.25	3.53 ± 0.57	3.42 ± 0.66	0.002
Median age (days)	9 ± 6	6 ± 2	14 ± 9	10 ± 7	> 0.05
Median BSA (m ²)	0.21 ± 0.03	0.40 ± 0.33	0.23 ± 0.03	0.25 ± 0.13	> 0.05
Aortic cross-clamping (min)	82 ± 33	104 ± 16	98 ± 33	90 ± 31	> 0.05
CPB time (min)	208 ± 64	243 ± 105	209 ± 55	214 ± 66	0.002

Conclusion

The results indicate that ASO on patients with simple anatomy does not show high risk of mortality; the risk factor is higher with patients having complex TGA. The practice and development of operation skills gives better results. To conclude, ASO can be done with acceptable morbidity and mortality.

According to the research the greatest value of survival is for BSA 0.23 m², age 5 days, time of cross-clamp approximately 70 minutes.

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