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Information for Authors



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The Iranian Journal of Cardiac Surgery is the official quarterly publication of the Iranian Society of Cardiac Surgeons (ISCS). The editorial board encourages submission of original papers concerned on any aspects of cardiovascular medicine including cardiac surgery, adult and pediatric cardiology, cardiac anesthesia and cardiac intensive care in the form of both basic and clinical research. Submitted articles should neither have been published previously nor be considered for publication elsewhere.

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Early Diagnosis of Cardiac Involvement in β -Thalassemia Major

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Abstract

Background. Cardiac involvement is the major cause of morbidity and death in (β)-thalassemia Major. We aimed to compare echocardiography findings in early diagnosis of cardiac involvement.

Methods: 46 Beta (β)-thalassemia Major patients aged less than 10-year and 46 beta thalassemia patients aged over 10-year were studied. Echocardiography and Doppler tissue imaging (DTI) were done.

Results: The mean of RV pre-ejection period to ejection time (PEP/ET), LV PEP/ET, mitral and tricuspid peak E:A velocities ratio (E/A), RV myocardial performance index (MPI) and LV MPI in group A and B did not show any significant differences. The mean of tricuspid deceleration time (DT), mitral DT and from DTI the tricuspid and mitral annular velocities in group A and B demonstrated significant differences.

Conclusions: This study showed abnormal diastolic dysfunction in asymptomatic children with Beta (β)-thalassemia Major that could be a useful biomarker to predict later and severe manifestations of cardiac disease.

Key words: Beta (β)-thalassemia Major; Systolic and diastolic dysfunction; Echocardiography.

Introduction

Cardiac complications are still the most common cause of death in Beta (β)-thalassemia Major. Although severe anemia leads to predominant cardiac symptoms, however, iron overload causes severe and permanent cardiac damage including recurrent pericarditis, recurrent forms of cardiac block, ectopic ventricular beats, ventricular tachycardia, ventricular fibrillation, cardiomegaly, left ventricular dysfunction and resistant heart failure [1-3]. Thalassemic patients carrying typical systolic function and iron overload, abnormal left ventricular relaxation time represented as prolonged isovolumic

relaxation time (IRT) which is the first symptom of diastolic dysfunction [4,5]. Doppler tissue imaging (DTI) is utilized for evaluation of right ventricular function in children with congenital heart disease. [6, 7]. MPI is a useful index to prove left ventricular dysfunction. MPI is simply measured by Doppler echocardiography without normalizing by heart rate and blood pressure. That is non-invasive and demonstrates systolic and diastolic ventricular functions [5, 8, 9, and 10]. There are few studies on echocardiographic parameters and ventricular functions in young thalassemic patients. We, therefore, conducted the present study to eval-



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uate the indices in early diagnosis of cardiac complications in Beta (β)-thalassemia Major.

Materials and Methods:

A case-control study was designed on patients with Beta (β)-thalassemia Major categorized into two groups of 5-10 year and an elder one. The study was approved by institutional ethical committee. Written consent form was obtained from the patients. Data on demographics, life style, family and medical and occupational history were collected using a detailed standard questionnaire. They underwent a detailed interview, physical examination, and laboratory analysis to exclude hypertension, cardiac structural disorders, heart failure, Hb < 10, and cardiac drug usage. Ninety two consecutive patients were selected, 46 patients aged 5-10 year old (group A) and 46 patients aged over 10 years old (group B). All patients underwent blood transfusion and echocardiography. The participants were age and sex-matched. Controls were healthy without any cardiac or

other problems. Two-dimensional, M-Mode and Doppler echocardiography were done and mean of every parameter calculated. In each subject, the DTI of the right and left ventricular diastolic velocities was obtained and tricuspid and mitral annular velocities were measured. Echocardiography was done by 3.5/5 and 2.5/3.5 MHZ transducer in supine position without breathe holding. Quantitative variables were defined by mean \pm SD. Statistical analysis was performed using SPSS ver.15. A 2-tailed P value of < 0.05 was considered statistically significant.

Results:

The mean of age in group A was 7.3 ± 1.9 year and in group B 16.3 ± 2.9 showing significant statistical difference ($P < 0.01$). Group A and group B were age-gender matched. The right heart echocardiography findings of both the groups are presented in Table 1. The mean of IRT in both the groups wasn't statistically significant ($P > 0.05$) reflecting IRT abnormality. Although, the mean of DT and tricuspid annular

Table 1: Right heart echocardiography findings in under and over 10-year-old patients With β -thalassemia Major

Echo finding	Under 10-year	Over 10-year	P value
IRT ms	126.82 ± 19.12	125.96 ± 23.09	$P > 0.05$
DT ms	103.82 ± 17.93	111.77 ± 27.27	$P < 0.02$
PEP/ ET	0.449 ± 0.439	0.369 ± 0.053	$P > 0.05$
E/A	1.32 ± 0.39	1.31 ± 0.32	$P > 0.05$
MPI	0.637 ± 0.154	0.605 ± 0.13	$P > 0.05$
A/E (by DTI)	0.619 ± 0.125	0.638 ± 0.21	$P < 0.05$

velocity by DTI in group A and B demonstrated significant difference statistically ($P < 0.05$), the mean of PEP/ET, E/A and MPI weren't ($P > 0.05$).

The left heart echocardiography findings in both the groups are presented in Table 2. The left isovolumic contraction time (ICT) in group A was 21 ± 20 and in group B was 30 ± 15 milliseconds. The mean of DT and mitral annular velocity by DTI in group A and B demonstrated significant difference statistically ($P < 0.05$). The mean of PEP/ET, E/A and MPI in group A and B weren't statistically different ($P > 0.05$). Moreover, Interventricular septal dimension in di-

astole (IVSDD), Left ventricular posterior wall dimension in diastole (PWDD), Left ventricular dimension in diastole (LVDD) and Left ventricular dimension in systole (LVDS) were statistically different in group A and B ($P < 0.0001$). Age could account for, but statistically significant difference of these parameters may be related to age and not to disease itself. Ejection fraction (EF) and shortening fraction (SF) in group A and B weren't statistically different ($P > 0.05$). These two parameters aren't good criteria to differentiate cardiac involvement in patients with Beta (β)-thalassemia Major under and over 10 years old.

Table 2: Left heart echocardiography findings in under and over 10-year-old patients with Beta-thalassemia Major

Echo findings	Under-10 year	Over-10 year	P value
IRT(ms)	114.80 ±21.23	108.67 ± 23.29	P > 0.05
DT (ms)	102.27±15.95	114.52 ±19.20	P < 0.0001
PEP/ ET	0.440 ±0.295	0.382 ± 0.061	P > 0.05
E/A	1.73±0.48	1.82±0.45	P > 0.05
MPI	0.527 ±0.149	0.528 ± 0.127	P > 0.05
A/E (by DTI)	0.729 ±0.123	0.619 ± 0.125	P < 0.0001
IVSDD (mm)	5.23±1.18	6.90±1.40	P < 0.0001
PWDD (mm)	3.43±0.67	4.43±1.1	P < 0.0001
LVDD (mm)	42.49±3.39	47.64±4.84	P < 0.0001
LVDS (mm)	29.07±2.98	32.62±4.09	P < 0.0001
EF (%)	60.07±6.85	59.12±6.57	P > 0.05
FS (%)	31.95±4.82	31.51±4.77	P > 0.05
SV (ml)	52.27±15.32	82.18±30.59	P < 0.0001

Discussion:

Beta (β)-thalassemia Major, the most common monogenic disorders in the world, is an inherited hemoglobinopathy characterized by severe chronic hemolytic anemia. The leading cause of mortality and morbidity in Beta thalassemia major, as a lethal hemolytic anemia, is cardiomyopathy attributed to regular blood transfusion and iron overload. Heart failure remains the leading cause of mortality, accounting for roughly two thirds of deaths in Beta (β)-thalassemia Major. Currently echocardiography is a valuable tool in evaluation of cardiac function and diagnosis of early cardiac involvement [1]. Another study was done in older ages that showed the mean right and left MPI in two groups had no significant difference statistically. It seems the difference in MPI is because of its occurrence in low age with an increase in both groups without statistical difference. In Ocal study, patients whom were treated with doxorubicin, MPI revealed a significant increase comparing with control group, due to an increase IRT and decrease ET without change in ICT [5]. Mounting MPI reveals systolic and diastolic ventricular dysfunction in Beta (β)-thalassemia Major; it means that an increased MPI represents a decrease in

cardiac function [4, 5, and 6]. Another study also revealed that ICT is a significant parameter in evaluation of systolic function and IRT was a significant parameter in evaluation of diastolic function [11]. These parameters are related to active contracture stage and primary relaxation stage in ventricle. It seems that MPI is a significant parameter in diagnosis of cardiac dysfunction especially in children [12, 13]. MPI is a simple and repeatable and not related to heart rate and ventricular snap and volume index. The mean of IRT in group A and B did not show any significant difference. Increased IRT showed diastolic dysfunction reported in many studies in patients with Beta (β)-thalassemia Major, representing impairment in ventricular relaxation due to iron deposition. That, in turn, leads to gradual restrictive cardiomyopathy [14, 15]. Since IRT increased in lower age and this increase also occurs in upper age, so no meaningful increase between the two groups is suspected. Chafours et al. revealed that an increase in PEP/ET ratio in left ventricle occurred in 2/3 of patients and that was an obvious marker for changing diastolic ventricular function [16]. Hahalis et al. reported abnormal changes in β -thalassemic Major diastolic function; however filling pressure in left ventricle is

correlated with preload pressure. The study showed normal left ventricular function in asymptomatic β -thalassemic patients. But there is a change in right ventricular function similar to increase IRT and decrease DT in tricuspid valve that indicates the second marker has diagnostic value and the first marker shows early involvement of right ventricle [17]. The echocardiography finding is a significant marker in an increased right ventricular pressure, whereas the patients had lower age without any symptoms of heart failure. Another study on the patients with CHD and increased right ventricular pressure used echocardiographic findings with high value like angiography.

In conclusion, patients with Beta (β)-thalassemia Major even in low ages revealed diastolic dysfunction and less often systolic dysfunction. This trouble progresses in older age. Our study showed that in both under 10 year and over 10 year groups, MPI increased in the right and left ventricle however, DTI raised only in over 10-year-old patients. PEP/ET showed no significant difference in both the groups in left ventricle, however in right ventricle, the condition was not the same. This is due to an increased PEP/ET in right ventricle in both the groups; being an early finding of diastolic involvement, especially in right ventricle. Reduced DT occurred with an increase of age and revealed cardiac involvement with a raise in age that is one of the earliest predictive outcomes of cardiac involvement. So we suggest serial echocardiography in asymptomatic major thalassemia in preschool age in order to provide early diagnosis of cardiac involvement.

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Conflict of interest: None declared

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Complete Atrioventricular Septal Defect: Comparison of One-Stage Primary Repair With Two-Stage Surgical Strategy

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Abstract:

Background: Complete Atrioventricular Septal Defect (CAVSD) is a congenital heart disease treated by surgical repair. There are two strategies for surgery: 1) Primary repair at lower ages (one-stage repair). 2) PA banding in lower age and then complete repair after normalization of PAP (Two-stage repair). The purpose of this study was comparison of mortality rate and short term complications of these two strategies.

Patients and Methods: This Cohort study covered 90 patients by CAVSD from a single center that underwent surgical repair from September, 2005 to October 2010. Forty seven patients operated by one-stage repair and 43 patients by two-stage method. Patients were compared based on preoperative data (age, sex, weight, Down's syndrome, Pulmonary Artery Pressure "PAP" and Preoperative EF) intraoperative data (data of Pulmonary Artery "PA" banding, CPB time and aortic cross clamp time) post operative data (post op EF, residual septal defects, residual AV valve regurgitation, ICU stay time and tracheal intubation time) short term complications (Pulmonary complications, bleeding, CHB) and hospital mortality rate.

Results: There were no significant differences among two groups concerning age, sex, weight, PAP and Preoperative EF. Failure rate of PA banding was 9.4% in two-stage group. CPB time and aortic cross clamp time in one-stage repair were significantly lower than two-stage repair ($P=0$, $P=0.002$). ICU stay and tracheal intubation time in one-stage repair were significantly lower than two-stage repair ($P=0$, $P=0$). There were no significant differences among the two groups concerning post operative EF, and residual septal defects. Severe TR was higher in two-stage repair group ($P=0.016$). Pulmonary complications were lower in one-stage repair group. The hospital mortality rate in one-stage repair was 6.4% and in two-stage repair was 16.3% ($P=0.136$). The risk factors for mortality were increased CPB time and aortic cross clamp time.

Conclusions: This study demonstrated that one-stage primary repair of CAVSD is a safe method with lower mortality rate and short term complications than two-stage repair and it can be considered as the preferable strategy in CAVSD repair in lower ages.

Key words: Complete Atrioventricular Septal Defect; Primary Repair; Two Stage Repair; Pulmonary Artery Banding.

Introduction:

There are two surgical methods to treat CAVSD. The first method is the traditional method which has been common from long ago; in which patients in lower

ages undergo a pulmonary artery banding (PAB), and after a while once the PA pressure is normal the total correction operation is done [1]. In this way, they can partly control the pulmonary artery pres-



sure; however since the anatomical defects remain high to the older ages, can affect the physiology of the heart. The second method -which is now more commonly done in the world- the total correction operation is done all at once in the lower ages. In this method not only the PH correction takes place and doesn't remain for long, but also the previous anomalies are corrected in the lower ages the normal physiology of the heart will be preserved or will get back to normal sooner [2,3].

Table 1: Demographic information

Variable	Mean	P
Age of PAB (two-stage)	7.7±4.3 month	0.340
Age of repair (two-stage)	38.2±18.5 month	
Period interval from PAB to secondary repair (two-stage)	30.4±17.7 month	
Age of repair (one-stage)	10.2±4.1 month	0.611
Weight at time of PAB (two-stage)	4.9±1.5 Kg	
Weight at time of secondary repair (two-stage)	12.5±4.8 Kg	
Weight at time of primary repair (one-stage)	6.3±2 Kg	

G. Stellin and his colleagues introduced the total correction surgery before 3 months of age as the ideal method to treat CAVSD [4]. In study of MJ Uddin, the primary repair of AV Canal before increased pulmonary vascular resistance was associated with reduced mortality [5]. The aim of this study was to compare two methods of one-stage and two-stage surgical correction, in terms of feasibility and outcome.

Material and Methods

From September 2005 to October 2010, 90 patients underwent the restoration surgery for CAVSD in Rajaei Heart Center. 47 patients (52.3 %) underwent one-stage restoration surgery (group one) and 43 patients (47.7 %) underwent the two-stage restoration surgery (Group two). 60% of patients were male and 58.9 % were suffering from Down Syndrome.

The two groups were comparable in terms of age, sex, weight, intensity of PH, anatomic type and the amount of common atrioventricular valve regurgitation, and didn't have significant statistical difference.

Statistical analysis

Comparisons between groups were made using the Fisher exact test for categorical data and an unpaired 2-tailed t test for continuous variables. A p value less than 0.05 was considered significant. All calculations were performed using StatView software (SAS Inc, Cary, NC).

Results

1. Intraoperative results:

In the two-stage group after the PAB surgery in 4 patients (9.4 %), PAB failed to reduce pulmonary artery pressure. The mean time for CPB in one-stage surgeries was 104.8 ± 22.9 minutes and in the two-stage surgeries it was 129 ± 24.8 minutes, which was significantly more in the second group (P=0). This is natural that in the second surgery a considerable time is spent to set the adhesions free from inside pericardial and especially the P.A debanding will increase the CPB time.

The mean aortic cross clamping time for group one, was 69.2 ± 20.7 minutes and in the group two, it was 82.5 ± 21.7 minutes, which was again meaningfully more in the second group (P=0). Although the increased time for aortic cross clamping and CPB has proven complications which comes along with an increase in mortality and morbidity.

2. ICU information:

The mean ICU stay time in group one, was 5.4 ± 2.1 days and in overall two surgeries in group two, it was 10.2 ± 3.2 days which was significantly less in group one (P=0). Reducing the time of ICU stay not only reduces the complications after surgery but also cuts down on hospital costs considerably.

The mean time of tracheal intubation in group one, was 39 ± 12.3 hours meanwhile in the overall two operations in group two, it was 85.5 ± 19.6 hours (P=0). Obviously reduced time of tracheal intubation is in association with reduced pulmonary complications.

3. Echocardiographic results after surgery:

5 patients from group one and 4 patients from group two developed Small Residual VSD (P=ns). Also two patients from group 2 developed Small Residual ASD (P=ns). 11 patients from group one and 7 patients from group two were suffering from Moderate MR and one case in group 2 from Severe MR (P=ns).

Also 6 cases from group one and 8 cases from group two were suffering from Moderate TR, and 1 case from group

one and 3 cases from group two from Severe TR; in which the amount of Severe TR was meaningfully higher in group 2 ($P=0.016$). The reason could be that the previous PAB leads to RV Dilatation and dilatation of tricuspid valve ring and so tricuspid repair wasn't desirable. 7 patients from group 2 (17.1 %) developed pulmonary artery stenosis, which although this one again is of the complications of the previous PAB.

4- Complications:

The overall pulmonary complications were more in the two-stage surgeries than the one-stage surgeries: Atelectasis in group one 9 cases and in group two 20 cases ($P = 0.047$).

Pneumonia in group one 3 cases and in group two 8 cases ($P = 0.058$).

Prolonged intubation in group one 11 cases and in group two 16 cases ($P = 0.335$).

Reintubation in group one 4 cases and in group two 9 cases ($p = 0.094$).

Although it was predictable that staying long in ICU and being readmitted in ICU in the two-stage group would have more complications.

The complete heart block happened for 2 cases in group one and 4 cases in group two ($p=ns$). Finally in 3 cases PPM had to be embedded (1 case from group one and 2 cases from group two)

Bleeding rate in group 1, was 2.1 percent and in group 2, it was 7 percent. ($P=ns$)

5. Mortality:

Mortality rate was overall 10 cases (11.1 %) in which 3 cases (6.4 %) were from group one and 7 cases (16.3 %) were from group two. Although the differences were not statistically significant, but they were worthy of attention. ($P=ns$) Among death cases, in group two 2 cases following PAB (4.6 %) and 5 cases following the second surgery (12.1 %) happened. Among death cases following PAB in one case, the cause of death was PH Crisis due to an unsuccessful PAB, and in the other case Sepsis following Pneumonia. In death cases following the second surgery in group two 2 cases died due to sepsis, 2 other cases because of HF and one case due to PH crisis. In this recent case however PAB was done, but patient still had a significant PH before the second surgery which shows an unsuccessful PAB.

Cause of death in one-stage surgeries was in one case DIC and in two other cases HF. Time of death in above mentioned cases were 12 hours until 40 days after the surgery.

The results of this survey showed that death has a meaningful relation with CPB time as if the mean of the CPB time in mortality cases was 136 ± 32.2 minutes whereas in other cases it was 114.1 ± 26.1 minutes. ($P=0.030$) We could also see a meaningful association between death and aortic cross clamp time, in a way that the mean time of aortic cross clamp in mortality cases was 94.3 ± 12.1 minutes and in other cases it was 73.5 ± 11.2 minutes. ($P=0.021$)

6. Follow up:

86 patients (95 %) were followed up and underwent serial echocardiography. The follow up time was between 2 to 60 months with a mean 34.4 ± 12.5 months.

Table 2: one-stage repair versus two-stage repair data

Variable	One-stage repair	Two-stage repair	P
Preoperative EF	68.7±8.2 %	71.3±9.2 %	0.259
Mean pulmonary artery pressure	50.6±9.2 mmHg	52.4±12.2 mmHg	0.769
Mean CPB time	104.8±22.9 minute	129±24.8 minute	0
Mean aortic cross clamp time	69.2±20.7 minute	82.5±21.7 minute	0.002
Mean ICU stay time	5.4±2.1 day	10.2±3.2 day	0
Mean tracheal intubation time	39±12.3 hour	85.5±19.4 hour	0
Postoperative EF	60.7±9.9 %	60.4±10.2 %	0.606

Discussion:

The results of our survey showed that the hospital mortality rate in CAVSD restoration surgery was 11.1 % whereas in similar studies mortality rate was reported to be about 10 to 15 [6,9,10,12,13,14]. In this study mortality in the two-stage method (16.3 %) was reported more than the one-stage method (6.4%). Although the differences were not statistically significant, but they're clinically important and worthy of attention. This study also showed that mortality is in direct relation with CPB time and aortic cross clamp time, and increase in CPB time and aortic cross clamp time will increase mortality rate after surgery. CPB time is mentioned as a risk factor also in similar studies like Kobayashi's [2].

In this study the mean time of ICU stay and the time of tracheal intubation in both groups were similar to the studies which have been done in the world [15,17], and there are not much of significant differences among the two groups, although these two criteria in overall two surgeries in group 2, was significantly more than group 1.

The pulmonary complications including atelectasis, pneumonia, prolonged intubation, and reintubation was more in group two comparing to group one. The results of our survey showed that CPB time and aortic cross clamp time were significantly more in group 2 comparing to group 1.

Although in the two-stage surgical method a considerable time is spent to set the adhesions free from inside pericardial and also the PA debanding, and the increased time of CPB and aortic cross clamp considering the results of our survey and other similar studies will increase mortality and morbidity. Some supporters of the two-stage repair believe that the restoration of atrioventricular valve in lower ages and low weight would not be so satisfying [8,16], but the results of our survey showed that the remaining regurgitation rate of mitral and tricuspid valves after surgery doesn't really have significant differences; in addition the severe TR rate was higher in group two that the reason could be dilatation of the tricuspid ring and the right ventricle following the previous PAB surgery.

We should also add the complications of PAB to the above mentioned cases. In our study PAB failed in 9.4 % of cases and couldn't lower the pressure of PA. PAB also paved the way for PA stenosis after restoration surgery in 17.1 % of cases. However PAB still plays an important role in complex congenital heart diseases, but this is not recommended for CAVSD routinely [7]. This type of surgery is only rec-

ommended in cases in which the patient suffers from severe heart failure or in severe non-cardiac diseases requiring surgical intervention and also in unbalanced ventricles [8,11]. Our advice is that if it is required to have a two-stage operation, shorten the interval between the PAB and the total correction surgery so that it doesn't lead to adverse effects on right heart performance and the tricuspid valve.

It must be acknowledged that our study had the following limitations as well: 1-Although we have studied all the cases of CAVSD in this center during the mentioned period, but it seems if we want to reach definitive results, more studies with larger sample size is required to be done. 2-In this study patients underwent operations by different surgeons that although there's not much difference in methods and skills of surgeons, but the results are affected anyway. 3-Comparing to similar studies, the period of follow up is shorter in this study, so in order to study the complications more accurately it's better to have studies following this one.

Conclusion:

The overall results of our survey considering the results of similar studies suggest that the one-stage surgical repair method in treatment of CAVSD is done with less mortality and more acceptable clinical complications comparing to the two-stage method that could be done in patients with lower ages and low weight. On the other hand comparing to the two-stage repair which requires two times being bedridden in hospital and operation room, spending more money and the probability of mortality and morbidity, the one-stage repair seems to be more reasonable.

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Does Retrograde Administration of Cardioplegic Solution Improve the Clinical Outcomes in Primary Coronary Artery Bypass Grafting?



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Abstract:

Background: The quality of myocardial protection during Coronary Artery Bypass Grafting (CABG) has a direct effect on post-operative cardiac function, recovery and complications. The optimal route for delivery of cardioplegia is still in debate in patients with ischemic heart disease. This prospective randomized clinical study was designed to assess and compare the use of combined antegrade-retrograde cardioplegia versus antegrade cardioplegia in providing adequate myocardial preservation during coronary artery bypass graft surgery.

Methods: A total number of 150 patients that underwent CABG between 2009 and 2010 were assigned randomly into two groups according to myocardial protection technique; 75 patients were randomly assigned to receive antegrade cold blood cardioplegia (group A) and the other 75 patients received combined antegrade-retrograde cold blood cardioplegia (group A/R). This prospective randomized study compared clinical, echocardiographic, markers of myocardial damage, morbidity and mortality in two groups.

Results: The two randomization groups had similar demographic characteristics. The number of grafted coronary arteries averaged 3.2 ± 0.4 in group A and 3.3 ± 0.4 in group A/R. Total duration of cardiopulmonary bypass (64.1 ± 23.2 and 66.3 ± 16 minutes) and aortic cross-clamping (36.9 ± 13.7 and 34.6 ± 8.6 minutes) were similar in both groups. There was one death in group A and one in group A/R, for a global early mortality of 1.3%. The cause of death was free wall LV rupture in group A and respiratory failure and pneumonia in group A/R. Release of total creatine kinase, creatine kinase-MB and troponin T were not significantly different ($p > 0.05$) between the two groups. The number of postoperative myocardial infarction (12% versus 8%), the need for inotropic support (17.3% versus 12%), the need for IABP (2.7% versus 1.3%), post-operative arrhythmias (4% in each groups) were similar in both groups ($P > 0.05$). Re-exploration, stroke, pulmonary complication, renal failure and wound infections also were similar ($P > 0.05$).

Conclusions: Our results indicate suggest that the retrograde cardioplegia administration essentially does not improve myocardial protection during the first operation for isolated coronary revascularization compared with the usual antegrade route. The data indicate that in this non-risk-stratified group of patients, the route of cardioplegia administration is not a determinant of clinical outcome.

Key words: Antegrade Cardioplegia, Myocardial Protection, Retrograde Cardioplegia. CABG

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Introduction:

Effective intraoperative myocardial protection requires adequate distribution of cardioplegic solution to all myocardial segments to be accomplished in a safe, simple, and rapid fashion (1). Nonhomogenous distribution of cardioplegia in severe critical proximal coronary artery stenosis and in evolving myocardial infarction has been demonstrated experimentally (2).

Perfusion of the heart through the coronary sinus, so-called retrograde perfusion, was originally proposed by Pratt in 1898 (3). In 1956, this technique was first used by Lillehei et al. during cardiac surgery for the protection of jeopardized myocardium because coronary atherosclerosis does not occur in the coronary venous system (3).

However the preferential way of giving cardioplegia for myocardial protection strategy in patients with severe coronary artery disease is still under debate. Some of cardiac surgeons suggest routine use of retrograde cardioplegia administration (2,4) and others prefer the antegrade route (5,6). This controversy arises due to the large amount of clinical, biochemical, and histological studies that have been performed during the last 2 decades (4). In human, retrograde cardioplegic solution is administered through the coronary sinus into the cardiac venous system. Most of the veins in the heart drain to the right atrium through the coronary sinus. However, a smaller part of the cardiac venous return drains directly to the cardiac chambers through the anterior cardiac veins and the thebesian veins (venae cordis minima), particularly in the right side (7).

Some studies indicate that combined antegrade-retrograde cardioplegia is superior to antegrade cardioplegia for myocardial protection during coronary artery bypass graft surgery (2,4,8). However, recent studies have documented that retrograde cardioplegia does not adequately perfuse the right ventricle. The possibility of delayed cardiac arrest due to the low flow rate used for retrograde cardioplegia has also been noted (9) and many studies have shown no clear advantage in myocardial protection of retrograde versus antegrade cardioplegia (10).

Our study was designed to determine if using combined antegrade-retrograde cardioplegia is associated with better clinical outcome than the usage of antegrade technique alone.

Materials and Methods:

A total number of 150 patients that underwent CABG between 2009 and 2010 were assigned randomly into two groups according to myocardial protection technique; 75 patients were randomly assigned to receive antegrade cold blood cardioplegia (group A) and the other 75 patients received combined antegrade-retrograde cold blood cardioplegia (group A/R).

After the patients had agreed to participate in the study and signed an informed consent form, assignment to one of the two treatment groups and randomization was done just before the beginning of the operation. Group allocation was blinded to the patient, using blocks of four for equal sample size in the two groups.

Patients with reoperations for myocardial revascularization and coronary operations associated with any other cardiac surgical procedures were excluded.

All procedures were performed by the same team. All the operations were performed via a median sternotomy and using cardiopulmonary bypass machine. Heparin was administered at a dose of 300 IU/kg to achieve a target activated clotting time of 480 seconds or greater. After aortic cannulation followed by two stage atrial cannulation, a 14F retrograde coronary sinus perfusion catheter with a manual-inflating balloon was inserted by palpation of the coronary sinus, just before restoration of (CPB) in the A/R group. If necessary, the catheter was repositioned until the middle cardiac vein was filled, when cardioplegic solution was administered. Cardiopulmonary bypass was instituted using moderate haemodilution with a haematocrit level of 20% to 25% and mild systemic hypothermia (nasopharyngeal temperature, 30-32 °C). Pump flows were 2.0 to 2.2 L/min/m², and the mean arterial pressure was maintained between 50 and 60 mmHg, with administration of nitroglycerin or phenylephrine hydro-chloride as required.

The delivery system for cardioplegic solution was a Y-shaped line with stop-cock on the incoming limb which used for directing the cardioplegic solution antegrade to the aortic root (in both groups) or retrograde to the coronary sinus catheter in group A/R only. The temperature of the blood collected for blood cardioplegia solution was 4°C at a 4:1 blood: solution ratio. After cross-clamping the ascending aorta, we accomplished the induction of cardiac arrest in both groups by giving cardioplegic solution contained

blood (1000 mL), potassium (20 mEq/L), sodium bicarbonate (10mEq/L), and magnesium sulphate (6 mEq/L) delivered into the aortic root ,the whole liter in group A and 2/3 liter in group A/R at a pressure of 60-100 mmHg in the aortic root, followed by coronary sinus infusion of the 1/3 liter (200 to 400 mL/min) at a pressure of 30-50 mmHg in the coronary sinus in group A/R. The maintenance solution contained blood (500 mL),potassium (10 mEq/L), and sodium bicarbonate (5 mEq/L) which was given with an antegrade infusion in group A and retrogradely through the coronary sinus in group A/R every 20 minutes. Cardioplegia was never given simultaneously by the two routes. The left internal mammary artery (LIMA) was used for revascularization of the left anterior descending coronary artery, and saphenous vein grafts were used for the others. Proximal anastomoses were always performed with aortic partial clamping.

All data were collected in a prospective manner and were expressed as mean \pm standard deviation (SD). Analysis of continuous variables was performed with Student's t-test, and that of repeated measures was performed with a 2-way analysis of variance test. Categorical variables were expressed as percentage and were compared by χ^2 statistical analysis. All analyses were performed using SPSS software, 2 versions 15 (SPSS, Inc. Chicago, IL). Results were considered significant when P values < 0.05 .

Results

Both groups were comparable regarding the perioperative characteristics, as shown in Table (1). There was no significant difference between the two study groups in gender, age, body surface area , extension of the disease, pre-operative ejection fraction and comorbidities (diabetes, hypertension and COPD).

Table 1. Preoperative Clinical and Angiographic Characteristics of the Patientsa

Characteristic	Antegrade Group (n =75)	antegrade-retrograde Group (n = 75)	P Value
Age (years)	60 \pm 9.4	61 \pm 8.8	0.45
Sex (M/F)	57/18	53/22	0.46
Height (Cm)	165.6 \pm 9	163 \pm 7.9	0.07
Weight (Kg)	72.7 \pm 13.2	70.1 \pm 11.9	0.19
BSA (m2)	1.8 \pm 0.19	1.75 \pm 0.16	0.08
Smoking	40 (53.3%)	36 (48%)	0.51
Opium usage	26 (34.7%)	23 (30.7%)	0.60
Hypertension	30 (40%)	27 (36%)	0.61
Hyperlipidemia	32 (42.6%)	43 (57.3%)	0.07
Diabetes	26 (34.7%)	20 (26.7%)	0.28
COPD	3 (4%)	2 (2.7%)	0.64
Left.main stenosis (>50%)	3 (4%)	3 (4%)	1
Urgent CABG	4 (5.3%)	5 (6.7%)	0.73
Pre op EF (%)	46.5 \pm 8.8	44.2 \pm 9.3	0.11
Pre op CPKMB	15.8 \pm 24.3	20.9 \pm 14.6	0.11
Preop. Troponin	0.19 \pm 0.37	0.26 \pm 1.6	0.70

There was no significant difference between the groups in regard to the number of bypassed vessels, duration of aortic cross-clamping, total cardiopulmonary bypass and total operation time (Table 2). With an average of 3.25 grafted ves-

sels per patient, complete revascularization was achieved in all of the patients.

The biochemical markers for MI showed no statistical difference between groups in terms of Troponin sampling

from postoperative hours 12 and 24.

Total serum CPK activity and CPK MB sampling 1 and 24 hours postoperatively has no significant difference between groups ($p>0.05$). (Table 3).

Table 2. Comparison of Operative Data Between the Two Groups

Variable	Antegrade Group (n = 75)	Antegrade-Retrograde Group (n = 75)	P Value
Aortic cross-clamp time (min)	36.9 ±13.7	34.6 ±8	0.84
Duration of CPB	64.1 ±23.2	66.3 ±16	0.49
Duration of surgery	218.8 ±52.4	226.6 ±43.4	0.32
Grafted vessels per patient (no)	3.2 ±0.4	3.3 ±0.4	0.80

Table 3. Comparison of Postoperative Data Between the Two Groups

Variable	Antegrade Group (n=75)	Antegrade-Retrograde Group (n=75)	P Value
Troponin at 12 h	1.76 ±1.88	1.64 ±4.58	0.85
Troponin at 24 h	1.1 ±1.26	1.01 ±1.41	0.81
CPK at 1 h	451.8 ±436.9	92.3 ±10.19	0.07
CPK-MB at 1 h	48.6 ±24.7	50 ±57.67	0.85
CPK at 24h	841.9 ±798.6	1086.9 ±1252	0.15
CPK-MB at 24 h	58.1 ±52	48.8 ±40	0.22
Post operative EF	43.6 ±7.5	43.4 ±8	0.88
Mechanical ventilation time (hours)	12.4 ±13.3	10.8 ±22.2	0.59
ICU stay (day)	2.67 ±1.5	2.59 ±2.1	0.79
Hospitalization time (day)	7.6 ±2.5	7.8 ±2.6	0.58

There was no difference ($p>0.05$) in the in-cidence of postoperative myocardial infarction (12% versus 8%).

There was no significant difference in the need for pharmacologic(inotropic) or mechanical (IABP) support postoperatively.

Postoperative bleeding has no significant difference be-

tween groups .The incidence of mediastinal hemorrhage and tamponade that required surgical exploration was similar between groups.

The incidence of stroke, acute renal failure (ARF), pulmonary complications, arrhythmias, wounds infections was similar between groups. There were no complications from right ventricle dysfunction and ischemia.

There were no complications of retrograde cardioplegia catheter including rupture or perforation of the sinus, hematoma, and rupture of the catheter cuff.

Two hospital deaths (1 from each group) among 150 patients were noted (1.3 %). Both patients presented with pre-operative MI and underwent urgent CABG. The cause of death was free wall LV rupture in group A and respiratory failure and pneumonia in A/R group (Table 4).

ICU stay, hospital stay and predischarge ejection fraction were similar in both groups.

Table 4. Comparison of Postoperative morbidity and mortality Between the Two Groups

Variable	Antegrade Group (n=75)	Antegrade-Retrograde Group (n=75)	P Value
MI	9 (12%)	6 (8%)	0.41
Need to Inotropes	13 (17.3%)	9 (12%)	0.35
Need to IABP*	2 (2.7%)	1 (1.3%)	0.56
Post op 24h bleeding volume(ml)	465±344	428±317	0.49
Reenploration	6 (8%)	2 (2.6%)	0.19
Stroke	1 (1,3%)	0	0.19
Renal failure	3 (4%)	1 (1.3%)	0.31
Pulmonary complications	10 (13.3%)	7 (9%)	0.19
Arrhythmias	3 (4%)	3 (4%)	1
Wound Infental	1 (1.3%)	4 (5.3%)	0.17
Mortality	1 (1.3%)	1 (1.3%)	1

*Intra aortic balloon pump

Discussion

Different strategies are used to keep the myocardium alive during on-pump coronary artery bypass grafting(4). Furthermore, there is no consensus on using an optimal method for the protection of myocardium during ischemic arrest, although it has been debated since the beginning of open heart

surgery (11). Myocardial protection during cardiac operations depends on adequate delivery of cardioplegia solution to all regions of the heart (12). The infusion of cardioplegic solution through the aortic root produces very quick diastolic arrest and good preservation of myocardial function. However, when advanced coronary disease is considered, it can result in an unequal distribution and consequently delayed functional recovery (13). It can be overcome by coronary sinus cardioplegia, when the unobstructed coronary venous system can be used as a route for homogenous distribution (4,11)

Several clinical studies indicate that retrograde cardioplegia provides adequate myocardial protection in the human (15). Evidence of a more homogenous distribution of cardioplegia is suggested with the retrograde route (13). In the presence of complete coronary artery occlusion, this method would appear to result in a better perfusion of the ischemic myocardial area (12,11)

More recently, studies have shown that the right ventricular myocardium is poorly perfused with retrograde cardioplegic infusion in the human (16,17). Uneven distribution of cardioplegia administered through the coronary sinus has also been found in the experimental animal, confirming the findings of clinical studies that the right ventricle and posterior septum are particularly at risk (18,19).

These results have stimulated the use of combined antegrade and retrograde infusion of cardioplegia to alleviate the problem of uneven distribution (2, 4, 8). Shirai and colleagues found that myocardial function was better preserved with alternate compared with simultaneous antegrade and retrograde cardioplegic infusions, although the latter method was more practical with a lesser risk of coronary air embolism (20).

Michel Carrier, MD and colleagues and also Aurel C. Cernaianu, MD and colleagues showed that defibrillation attempts and spontaneous return to sinus rhythm, the use of intraaortic balloon pump counterpulsation, and inotropic support during weaning from cardiopulmonary bypass, were not statistically different between the two groups. The postoperative cardiac output, electrocardio-graphic and cardiac enzyme evidence of ischemia, the need for temporary pacing, and 30-day morbidity and mortality were similar for both groups.(10, 22)

In our study the two groups did not differ significantly in

regard to their preoperative clinical and angiographic profile, surgical characteristics, and cardioplegic solution infusions other than the route of administration. None of the postoperative variables used as end points differed between groups.

In present study the incidences of elevated amounts of myocardial biomarkers were similar in both study groups, however, the rate of post-operative MI was lower in A/R group but this difference was not statistically significant. So it seems that the combined antegrade & retrograde route of cardioplegia infusion cannot improve the myocardial management at least in non-complex primary routine cases. Also there were no differences in early mortality and morbidity between the two groups.

Although the need for inotropic agents and intra aortic balloon pump after the procedures were lower in A/R group but this difference was not statistically significant.

A number of drawbacks were associated with retrograde perfusion, including coronary sinus rupture, myocardial edema) and right atrial conduction irregularities (14). The older techniques of retrograde perfusion required direct visualization of the coronary sinus and right atrial exclusion. However, a transatrial technique of retrograde perfusion through a balloon-tip catheter helps to simplify cannula insertion and to avoid injury both to the coronary sinus (by eliminating the need for purse-string sutures) and to the right atrium (by reducing the need to manipulate it)(21). In the present study, there was no failure of retrograde cannulation (crossover to the antegrade group) and we did not have any coronary sinus catheter insertion complications.

In conclusion, although Retrograde Administration of Blood Cardioplegia is a safe and simple procedure, but it seems that the routine use of this method cannot improve the patient early outcome significantly in patients underwent primary CABG with non-complex coronary lesion with an aortic cross clamping less than 40 minutes. It is clear that for achieving the definitive results, we need to conduct more studies with more patients. We believe that the combination of retrograde and antegrade route of administration of cardioplegia will be useful for high risk patients including left main or complex coronary lesion, patients with LV dysfunction or concomitant valve procedure and all cases with prolonged ischemic time.

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Pulmonary Valve Replacement in Patients With Congenital Heart Disease: Is There Any Place for Mechanical Valves?



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Abstract:

Background: We would report the results of 112 mechanical valve replacements in the position of pulmonary valve during 6 years in the Rajaie Heart Center.

Material & Methods: Between March 2004 and September 2010, 246 patients underwent pulmonary valve replacement for a congenital heart defect. In 112 cases (45.5%) a mechanical valve was implanted in the pulmonary position. These 112 patients were the subject of our retrospective descriptive study. All cases were followed on a pre-determined regular interval in our center (2 weeks, 3 & 6 months post-operatively and then every six months). Special attention was paid to RV function and prosthetic valvular performance by trans-thoracic and/or trans-esophageal echocardiography. Statistical analyses were performed using SPSS software (version 19). All data are presented as mean values \pm standard deviation (SD) or percentages. The χ^2 test or the Fisher's exact test was used for the comparison of categorical variables. Student's T-test or Wilcoxon's signed rank tests were used for the comparison of parametric and non-parametric variables, respectively. Any P value of less than 0.05 was considered statistically significant.

Results: Mean age: 21.8 ± 9.06 yrs (Range: 3.5-58 yr). They consisted of 82 (73.2%) male and 30 (26.8%) female. TF was the most common basic lesion in 89 patients (86.4%). Mean time of follow-up was 27.27 ± 16.16 months, (Range: 6-72 months). Mean duration of ICU and hospital stay was 3.17 ± 3.14 days & 10.12 ± 6.13 days, respectively. A positive past history of Gore-Tex shunt was present in 21 (18.8%) and in 9 patients (8%) PVR was their first operation without prior history of any intervention. Dyspnea on exertion was the most common presenting symptom (82, 73.2%). Severe PI associated with RV-dysfunction was the most common indication for PVR. Ironically in 6 patients (5.4%), PVR was performed due to degeneration of previous biologic valve in the pulmonary position. Most patients had moderate RV dysfunction before operation (44, 39.3%).

Post op hemorrhage requiring re-exploration was noted in 8 (7.2%). Prosthetic valve malfunction was present in 12 cases (10.8%); of whom, 8 (66.6%) improved with SK infusion and did not require re-operation. Redo surgery for valve replacement was required in 4(3.6%). Freedom from re-operation at 1 yr was 100% and at the mean follow-up period (27.27 months) was 96.4%. Mean interval between PVR and malfunction was 19.84 ± 12.11 months. Other complications were as follows: Subdural hematoma in one (0.9%), GI complications in 2 (1.8%), Pulmonary complications in 7 (6.3%), Anticoagulation related hemorrhage in 3 (2.7%), post op arrhythmia in 5 (4.5%), superficial or deep wound infection in 2 (1.8%), HIT in one (0.9%), Warfarin toxicity in 2 (1.8%) patients. There was no evidence of thrombo-embolic

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complications. No post-op renal complication was noted. Post op mortality was observed in 4 (3.6%) which included one intra-operative (0.9%) and 3 in hospital mortality (2.7%). There was no statistically significant relationship between sex and post op complications. Again there was no significant relationship between sex and age with mortality. Post op LVEF as well as post op RV function improved following PVR ($P=0.033$ and, $P=0.004$ respectively).

Conclusions: We do not confirm the bad reputation of mechanical valvular prosthesis in the pulmonary position in our center; on the contrary they perform well and potentially results in lower re-operation rate than can be expected after bio-prosthesis usage. No thrombo-embolic complications were noted. Crucial is anti-thrombotic therapy with Coumadin's, maintaining an INR of 2.5-4. Therefore mechanical valvular replacement of the pulmonary valve may be considered as an alternative to biologic valves in patients with multiple previous operations and in patients requiring anticoagulation for other reasons, especially in this young age group.

Key words: TOF: Tetralogy of Fallot, PVR: pulmonary valve replacement, SK: Streptokinase

Introduction:

With the advances in surgical techniques and peri-operative care, complete repair of Tetralogy of Fallot (TOF) is being performed earlier, and in younger age-groups [1-3], with a view to early elimination of hypoxemia and thus promotion of normal growth and organ development [2]. The early mortality of TOF repair in patients beyond infancy is low [4] and many survive to adulthood. Many of them, however, present later in life with increasing exercise intolerance and progressive right ventricular dilatation, dysfunction, or failure [5]. It has been suggested that chronic pulmonary regurgitation (PR) after complete repair of TOF together with myocardial scarring contributes to such deteriorating right ventricular performance [6], many of whom eventually underwent pulmonary valve replacement (PVR), although the timing of such an intervention is still debated. For these patients benefit from PVR may also extend to improved exercise capacity and right ventricular function [11]. Pulmonary regurgitation (PR) is encountered not only after surgical repair of TOF but also following any surgical procedure to relieve pulmonary valve stenosis with or without a trans-annular patch [7].

PR is well tolerated by most patients for many years [8]. However; the chronic effects of long-term volume overload, have deleterious consequences on the RV function. Exercise capacity decreases, and supra-ventricular and ventricular arrhythmia may even lead to sudden cardiac death [9]. An increase in pulmonary micro-vascular resistance combined with restricted RV diastolic physiology and RV dilatation, even with the onset of tricuspid regurgitation, is the most effective predictor of PR and chronically leads to RV fibro-

sis [10]. Most surgeons replace the pulmonary valve with a bio-prosthesis either xenograft or allograft [12-14]. However; these valvular substitutes both deteriorate over time, making (potentially multiple) reoperations necessary, each associated with morbidity and mortality [15-17]. Additionally, patients usually do not enjoy the prospect of multiple re-operations. Replacement with mechanical valvular prostheses most likely reduces the number of reoperations but has a less favorable reputation.

We offered implantation of a mechanical valvular prosthesis mainly to our adult patients, in order to minimize the expected total amount of operations. Our aim is to report the medium term results of this policy.

Materials and Methods:

Between March 2004 and September 2010, 246 patients underwent pulmonary valve replacement for a congenital heart defect in our center. In 112 cases (45.5%) a mechanical valve was implanted in the pulmonary position. These 112 patients were incorporated into study. Clinical indications for PVR included: (1) Symptomatic patients with right heart failure and moderate-to-severe dysfunction of the pulmonary valve and (2) asymptomatic patients with moderate-to-severe dysfunction of the pulmonary valve and evidence of significant RV dysfunction. In view of sex distribution, they were 82 (73.2%) male and 30 (26.8%) female. Mean age of PVR was 21.8 ± 9.06 yrs (Range: 3.5-58 yr). TOF was the most common primary diagnosis (89, 86.4%). A positive history of Gore-Tex shunt was present in 21 (18.8%) and in 9 patients (8%), PVR was their first operation without prior history of any intervention.

Table 1 and 2 outline some pre-op characteristics of our patients.

Table 1: Mean of pre-op characteristics of patients

	Mean	Min	Max
Age at previous operation (years)	8.03±5.19	2	37
Age at PVR (years)	21.8 ±9.06	3.50	58
Time interval between 2 operations (years)	13.23±5.97	0.3	31
BSA* (m2)	1.56±0.31	0.51	2.02
LVEF (%)	50.18±10.57	30	85
Size of RVOT aneurysm (cm)	4.3±0.84	0.43	7

Table 2: Prevalence of some pre-op characteristics

	N	Percent (%)
Primary diagnosis	89	86.4
TF	14	13.6
Others		
Number of sternotomy	9	8
1	98	87.5
2	5	4.4
3		
CPB before sternotomy	7	6.2
History of Gore-Tex shunt	21	18.8

Surgical technique:

All operations were performed through a median sternotomy and subsequent cannulation of the ascending aorta and caval veins in 105 patients, in the remaining 7 patients cardiopulmonary bypass was established before redo sternotomy with cannulation of femoral artery and vein for increased safety. Aortic cross clamping was performed in all cases and heart was arrested using antegrade injection of cardioplegic solution but it is not mandatory. An incision was made into the right ventricular outflow tract (RVOT), the native pulmonary valve, if present, was resected and valve replacement performed with a mechanical valve. St. Jude Medical mechanical valve was chosen in 95 (84.8%) patients. In the remaining 17 (15.2%) Carbo-Medics mechanical valve was implanted according to the surgeon's preference. Usually about two thirds of the circumference of the prosthetic valve was sutured to the infundibular septum,

at the insertion of the original pulmonary valve to allow for insertion of a prosthetic valve of adequate size. The remaining roof was constructed with a diamond shaped patch of Dacron, covering the RVOT, as well as the pulmonary trunk. For the remaining one third of the circumference the patch was sutured to the valve prosthesis. The appropriate concomitant operation was conducted based on pre-op investigations such as repair of residual VSD or relieving PA branch stenosis.

Provided there was no excessive post op bleeding, heparin infusion was commenced for all patients six hours following operation with PTT monitoring in the range of 50-70. They were on warfarin regimen, the day after surgery with the target INR of 2.5-4.

Follow-up: All cases were followed on a pre-determined regular interval in our center (2 weeks, 3 & 6 months post-operatively and then every six months). Special attention

was paid to RV function and prosthetic valve performance by trans-thoracic and/or trans-esophageal echocardiography. Mean time of follow-up was 27.27 months (Range: 6-72 months).

Statistics:

Statistical analyses were performed using SPSS software (version 19). All data are presented as mean values \pm standard deviation (SD) or percentages. The χ^2 test or the Fisher's exact test was used for comparison of categorical variables. Student's T-test or Wilcoxon's signed rank tests were used as appropriate for comparison of parametric and non-parametric variables, respectively. Any P-value of less than 0.05 was considered statistically significant.

Table 3: Post-op characteristic of patients

Characteristic	Mean	Min	Max
LVEF (%)	51.52 \pm 9.49	25	78
ICU stay (days)	3.17 \pm 3.14	1	21
Hospital stay (days)	10.12 \pm 6.13	1	40
Post-op bleeding (cc)	257.31 \pm 263.12	0	1800
Peak trans-valvular gradient (mmHg)	16.62 \pm 7.89	5	75
Mean trans-valvular gradient (mmHg)	8.81 \pm 4.85	2.5	45
Follow-up period (months)	27.27 \pm 16.16	6	72

Results:

Follow-up was completed in 100% of cases. Mean follow-up time was 27.27 \pm 16.16 months (Range: 6-72 months). Mean length of ICU and hospital stay was 3.17 \pm 3.14 days and 10.12 \pm 6.13 days respectively. The amount of post-op hemorrhage within first 24 hr of surgery was 257.3 \pm 263.12 cc (Range: 0-1800 cc). Table 3 shows some post-op characteristics of patients.

Isolated PVR was accomplished in 46 patients (41.1%). Repair of residual VSD was the most common concurrent operation (13, 11.6%). In 4 (3.6%) patients, coincident PVR and correction of TOF was conducted.

Dyspnea on exertion was the most common presenting symptom, (82, 73.2%). 12 (10.7%) of the patients were asymptomatic at the time of operation and discovered based on routine follow-up incidentally. Severe PI associated with RV dysfunction was the most common indication for PVR (71, 63.4%). Ironically, in 6 (5.4%) PVR was performed due to degeneration of previous biologic valve in the pul-

monary position.

Most patients had moderate RV dysfunction before operation (44, 39.3%).

With respect to the size of mechanical valve, 25 was the most commonly used valve size; (57, 50.9%), followed by size 23; (38, 33.9%).

In view of post-op complications; post op hemorrhage requiring re-exploration was noted in 8 (7.2%). Prosthetic valve malfunction was present in 12 (10.8%); of whom, 8 (66.6%) improved with SK infusion and did not require re-operation. Redo surgery for valve replacement was required in 4 (3.6%). Freedom from re-operation at 1 yr was 100% and at the mean follow-up period (27.27 months) was 96.4%. Mean interval between PVR and malfunction was 19.84 \pm 12.11 months. Other complications were as follows: Subdural hematoma in one (0.9%), GI complications in 2 (1.8%), Pulmonary complications in 7 (6.3%), Anticoagulation related hemorrhage in 3 (2.7%), post op arrhythmia in 5 (4.5%), superficial or deep wound infection in 2 (1.8%), HIT in one (0.9%), Warfarin toxicity in 2 (1.8%) patients. There were no evidence of thrombo-embolic complications. No post-op renal complication was noted. Post op mortality was observed in 4 (3.6%) which included one intra operative (0.9%) and 3 in hospital mortality (2.7%). Using statistical methods and calculation of P value, no statistically significant relationship was detected between sex and post op complications. Again there was no significant relationship between sex and age with mortality. Post op LVEF as well as post op RV function improved following PVR (P=0.033 and, P=0.004 respectively).

Discussion

Pulmonary valve replacement is performed in an increasing number of patients for pulmonary regurgitation causing right ventricular failure, mostly late after the correction of Tetralogy of Fallot [18]. These patients have right ventricular failure and often have ventricular rhythm disturbances, but can be treated easily by pulmonary valve replacement. Studies have shown that early restoration of pulmonary valve competence can result in restoration of the right ventricular function and exercise capacity, but the exact timing of such intervention remains controversial [19]. The traditional method for restoration of pulmonary valve competence is by surgical PVR using a mechanical, or bio-prosthetic valve, jugular vein valved conduit, or homograft.

Pulmonary homograft has the advantage of providing low trans-valvular gradient, and good long-term outcomes without the need for anticoagulation. In many centers, however their cost and availability may prevent their use [20-21]. A mechanical prosthesis has the advantages of a low re-operation rate, but the need for long-term anticoagulation and potential thrombo-embolic complications and risk of bleeding are drawbacks. The majority of our patients had bioprosthetic PVRs. These valves are readily available and require only short-term anticoagulation.

In our center from 2004 to 2010 during 6 years, of 246 patients, PVR was performed with bioprosthesis in 134 (54.5%) and mechanical valve in the remaining 112 (45.5%) of the patients.

Despite the unfavorable reputation, we showed that mechanical pulmonary valvular replacement can be performed with promising early and mid term results. These results are not surprising from a theoretical stand point, since flow through these prostheses is essentially the same as through an aortic valvular prosthesis, although that pressures are obviously much lower [22].

Why mechanical pulmonary valve replacement has such an unfavorable status is somewhat of a mystery. Until recently there was almost no support for this strategy in the literature, on the contrary implantation of mechanical valves is advised against because of hearsay evidence of pulmonary thrombo-embolic complications [23].

Reviewing the literature reveals that most studies especially more recent ones, have emphasized on mechanical valves as an alternative to bio-prosthesis in the pulmonary position [22, 24-29].

On the other hand, if we pay attention to the studies that discourage the use of mechanical valves in the right side of the heart, it will be clarified that most of these, have performed during 1989-91 i.e. Nearly two decades ago and mainly in one country (Japan) and they lack sufficient samples and acceptable follow-up period [30-32].

Furthermore, in some studies there was no statistically significant difference between mechanical and bio-prosthesis outcomes, nonetheless, the use of mechanical valve has been discouraged relying on theoretical points [33].

We believe that there is insufficient evidence against the use of mechanical pulmonary valve prostheses, although the experimental work of Kiyota et al must be taken into ac-

count. [34] This study reports in vitro experiments on leaflet closure of mechanical bi-leaflet valves in low-pressure circumstances and conclude that forces in the pulmonary system are insufficient to close both semi-discs at all times and that as a result, pulmonary regurgitation remains in this experimental setting. Although the authors advocate in vivo assessment of mechanical valves in a low-pressure system, we could not find any subsequent report on these views. On the contrary, our clinical echocardiography studies did not show any evidence of regurgitation of the mechanical valvular prosthesis, apart from the normal early diastolic jets, that also can be seen after placement of a mechanical valve in the aortic position.

The drawback of the need for anticoagulation is counterbalanced by the prospect of the likely absence of re-operations due to valve malfunction as compared to biological valvular substitutes.

The reported freedom from reoperation of allograft in the right ventricular outflow tract varies in different papers. The most favorable figures are 89% actuarial freedom from reoperation at 10 years and 80% at 20 years [35]. Other papers report 81% at 5 years and 70% at 7 years [16]. Second and third replaced allograft fare worse [15], so that the interval between reoperations becomes shorter over time. Preservation techniques of allograft and subsequent rejection-like phenomena play a role, as yet not fully elucidated [36]. Multiple re-operations are to be anticipated in this strategy, when taking the otherwise good life expectancy of these patients into account, a prospect most patients do not relish.

Xenografts can also be used in the right ventricular outflow tract, and have a reported 10 year survival of 85% [17]. Essentially, Xenografts have the same drawback as allograft do, resulting in multiple reoperations. Patients with an allograft or Xenografts therefore have an estimated risk of reoperation of 15-20% in 10 years [37]. Mean age of our patients was 21.8 years, taking into account their normal life expectancy; multiple reoperations could be expected with the use of tissue valves.

In our study of 112 patients with mechanical valvular PVR, six cases were due to degeneration of previous biologic valve within less than 5 years of their implantation. Out of the total 112 patients who underwent PVR with mechanical valve, prosthetic valve malfunction was observed in 12

(10.8%) during follow-up period with the mean interval of 27.27 ± 16.16 months following PVR, most of whom improved with streptokinase and did not require reoperation. Reoperation was needed in 4 (3.6%) patients with the minimum interval of 14 months & maximum, 48 months, thus freedom from reoperation within one year of operation was 100% and during mean follow-up of 27.27 months was 96.4%

The risk of thrombo-embolic and bleeding complications in patients on oral anticoagulant therapy for mechanical heart valves has been thoroughly analyzed by Cannegieter et al [38]. The linear risk of cerebral emboli was 0.68 per 100 patient-years, whilst the risk of peripheral emboli was much lower at 0.03 per 100 patient years, most likely due to the lack of detection of the latter. These embolic risks must theoretically be similar for pulmonary valvular prostheses. Thus the embolic risk of a mechanical pulmonary valvular prosthesis seems to be slight. The risk of thrombosis of the valve must also be minimal when anticoagulation is adequate.

Bleeding complications, in the Cannegieter paper [37], whether intracranial or spinal, were reported to be 0.57 per 100 patient years.

It is difficult to compare these risks because of their disparate nature. In our opinion, mechanical PVR and bio-prosthetic PVR probably do not differ in the incidence of complications, but do, in mode of complication. Where patients that need re-do operations risk mortality, patients that use anti-coagulant medication, suffer more from morbidity, albeit during entire lifetime. Furthermore we do realize that fatal thrombo-embolic or bleeding complications do occur occasionally. We advocate maintaining an INR of 2.5-4.

In our study of the total 112 patients who underwent PVR with mechanical valve, 4 (3.6%) mortality was noted which included 1 intra-operative (0.9%) and 3 (2.7%) during hospitalization. None of the fatalities could be attributed to the type of prosthesis used (mechanical valve).

As previously described, no statistically significant relationship was noted between sex and age of the patients with mortality.

Another important point which deserves mentioning was the significant relationship between pre & post-op myocardial performance, so that both ventricles showed improved function following operation. In the case of RV, owing to

relieving PR and consequent volume overload, this is predictable, however concerning LV, it could be interpreted that RV distention due to PR leads to deviation of interventricular septum toward LV and results in decreasing LVEF. However ameliorating the distention of RV, resulted from PVR might potentially be responsible for improved post-op LVEF.

We confess to special limitations in our study. In addition to defects in medical records of patients in some instances, insufficient follow-up period could not be overlooked; so that only mid-term results (maximum 6 yrs) were evaluated. It's obvious that studies with more samples and longer follow-up are needed to investigate the long-term results of mechanical valves in the pulmonary position. Furthermore studies incorporating two groups of patients are required to compare special valve-related outcomes between commonly used bio-prostheses and mechanical valves in the RVOT position.

Conclusion

Replacement of pulmonary valve with mechanical valve prosthesis can be performed with promising early and mid-term results. The unfavorable reputation of PVR with mechanical bi-leaflet valve prosthesis must be reconsidered in the light of our findings. Our experience is in keeping with that of others, but consists of more patients and a longer follow-up. Anti-thrombotic therapy with coumadins is critical, maintaining an INR of 2.5-4. On the condition that this can be managed, fewer reoperations can be expected. Patients that fulfill with this condition can safely be offered replacement of their pulmonary valve with mechanical valve prosthesis. Complications due to anti-thrombotic therapy will occur but must be weighed against the complications of multiple re-operations. Therefore, mechanical valve replacement in the position of pulmonary valve could be considered as an alternative to bio-prostheses especially in patients with multiple prior operations or when there is another need for warfarin anticoagulation as in rhythm disturbances.

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Does Clopidogrel Increase Blood Loss Following Coronary Artery Bypass Surgery?

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Abstract:

Introduction

Clopidogrel treatment is associated with a reduction in thrombotic complications in coronary stent placement, improved outcome after acute coronary syndromes and decreased mortality in patients with coronary artery disease. The purpose of this study was to analyze the effect of preoperative clopidogrel exposure on bleeding complications, blood transfusion requirement and reoperations and ICU and ward stay and mediastinitis in patients undergoing coronary artery bypass grafting (CABG).

Materials and Methods:

This study included 82 patients from a single institution (Shahid Rajaie Hospital) that underwent an isolated CABG who were discharged 2010. The cohort of 82 patients was classified into 2 groups. The control group consisted of 46 patients that did not receive clopidogrel or stopped 5 days before surgery but were treated with aspirin and clopidogrel group consisted of 36 patients that were taking clopidogrel within 5 days of surgery.

Patients were compared based on preoperative data (age, gender, use of clopidogrel, ejection fraction), intraoperative data (cross clamp & CPB time) and postoperative data (chest tube output, rate of reoperation, units of transfused blood length of stay in the intensive care unit and ward).

Results:

There were no significant differences among 2 groups concerning age, sex and ejection fraction. There were no differences in length of intensive care unit and ward stay among 2 groups. Patients in clopidogrel group had more units of platelet transfusion than the control group ($P=0.001$). There is also a non significant trend toward more chest tube output in clopidogrel group compared with the control group, the mean chest tube output in clopidogrel group was 1185 ± 850 ml and in control group was 1020 ± 590 ml ($P=0.305$). 7 patients of the total group required reoperation secondly to bleeding, 5 patients in clopidogrel group (13.9%) and 2 patients (4.3%) in control group but was not significant statistically ($P=0.125$).

Conclusions:

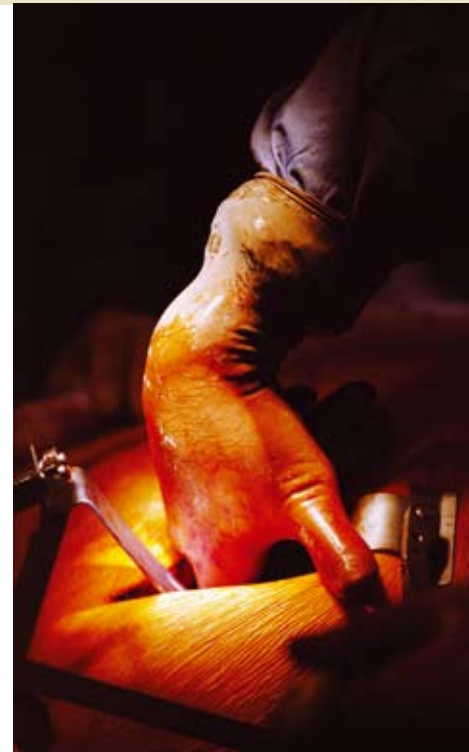
This study demonstrated that clopidogrel within 5 days preoperatively increases the requirement for platelet transfusion and packed cell transfusion only in clopidogrel group that needed reoperation for hemostasis. The reoperation rate of patients that took clopidogrel within 5 days of their procedure was not different from reoperation rate of the patients that did not take clopidogrel.

Our results don't support the recent history of clopidogrel treatment associated with increased blood loss. Transfusion and reoperation was required after CABG.

Key words: CABG; clopidogrel; postoperative blood loss

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Introduction:

Postoperative bleeding following coronary artery bypass surgery necessitates re-exploration in approximately 3% of cases and can cause significant morbidity and mortality. Other than inadequate control of bleeding during surgery, small body size, female gender, concomitant procedures, urgency status, and increased cardiopulmonary bypass time have been previously identified as risk factors [1,2]. In 50% of re-exploration for bleeding no identifiable cause is found [1,3]. Since platelet dysfunction is a crucial part of bleeding after cardiopulmonary bypass [4], antiplatelet agent, adding insult to already dysfunctional platelets, can also affect hemostasis in the postoperative period. Generally these agents are discontinued at the appropriate time before operation to ensure adequate platelet function at the time of operation. However in a group of patients it may not be possible to delay surgery due to ongoing ischemia. Those patients have generally received more potent antiplatelet agents like clopidogrel.

Clopidogrel, a thienopyridine is an irreversible and potent inhibitor of platelet aggregation and has been mainly used to prevent clotting complications immediately before and after intracoronary stenting. Additionally, in patients with acute coronary syndrome, carotid and peripheral vascular disease and acetyl salicylic acid (ASA) intolerance, the cardiologist has been increasingly favoring clopidogrel [5]. As a result more patients are undergoing elective, urgent or emergent CABG while under the influence of clopidogrel. Its beneficial effect on preventing clot formation may return to hazardous on hemostasis in patients who need urgent or emergent CABG. The aim of this study was to evaluate the effects of clopidogrel on blood loss and blood product usage following CABG.

Methods:

2.1 Patient population

Eighty two consecutive patients underwent isolated coronary artery bypass graft (CABG) by the same surgery team between August 2009 and August of 2010; 36 of those patients had clopidogrel exposure (group 1) within 5 days of operation and remaining 46 patients were not on clopidogrel therapy (group 2) within 5 days of operation. Exclusion criteria included off-pump bypass, reoperations, end stage renal failure, severe liver dysfunction, preexisting bleeding disorders and warfarin usage. Mean age in group 1 was

61±0.6 years and mean age in group 2 was 57.5±8.6 years. There were 52 men (27 in group 1 and 25 in group 2) and 23 women (9 in group 1 and 14 in group 2). Mean LVEF in group 1 (on plavix) was 44%±7.4% and mean LVEF in group 2 (without plavix) was 44.2%±9.15. The left internal mammary artery (LIMA) was used in all of 82 patients (100%). Preoperatively intraaortic balloon counter pulsation was not used in any of the patients. All the operations were performed on-pump with the use of a standard circuit and crystalloid prime. Anticoagulation was achieved with heparin. Aprotinin was not used for any of the patients. The degree of hypothermia induced during CPB was monitored by using an nasopharyngeal temperature probe and ranged from 30 to 32±C. Patients were rewarmed to a target temperature of 37±C before CPB was discontinued. After weaning from CPB heparin was neutralized with protamine sulfate (1-1.5 mg/100 U heparin). During extracorporeal perfusion, transfusion of red blood cells was performed when hematocrit value decreased under 0.20. Postoperative transfusion of packed red blood cells was found to be indicated when hematocrit value was lower than 0.21. The clinical criterion for platelet and fresh frozen plasma (FFP) transfusion in the operating room, just before closing the sternum, was excessive microvascular bleeding despite normalized ACT as determined by the surgeon and in the ICU; the clinical criterion was chest tube drainage of greater than 250 ml/h after the first hour despite normalized ACT. In the patients with excessive bleeding, platelet count, bleeding time and ACT were done to assess global coagulation status. Surgical re-exploration was found to be indicated when bleeding exceeded 400ml during the first hour or when it was more than 300 ml/h during the next 3hrs despite ACT and global coagulation status. The pre-operative demographics, pre-operative co-morbidities, pre-and postoperative variables of these groups were compared (Table 1). Total chest tube drainage during the first 48 hour, the incidence of re-exploration, the exposure to blood products and the early outcome (The intensive care unit stay and total surgical ward stay) were assessed.

2.2. Statistical analysis

Continuous preoperative, intraoperative and postoperative variable are expressed as the mean ±SD. Dichotomous variables are shown as percentages. Mean differences between

the groups were analyzed using the Fisher exact Chi-square analysis using SPSS statistical software. Variables were considered significant at P values <0.05.

Results:

The baseline characteristics of the patients in each group were comparable in age, gender and body surface area (Table 1).

Table 1: Preoperative variables

	Group 1	Group 2	P value
Age	71±0.7	57.5±8.6	ns
Gender (% male)	27 (75%)	62 (69.6%)	ns
Body mass index	22.4±2.6	25.9±1.4	ns
Diabetes (%)	16 (44.2%)	27 (58.71)	ns
Hypertension (%)	16 (44.4%)	20 (43.5%)	ns
Preoperative EF (%)	44.3±7.4	44.2±9.5	ns
HCT	35±11	36±12	ns
aPTT(s)	32.4±4.4	32.7±4.4	ns

ns: not significant

The baseline hematocrit and platelet levels were also comparable between the groups. The mean number of grafts per patient was 3.6±0.8 in group 1 (on plavix) and in group 2 (without plavix) was 3.5±0.9 without significant difference statistically. We did not find any significant difference in bypass time, cross-clamping time and use of LIMA (Table 2).

Table 2: Intraoperative variables

	Group 1	Group 2	P value
Number of distal anastomosis	3.6±0.8	3.5±0.9	ns
CPB time (min)	96.7±18.8	99.3±23.6	ns
Cross clamp time (min)	43.1±8.3	46.8±12.5	ns
LIMA (%)	100	100	ns

ns: not significant

Total chest tube drainage was not significantly higher in the patient with clopidogrel exposure (group 1) and an increased amount of transfusion of blood products (platelets) was observed in these patients (Table 3). The mean chest tube in clopidogrel group was 1185±859 ml and in control

group was 1020±590 ml (P=0.305).

Table 3: Postoperative variables

	Group 1	Group 2	P value
Drainage (ml)	1185±850	1020±590	0.305
Re-exploration (%)	13.9%	4.5%	0.202
Packed red blood cells (ml/patient)	450±626	420±44	0.761
Platelet (U/patient)	2.5±1.8	0.85±0.5	0.001
Fresh Frozen plasma (U/patient)	1.7±1.06	1.1±0.6	0.132
Length of ICU stay (days)	4.2±2.1	3.9±1.5	0.505
Length of hospital stay (days)	5.5±3.8	4.8±1.5	0.525

The patients with clopidogrel exposure did not have to be taken back to OR significantly more for mediastinal re-exploration. Mediastinal re-exploration for bleeding was required in 5 patients (13.9%) in group 1 and in 2 patients (4.3%) in group 2 (Exact Fisher test, P=0.202). After re-exploration, no specific sources were identified and bleeding was thought to be secondary to coagulopathy in each case. In terms of total length of hospital stay, clopidogrel within 5 days of operation was not associated with prolonged hospitalization. The mean ICU lengths of stay in group 1 was 4.2±2.1 days and in group 2 was 3.9±1.5 days and the mean surgical ward stay of group 1 was 5.5±3.8 and in group 2 was 4.8±1.5 days with P value=0.505 and 0.525 respectively.

Discussion

The thienopyridine derivative, clopidogrel, is an antiplatelet agent that inhibits the platelet aggregation induced by adenosine diphosphate, thereby reducing ischemic events. Clopidogrel has a significantly rapid onset of activity and has been the drug-of-choice for acute ischemic events. Clopidogrel has been proven significantly to reduce the risk of the composite outcome of death from cardiovascular causes, nonfatal myocardial infarction or strokes; as well as a range of related ischemic events[6]. The CURE trial attests strongly to add clopidogrel to acetyl salicylic acids (ASA) as soon as possible after hospital admission

in patients with unstable angina and myocardial infarction without ST-segment elevation [7-9]. A combination of clopidogrel with ASA, which blocks the thromboxane-mediated pathway, may have an additive effect. Furthermore in patients who are undergoing percutaneous transluminal angioplasty (PTCA) with stenting, short-term ASA treatment plus clopidogrel results in a substantially lower rate of myocardial infarction than does either aspirin alone [7]. These beneficial effects on preventing clot formation may increase the risk of major nonsurgical bleeding in patients who need urgent or emergent CABG [10,11]. Withholding the clopidogrel preoperatively until normal coagulation is restored will be adequate in elective cases. The optimal duration of this delay, however is still unclear. The drug manufacturer recommends that clopidogrel should be discontinued for 7 days prior to elective coronary surgery. In the CURE trial, patients who were withheld from clopidogrel treatment within 5 days prior to CABG had a trend towards more bleeding than these patients in the control placebo group [12]. Chu and associates reported that withholding of clopidogrel for more than 4 days before CABG is not associated with increased blood losses and reoperation for bleeding [11]. However, the management of patients who need urgent or emergency CABG presents a dilemma. Delaying the operation while clopidogrel is withdrawn may end up with a thrombotic episode. On the other hand, if the operation proceeds, surgeon will take the risk of excessive bleeding and possible surgical reexploration and increased blood product which is associated with increased in-hospital morbidity and mortality.

The major objective of this study was to clarify whether blood loss and transfusion requirement would increase in patients undergoing on-pump CABG with a recent history of clopidogrel treatment. Our data and some of others clearly document no excess blood loss in these patients. However, results of the most of others suggested that preoperative use of clopidogrel is associated with increased bleeding and the need for surgical exploration as well as risk of blood and blood product transfusion after CABG [14]. In one of the previous study interestingly, no patients received platelet transfusion and the amount of transfused blood per patient was very low. Comparing with other studies, choosing lower hematocrit levels as criterion for blood transfusion and significant difference between the number of the patients

on study and control groups might explain this result. Chen and associates recently published study aiming to improve transfusion management of patients undergoing CABG with a recent history of clopidogrel treatment [15]. Some of researchers developed an algorithm based on both clinical and laboratory criteria including two platelet function tests (ADP aggregometry and platelet function analyzer 100). Using this algorithm, they were able to reduce transfusion rate significantly, reoperation per bleeding and hospital stay. However, this algorithm may not be practical for most of the patients with postoperative bleeding since ADP aggregometry takes 45min.

The impact of preoperative acetyl salicylic acid (ASA) exposure on transfusions following CABG is controversial. Preoperative aspirin is now suggested to decrease mortality in CABG patients [16]. In previous studies questioning the effect of clopidogrel after CABG, patients were not grouped to analyze the potential synergistic effect of combination treatment of ASA and clopidogrel. In our study, no significant difference on bleeding and surgical exploration were found neither between patients receiving clopidogrel plus ASA and patients receiving ASA and no other antiplatelet treatment.

Despite our results, most of other studies [10-13, 17] have found longer duration of mechanical ventilation and ICU stay in patients with clopidogrel exposure within five days of surgery. There was also a non-significant trend towards longer postoperative hospitalization in these studies.

Conclusion

Our results do not support that in patients with a recent history of clopidogrel treatment it is associated with excessive blood loss, blood transfusion rate and reoperation for bleeding. Prescribing clopidogrel does not necessarily contraindicate elective CABG. CABG should not be delayed.

Limitations

Limitations of this study include all those inherent to any retrospective single institution analysis. All data elements, however, were prospectively entered in a cardiac surgery research data base according to pre-specified definitions and the data analysis was performed using appropriately risk-adjusted statistical models in order to adjust for differences in preoperative risk factors. One might suggest that surgeons and aestheticians could be aware of patients who re-

ceived antiplatelet agents preoperatively, possibly lowering their threshold for administering blood products to them. Although such a bias might have occurred with certain secondary end point, it is unlikely to have affected the primary endpoint (need for reexploration due to hemorrhage).

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Mortality of Pulmonary Artery Banding



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Abstract:

Background: Although pulmonary artery banding (PAB) seems to be a technically simple procedure it presents several peculiarities and is related to a significant morbidity and mortality. We lack information on this procedure in our center.

Methods: Seventy patients who were randomly allocated into two groups underwent anesthesia by Total IV anesthesia, midazolam, fentanyl and atracurim and, in end of surgery each group received morphine sulfate 0.2 mg/kg after arrived in ICU, morphine PCA was started with demand (bolus) dose 1mg, lockout interval 10 minutes. The Tramadol group after separated from cardiopulmonary bypass received an intra operative initial loading dose of Tramadol (1mg/kg) and a postoperative infusion of Tramadol at 0.2 mg•kg⁻¹•h⁻¹. The control group received an intra operative equivalent volume of normal saline and a postoperative saline infusion (placebo). The demographic data of both groups were the same. Post-operative data were recorded in the cardiac intensive care unit at 30 min, 1 h, 2 h, 4 h, 12 h and 24 h after extubation by the same anesthesiologist, who had no knowledge of the groups, and the side-effects were also evaluated.

Results: From January 2003 to December 2009, 100 patients underwent PAB due to congenital heart disease with increased pulmonary blood flow at Imam Reza hospital. They were assessed as for hospital mortality and complications.

Conclusions: We found no improvement in the hospital mortality of pulmonary artery banding. These results will support the preference for primary repair of intracardiac anomalies in small infants.

Introduction

Muller and Dammann introduced pulmonary artery (PA) banding in clinical practice in 1951. Since then, this operation has been used as a palliative procedure for small infants with congenital heart defects, to be followed by definitive repair at an older age [1].

In children with congenital heart disease and increased pulmonary blood flow, pulmonary artery banding remains a useful palliative procedure when the risk of primary repair is unacceptably high or when a corrective surgical procedure is not feasible [2-4].

The mortality of PA banding improved

dramatically in the 1980s[5-6]. However, the pulmonary artery banding (PAB) is currently still accompanied by high morbidity and mortality, with significant complication rates[7-9]. This fact is due to the difficulty of assessing the degree of pulmonary constriction to be produced, considering that this assessment is performed in very special circumstances, since the patient is under general anesthesia, muscle relaxant, with the chest opened and ventilation controlled. Thus, what could be considered an appropriate adjustment in these circumstances, can be shown excessive or inefficient when the patient recovers his physiological condi-

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tion. The complexity of heart disease also interferes with the mortality of the procedure, ranging from 3% to 25% in the literature [10-12].

The aim of this study is to assess the service experience in PAB surgery, detailing and correlating the main aspects observed as for its distribution and clinical outcome.

Methods:

Between May 2003 and December 2009, 108 patients underwent PA Banding at Imam Reza hospital for treatment of various congenital heart diseases with pulmonary hyperflow. The clinic and hospital records of these patients were retrospectively reviewed. 8 patients were excluded from analysis due to the lack of data. The study included 100 patients, including 46 female. The distribution of heart disease is shown in Figure 1. The main heart disease was ventricular septal defect (VSD), by 36% of patients. These children, specifically, had undergone PAB for not presenting clinical conditions for total correction at some point (malnutrition, infection) and/or due to unfavorable anatomy of the VSD (apical, multiple, etc)

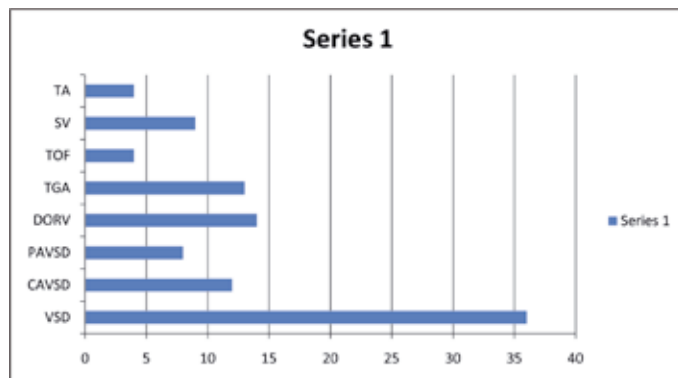


Fig.1 Distribution by heart disease. VSD =ventricular septal defect ; CAVSD =complete atrioventricular septal defect ; PAVSD =partial atrioventricular septal defect ; DORV=double outlet right ventricule; TGA =transposition of great arteries ; TOF=tetralogy of fallot ; SV=single ventricule ; TA=tricuspid atresia

Surgical procedure:

The patients underwent surgery under general anesthesia and orotracheal intubation (OTI). A standard surgical technique was used for most of the patients. The pulmonary artery was approached through a median sternotomy or lateral thoracotomy. In patients with a ductus arteriosus, coarctation, or an interrupted arch present, posterolateral thoracotomy was performed. A tape was placed around the

pulmonary artery just above the sinus of the pulmonary valve. The band material preferred in operations has been polytetrafluoroethylene. The circumference of the band in millimeters was set equal to the child's weight in kilograms plus 20. This formula is a modification of that suggested by Trusler and Mustard [13]. This circumference was used as a starting point for the banding; additional adjustments to the band were made based on measurements of the pulmonary artery pressure distal to the band. The pulmonary artery pressure was reduced to one-third of the systemic blood pressure and The minimal arterial oxygen saturation was allowed at least 75%-80%, with fraction of inspired oxygen of 40%. . Then the band was secured to the adventitia to prevent its migration to the distal pulmonary artery.

Statistical Analysis:

Statistical analyses were performed using the SPSS software. The data for weight, age and time were described as mean \pm standard deviation. For the relationship between weight of the patients who died and those who survived, we applied the Student's t test for analysis of unknown and equal variances. The chi-square test was applied to contingency tables, assessing the relationship between associated procedure and complications.

Results:

- 1-Weight and age: In this study we considered 100 patients with ages ranging from 1 - 36 months (6.58 ± 7.5) and weighing from 1.8 to 13.5 kg (4.24 ± 3.11). Based on the physical growth NCHS percentiles, only 17% of the patients had normal weighing range.
- 2-Incidence of reoperations for adjustment of banding: It was required in 8 cases (8%)
- 3-Respiratory failure: In 8 (8%) patients presented respiratory failure, in three of them peritoneal dialysis was required.
- 4-Heart failure: In 7 (7%) patients, there was a significant degree of heart failure in their evolution.
- 5-Severe complications (considering heart and respiratory failure): 40 severe complications were found in this group, affecting 24 (24%) patients. There is significant relation between the inappropriate weight gain and complication ($P < 0.05$). The distribution of all complications is shown in Table 1.

Table 1. Severe complications after the procedure

Complication	Total
Arrhythmia	5
Respiratory failure	8
Heart failure	7
Renal failure	3
Bleeding (reoperation)	4
Chylothorax	1
Pneumothorax	4
Hypoxia	6
Seizure	2

6-Deaths: 18 (18%) patients died.

Analysis results:

There is a significant difference between the weights of died children and those who survived ($P < 0.05$).

In the patient with a normal weight (17%), no mortality was recorded.

There is a significant relation between the patient with inappropriate weights and early postoperative complication, shown in Table 2.

There is no significant difference between the type of CHD and the age of died children and those who survived ($P > 0.05$).

Table 2. Influence of weights on hospital mortality and early complication

Weight	Mortality	complication
Normal (17%)	0 (0%)	6 (25%)
Low(83%)	18(100%)	18(75%)

Discussion:

Improvements in surgical and cardiopulmonary bypass techniques, as well as perioperative care, allowed surgeons to successfully perform early repair of CHD in infants [14-17]. Nevertheless, there are situations in which early repair in infants is not feasible or is accompanied by unacceptable risk because of the presence of unfavorable intracardiac anatomy (unbalanced ventricles, associated lesions, or both) and/or poor clinical condition (infection, chronic lung disease, or associated noncardiac malformation). In these situations palliation with PAB procedure followed by late

repair is recognized as a viable surgical option. PAB is still a necessary procedure, for the protection of the increase of pulmonary vascular resistance in congenital heart disease [18-21].

PAB is usually not a low-risk procedure, particularly in small infants. Hospital mortality of 8.6% (47/711 patients) has been reported in the European Congenital Data-Base (www.eactscongenitaldb.org) for all patients who underwent isolated PAB for any congenital heart defect. A mortality rate of 13% (12/92 patients) has been recorded in the Society of Thoracic Surgeons Congenital Database (www.sts.org). In our retrospective study we observed a high mortality rate (18%). Historically, when palliation with PAB instead of primary repair was widely used to treat congenital heart defects, the mortality with PAB was higher (59%) in infants less than 3 months of age when compared with that seen in infants greater than 3 months of age (21%) [22]. A recent analysis of the Society of Thoracic Surgeons Congenital Heart Database 18 showed that cardiac surgery in infants with low birth weight is associated with increased mortality.

Takayama et al analyzed the mortality of the PAB in their series since 1966, decade by decade. They noted progressive reduction in mortality, stabilized in the last two decades around 13.5%. No single variable such as gender, weight or diagnosis, represented a significant risk factor [13].

In our retrospective study, there was no relation between mortality and complication with variables such as age, gender and diagnosis, but lower weight patients (based on the physical growth NCHS percentiles) correlated with high mortality and post operative complication.

Conclusion:

In our study mortality rates compatible with the ones of the world literature. Despite the advances in perioperative management, we found no improvement in the hospital mortality of pulmonary artery banding. These results will support the preference for primary repair of intracardiac anomalies in small infants. However, we believe that pulmonary artery banding has a role in the treatment of congenital cardiac anomalies.

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Analysis of Different Aspects of Delayed Sternal Closure in Pediatrics and Adults: A Review



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Abstract:

Introduction: Delayed sternal closure (DSC) has been shown to be useful following cardiac surgeries in case of indications including hemodynamic instability, noticeable myocardial edema, respiratory compromise, stubborn bleeding, placement of extra-corporeal support device, and persistent arrhythmias. In this review, we summarize the investigations on this topic to analyze the controversial aspects of DSC in pediatrics and adults.

Methods: Med-Line systematic review of the relevant literatures, which have been published through 1970-2010, was performed.

Results: A total of 191 studies were identified, 62 of which were eventually deemed relevant

to this review. According to proper indications, DSC has been used in several types of cardiac surgeries in pediatric (newborns, infants and children) and adult cardiac surgeries in recent 35 years. The outcomes concerning survival and complications seem to be acceptable.

Conclusion: DSC is more frequent in pediatric cardiac surgery rather than adult cardiac surgery. DSC is an effective and safe strategy in patients with appropriate indications. Surgeons should be aware of its suitable use and also physiologic alterations and management of the patients when the sternum is still open. Several previous investigations showed wide variations in methods of DSC by institutions. Apparent differences in post-operative care of the patients with DSC clarify the demand for planning prospective multicenter trials with available control groups which can result in the implementation of standardized supervision protocols across institutions.

Sternal closure at the end of the surgery is sometimes associated with difficulties and complications. Moreover, in some patients, re-opening of the sternum and secondary delayed sternal closure (DSC) might be necessary during post-operative course in intensive care unit (ICU) or operating room. There has always been a serious concern about the increased rate of post-operative infection and mortality in this situation. In this review, we sum-

marize the literature regarding the thus far described different controversial aspects of DSC in pediatric and adult cardiac surgeries.

Methods:

Med-Line (1970-2010) was searched using the subsequent keyword "DSC", pediatric DSC and adult DSC. Searches were not restricted by language or study format. A total of 191 studies were iden-

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tified. Reference lists of the identified papers were also screened to recognize additional relevant publications. Overall, a total of 61 observational and comparison studies were considered relevant to this review and were summarized. Applications and consequences of DSC in all types of cardiac surgeries and also in all age ranges (newborns, infants, children and adults) were focused in this review.

History:

Primary DSC after surgery was first reported by Riahi et al (1975) in a pediatric population (1). He indicated that primary sternal closure results in hemodynamic instability and may not be possible in some cases for a few days. Ott et al; (1978) also reported primary DSC to prevent post-operative bleeding or cardiac compression (2). Gielchinsky et al; (1981) reported this technique in 29 adults (3). Since the first report of Riahi et al, several small and large scale studies in different cardiac surgery centers in numerous regions of the world have been performed, which resulted in valuable but still controversial findings.

Prevalence:

Occurrence of DSC in different centers has been reported to range from 0.29% to 30% (4, 5). Several previous investigations have reported the prevalence of DSC to be 4.5% in children and 1.5% in adults (4-10). However the incidence of DSC in the adult cardiac surgery population has been stated up to 4.2% in two investigations (6,7).

Vojtovic et al (2009) revealed that DSC is used in two-fifths of newborns in their institution in Czech (11).

Hashemzadeh et al (2009) from a major cardiac surgery center in Tabriz, Iran reported that out of 2485 cardiac operations between June 2006 and January 2008, DSC strategy was adopted for 3.3% of patients (12).

This wide variety of figures is mainly due to the differences in therapeutic strategies, experiences and tendencies of the surgeons, and diversity of pathologies in different study groups. DSC is more prevalent in pediatric surgeries and complex operations of adults (e.g. combined coronary bypass and valvular surgery) in comparison with closed heart surgeries and isolated coronary bypass operations.

Circulatory and Respiratory Physiology in DSC

Patients who have the marginal cardiac index (CI) might experience a remarkable decrease in CI and blood pressure

after sternal closure. The study performed by Moggio et al (1986) showed that DSC is beneficial in patients with severe decrease in CI after sternal closure, re-opening of the sternum increased the CI from 1.1 to 1.9 (9). CI significantly increased after 3-11 days and sternal closure became possible in this study. Shalabi et al also reported 59% increase in CI and 18% increase in blood pressure after re-opening of sternum in patients experiencing extraordinary CI fall after sternal closure (10).

These changes actually happen in all patients undergoing sternotomy; however, they are more significant in patients with decreased cardiac output. In a study carried out by McElhinney et al (2000), primary sternal closure in patients under 1 year old resulted in 5 mmHg increase in pulmonary artery pressure, 3mmHg increase in left atrial pressure and 2.5mmHg increase in right atrial pressure (13). Reuter et al (2005) also reported that CI decreased from 2.9 to 2.3 after primary sternal closure in patients with normal cardiac output prior to operation (14). Left ventricular end-diastolic volume decreased as much as 14% after sternal closure (14). In conclusion, cardiac physiology is different in open and closed sternal situations and sternal closure in cases with impaired systolic function can cause intolerable alterations of blood pressure and cardiac output, and endanger the life.

It is worthwhile to mention that cardiac response to the increase of intravascular volume is the same in open and closed sternal situations, thus changes of pulse pressure and systolic blood pressure can be accurately applied to determine the cardiac response to increase of intravascular volume. Moreover, it has been shown that the effects of Positive End Expiratory Pressure (PEEP) on systolic blood pressure are not influenced by sternal closure (14). PEEP effects on blood pressure are mostly due to increase in small pulmonary vessels resulted by longer dilation of alveoli, and less often because of changes in respiratory pump (14).

The effects of sternal closure on respiratory system are remarkable too. Sternal closure in a normal patient without underlying pulmonary disorder results in 1.2mmHg increase of mean airway pressure and 2mmHg increase of maximum inspiratory pressure (13). Sternal closure in normal surgical patients also causes 17% decrease in expired tidal volume, 29% decrease in CO₂ elimination, 19% decrease in pul-

monary compliance and increased endotracheal tube leak (15). The influence of sternal closure on increase of pulmonary vessels resistance is significant and can significantly decrease arterial saturation in patients who have shunt dependent circulation, specifically (5).

Indications

According to several previous studies it can be concluded that DSC is indicated in the following conditions: hemodynamic instability, myocardial edema, cardiac dilatation, intractable bleeding, coagulopathies, dysrhythmias, respiratory compromise, and placement of a circulatory assist device (16).

The most common DSC indication in corrective surgery of congenital cardiac anomalies is hemodynamic changes at the time of sternal closure (5). These changes are the result of edema or dilation of cardiac chambers (17). Shunts might become bi-directional at the time of sternal closure in cyanotic diseases and result in decreased O₂ saturation which is probably due to the increase of airway pressure and pulmonary vessel resistance. This problem can be dealt with by DSC (5). Another indication of DSC in children and adults is non-surgical bleeding or uncontrolled bleeding which is only responsive to packing (7,10,17). Application of extra-anatomic homograft can also result in hemodynamic changes at the time of sternal closure (17).

Recurrent ventricular arrhythmias and need for high positive pressure to maintain normal O₂ saturation are other indications of DSC (17). The latter mostly occurs in children because of pulmonary edema caused by cardiopulmonary bypass (CPB). Larger cardiac size relative to the thoracic cavity in the children may increase the benefits from DSC in children compared to the adults. Wernovsky et al (2007), in a large review from 52 centers treating over 1000 neonates with hypoplastic left heart syndrome per year, reported that the efficiency of DSC in children has become obvious over the last two decades (18).

Alexi-Meskishvili et al (1995) following an investigation of 113 infants and children with congenital heart defects confirmed that indications of DSC in children are similar to those described in adults, including myocardial edema, depressed myocardial function, inadequate intraoperative hemostasis, dysrhythmias, and access for external cardiac support systems (19). Riphagen et al (2005) expressed that

inadequate hemostasis was the most common indication of DSC in children who underwent cardiac surgeries in a single center study over a 3-year period (20).

Yasa et al (2010) reported that DSC is a secure and straightforward technique for treating bleeding, arrhythmia and myocardial edema following on pump cardiac surgery (21). It is expected that as cardiac surgeons become more expert in the technique of DSC, the incidence of its application following on pump cardiac surgery may increase.

DSC in heart transplantation is an accepted method with favorable results. Takayama et al (2004) investigated 410 heart transplants from 1985 through 2004 and reported that open chest management followed by DSC is effective and safe in selected patients who have hemodynamic instability after orthotopic heart transplantation (22).

Risk Factors

Samir et al (2002) evaluated 119 children after surgery using DSC in 2002. They showed that weight, gender, inotropic support, PGE₂ administration and mechanical ventilation did not affect the final decision, while CPB time above 185 minutes, cross-clamp time above 98 minutes, mixed venous O₂ saturation below 51% after termination of CPB, age of below 7 days and cardiac disease type [e.g. aortic interruption and total anomalous pulmonary venous connection] were the main risk factors of DSC (17). In this study, all children who had CPB time above 196 minutes, cross-clamp time above 108 minutes or mixed venous O₂ saturation below 47% experienced instability at the time of sternal closure and were treated using DSC. However, another study did not verify the role of cross-clamp time in making the final decision (23). The latter has mentioned ventricular fibrillation at the time of CPB termination as a main risk factor of DSC.

Postoperative hyperglycemia which is a probable risk factor for the development of mediastinitis in infants and children following cardiac surgeries, is a factor which might be another risk factor of DSC (24). Generally exact independent predictive risk factors of DSC have not been indicated in available studies. Prospective investigations in both children and adults are necessary which may elucidate the important risk factors of DSC.

Time of sternal closure

Sternal closure is frequently possible after 1-2 days in adults,

while children may need more time. It is important to notice that the most suitable time frame for DSC in the critical care units depends on the patients' conditions, but it is usually within the first 24 to 72 hours of the recovery phase (25). Riphagen et al (2005) investigated the retrospective chart review of all bypass surgeries performed in a single center over a 3-year period in UK, and concluded that DSC was performed at a median of 21 hours (range, 18-40 hours) after surgery in 60 children patients with median age of 5 year old (25).

In some clinical circumstances, such as mediastinitis or implantation of a mechanical support device through the open sternum, the sternum must remain open for longer than 72 hours. Different ranges of the duration of open chest management (from 2 to 14 days) postoperatively (12, 26, 27) revealed that the most probable time seems to be dependent on patient condition and surgeon decisions.

Ziemer (1992) reported the mean sternal closure time to be 3 days (5), while this value was reported as long as 5.5 days by Moggio et al (1986) (9). Other studies have reported a range of 2-5 days for sternal closure (28).

Samir et al (2002) suggests that sternal closure should not be tried prior to 3rd post-operative day in children (17); however right decision might be better made considering the condition of each individual case (6).

At the presence of following conditions, sternal closure can be tried (6,17):

1. Hemodynamic stability in the last 24 hours (minimal dependence on intra-aortic balloon pump (IABP) and inotropic support below 2µg of epinephrine(per minute) or equivalent doses of other inotropic agents
2. Negative fluid balance
3. Appropriate coagulation state
4. Improvement of respiratory situation and normal arterial gases

Following conditions after trial of sternal closure indicate failure and warrant re-opening of sternum (17,23):

1. Fall in heart rate, arterial O₂ saturation or mixed venous O₂ saturation
2. Increase of heart rate, central venous pressure (>2mmHg), left atrial pressure (>2mmHg), airway pressure or pulmonary artery pressure
3. Acidosis

Risk factors of elongated sternal opening time are (29-31):

1. Coagulopathy and continuous bleeding
2. Cardiomegaly with or without dysrhythmia
3. Extra-cardiac devices [e.g. ventricular assist devices (VADs) or extra-anatomic conduit]
4. Pulmonary edema and the decrease of pulmonary compliance

Operative technique

During the time when sternum is open, mediastinal viscera should be provided with coverage (30, 32). Many surgeons prefer to repair the skin and leave sternum open; however, this method seems not to provide the chest with enough space and Gortex patch (PTFE) is a better option for incision site repair (9,17).

Pleura should not be opened in cases of DSC, because in addition to the increase of infection risk, opening the pleura does not provide us with further space as lungs are edematous due to right and left ventricular insufficiency. Moreover, appropriate draining tubes have to be inserted in pericardial space with negative pressure of -20cmHg connected to suction (9).

At the time of sternal closure, culture samples have to be obtained and then normal saline with or without povidone iodine has to be used for irrigation (8,33). Complete debridement of the dead tissue and refreshment of the incision margins are necessary (21).

During prolonged open chest management, the skin could be closed by heavy merselin stitches and covered with sterile dressing. The dressing should be changed daily using strict sterile method with povidone-iodine (21). McElhinney et al (2000) explained the application of a Silastic sheet (Dow Corning, Midland, Michigan) cut into the shape of the open mediastinal cavity, attached to the external skin via sutures, and covered with an occlusive sterile dressing (13).

Sternum closure can be performed in ICU with full sterility and transferring the patient to operating room is not necessary (10). However some surgeons prefer to do the sternum closure in operation rooms (21). It is of importance to notice that not only the technique of sternotomy closure but also the material and size of sutures can influence the incidence of mediastinitis.

Re-opening and irrigation is not necessary during the time when sternum is open provided that appropriate coverage

(skin or Gortex) is applied, otherwise, daily re-opening and irrigation of the incision is necessary; however, this issue is still controversial. Estrera et al (2010) recommended that DSC after complex aortic surgeries should be followed by mediastinal exploration every 24–48 h until complete duration of DS (34). Estrera et al suggested the performance of mediastinal exploration in the operating room or in the ICU with sterile irrigation of mediastinal contents (34).

The vacuum-assisted closure system (VAC) is a noninvasive active therapy which results in better healing in difficult wounds that are refractory to conventional therapies and could be used in complicated wounds of DSC (35-37). VAC system is based on the application of negative pressure by controlled suction to the wound surface. Several studies confirmed the effectiveness of the VAC system on microcirculation and the promotion of granulation tissue proliferation (35-38). Baillot et al (2010) in a 15-year review of 23,499 sternotomies reported the lower mortality of VAC method in comparison with the conventional methods of open chest wound management (39). So, VAC is a way to improve the outcome of DSC.

Mortality Rate

Evaluation of mortality rate in different studies might not be accurate enough as some studies have reported total mortality, while others have reported the mortality during the time that sternum was still open. On the other hand, age range of the patients was from 1 day to 80 years in different studies and it was even 1 day to 19 years in studies of congenital cardiac diseases. These studies have reported mortality from 0% (40, 41) to 60% (42) but the mean mortality rate was 15-25% in different studies (11, 27, 43-46). Thirty three to fifty percent of the mortality occurred in the period after sternal closure (10, 13). In-hospital mortality of DSC following complex aortic surgery have been reported about 17% (34). Yasa et al (2010) reported that 30 day mortality of the 46 patients, ranging in age from 2 to 73 years, who underwent DSC was 23.9% (7 patients died before closure and the remaining 4 after closure) (21).

Mortality rate is higher in cases of secondary DSC (reopening the chest after closure in operating room or ICU) in comparison with primary DSC (more than twice) (10, 17). This finding emphasizes the importance of correct decision making at the time of sternal closure during operation. Furthermore, the surgeons have to put aside their tendency

not to re-open sternum in ICU and awaiting severe hemodynamic changes to make this decision. However, these findings should not persuade the surgeons to overuse this technique. A study by Owens et al (2001) showed that application of DSC in all patients undergoing arterial switch did not yield a better outcome in comparison with selective use of DSC and did not reduce mortality (47).

Johnson et al (2010) examined in-hospital mortality of the newborns with median age of 6 days (4–9 days) reported from 45 centers who underwent DSC after stage 1 palliation for hypoplastic left heart syndrome. He concluded that in centers with high, moderate and low incidence of DSC, mortality rates were: 15%, 26% and 23% respectively (48).

Moreover, the cause of DSC significantly affects the mortality. Uncontrolled bleeding is associated with the highest mortality among the indications of DSC (4,7, 49). This finding emphasizes the role of coagulation disorders in mortality.

The most common cause of death is biventricular failure during the time when sternum is open; and renal failure, respiratory failure and sepsis are the most common causes after sternal closure (9). A study carried out by Furnary et al (1992) listed the risk factors of mortality in 6000 patients as follow (50):

1. Application of more than 4µg/minute epinephrine or equivalent doses of other inotrops
2. Cerebrovascular accidents after surgery
3. Creatinine >3mg/dl
4. Severe ventricular arrhythmia

(The last 2 increase the mortality up to 50%)

Other risk factors of mortality based on other studies are (6, 7, 9):

1. Malnutrition
2. Prolonged mechanical ventilation and need for tracheostomy
3. IABP (increase of mortality rate up to 3 times)
4. reoperation due to bleeding (increase in mortality rate up to 3.4 times)
5. VAD (increase of mortality rate up to 3.8 times)

Complications

Contradictory results of previous investigations could not be able to clarify the exact effect of DSC on outcomes of

surgeries including survival to hospital discharge and morbidities such as postoperative infection (19, 20, 51-58). These studies due to small sample population and also lack of relevant control group did not elucidate the clear association between DSC and considered side effects.

The most common concern of the surgeons in using DSC is increase of infection rate. Some investigations reported lower rate of mediastinal infection with DSC (between 1 and 4%) and they concluded that no significant increase in the rate of mediastinitis has been observed when compared to primary closure (43). Other studies have reported the infection risk to be 0-20% (4, 10, 13). The causes of this variety of results can be:

1. Different strategies of different centers regarding the coverage of mediastinal viscera during the time when sternum is open
2. Age variety and different indications of DSC
3. Variety of infection definitions (superficial, deep, mediastinitis, asymptomatic positive culture)

It is interesting that Jason et al (2010) reported that the surgical centers with more frequent use of DSC have higher postoperative infection rates (48). The methods of wound care and the therapy approaches was not compared in this Jason et al investigation, but it seems that the higher rate of nosocomial infection could be an effective factor in outcome of DSC. Special attentions in this regard are highly recommended to prevent infectious morbidity and mortality of the open wounds following cardiac surgeries which are susceptible to acquire hospital infections.

Mediastinal covering and time of sternal opening have not been completely assessed in association with infection; nevertheless, they both seem to be influential in occurrence of infection. There are also studies indicating that infection may be more prevalent in younger patients and patients who undergo DSC due to uncontrolled bleeding (47, 49). Asymptomatic positive sternal culture is observed in 36-100% of the patients and gram negative bacilli are the most prevalent growing germs; however, clinical infection is rare (5,8,9). Owens et al (2001) (47) showed that deep sternal infection rate was equal in patients who underwent primary sterna closure and DSC after arterial switch for transposition of great vessels. Furthermore, the rates of deep sternal infection and mediastinitis have been shown to be the same in patients undergoing primary sternal closure and DSC in a

study performed by Christenson et al (1996) (7).

Conclusively, there have been little data indicating higher deep infection in patients undergoing DSC; however, superficial infections might be more prevalent.

Other complications of DSC include respiratory failure, renal failure, cerebrovascular accidents, myocardial infarction, cardiac failure and gastrointestinal complications (hepatic failure, intestinal ischemia, etc.). Hashemzadeh et al (2008) reported that the most common causes of death included low cardiac output (67.2%) and multiorgan failure (26.2%) (12). New onset of acute renal failure reported the predictive risk factor of in hospital mortality (12).???

The most common complication in post-operative course was respiratory failure which was reported up to 50% in some studies (9). However, the studies of Owens et al (2001) and Christenson et al (1996) did not show a higher rate of respiratory failure and longer mechanical ventilation in patients undergoing DSC (7, 47). Vojtovic et al (2009) showed that DSC may cause an important transitory decrease in stroke volume, cardiac output and arterial blood pressure (11).

Nevertheless, overall rate of complications is higher in patients undergoing DSC and roughly 30-50% of these patients experience at least 1 major complication after surgery (4,6,9) Hospitalization period and ICU stay are also significantly longer in these patients (7).

The summary of characteristics and major findings of selected investigations in regard of DSC in pediatrics and adults can be observed in Tables 1 and 2.

Conclusion

DSC is a surgical strategy that has been used in children and adults during the past 35 years in cardiac surgery centers. DSC is an effective technique in patients with severe reduction in cardiac output, respiratory failure, uncontrolled bleeding, arrhythmia, myocardial edema following on pump cardiac surgery and some very ill patients. It can end in reasonable mortality and morbidity rate if used appropriately. DSC is more common in infants and children heart surgeries than adults. Transient consequences following DSC including decrease in stroke volume, cardiac output, arterial blood pressure and also impaired lung compliance and blood oxygenation should be considered in management of the patients .

Surgeons should be aware of its proper use and also physi-

ologic changes and management of the patients when the sternum is left open.

According to several previous investigations it can be concluded that a wide variation in practice of DSC by institutions exist. Different strategies in post-operative care of

the children and adults in different centers necessitate prospective multicenter trials to draw more conclusive results. These trials may need to stratify or randomize the cases and apply standardized supervision protocols across institutions.

Table 1: Review on Selected articles on pediatrics DSC

Author	Year	Sample Size	Important findings
Shore et al (46)	1982	n=9 (with average age of 27 months)	Mortality rate :22%
Ziemer et al (5)	1992	n =42 (age at operation ranged from 1 day to 15 years, mean: 2 years and 1 month).	Mortality rate: 33.3% in newborns younger than 30 and totally 40.4% mortality in patients younger than 10 year old.
Alexi-Meskishvili et al (19)	1993	n =113 [including 43 newborns (38%), 36 infants (32%) and 34 children (30%) between the ages of 1 and 14 years].	Overall mortality was 36.2%
Hakimi et al (44)	1994	n = 55 (with average age of <30 days)	Mortality rate: 20% 2.4% superficial surgical site infection
Iyer et al (59)	1997	n = 150 (age at operation was 229 ± 51 days)	Survival rate: 88% The sternum was left open for 3.86 ± 0.29 days. Fifteen patients had minor wound infections requiring antibiotics.
Tabbutt et al (27)	1997	n =178	Overall mortality :19% Myocardial distention or chest wall edema (n = 47) was a common indication Sternal closure was achieved in 89% of patients at a mean of 3.4 ± 1.8 days after opening
McElhinney et al (13)	2000	n = 128 (age <1 y/o)	Mortality rate:11.4% During sternal closure: significant increases were noted in pulmonary arterial, left atrial and right atrial pressures. In addition, mean airway pressure and peak inspiratory pressure increased. Sternal wound infection occurred in one patient.
Main et al (15)	2001	n = 17	Respiratory function may be compromised after DSC, requiring ventilator changes at the time of closure
Samir et al (17)	2002	n =119 (neonates)	Interruption of the aortic arch or total anomalous pulmonary venous drainage was most important predictive risk factor of use of DSC

Table 1: Review on Selected articles on pediatric DSC (Continued):

Author	Year	Sample Size	Important findings
Riphagen et al (20)	2005	<i>n =60 (with median age 5 days old)</i>	<i>Median time of sterna closure: 21 hours (18 to 40 hours)</i> The most common indication was inadequate hemostasis Overall mortality was 19.7% <i>Median duration of ventilation and intensive care stay among survivors: 3.8 days (2.4 to 6.3 days) and 4.8 days (3.7 to 7.9 days), respectively.</i>
Johnson et al (48)	2010	<i>n=1283 (in 45 centers which in 74% of cases DSC was performed; median age at surgery was 6 days (4–9 days), and median weight at surgery was 3.2 kg; 59% were male)</i>	Centers with high and middle DSC use had prolonged length of stay and more infection In centers with high, middle, low DSC use mortality rate were: 15%, 26% and 23% respectively.
Pye et al (25)	2010	<i>A review on nursing considerations for children undergoing DSC after surgery for congenital heart disease</i>	<i>Use of open sternotomy and DSC will continue to be an important management strategy for some time, particularly with the trend toward earlier age for surgical repair or staged palliation.</i>

Table 2: Review on Selected articles on Adult DSC

Author	Year	Sample Size	Important findings
Ott et al (2)	1978	<i>n =4 (3 adult patients and 1 infant patient)</i>	<i>Reviewed the use of DSC for cases of cardiac compression or risk of cardiac tamponade due to excessive bleeding</i>
Ugorji et al (60)	1980	<i>n =28 (mean age: 60.4 ± 3 years; Transcending aortic intraaortic balloon insertion was done for the patients)</i>	<i>DSC was accomplished within 48 to 96 hours.</i>
Gielchinsky et al (3)	1981	<i>n =29</i>	<i>The indications were enlarged heart with tamponade when the mediastinum was closed, poor lung compliance, hemodynamic instability due to intractable arrhythmias or coagulopathy, and presence of a mediastinal assist device.</i> Of the 29 patients treated, 19 were long-term survivors and only 1 patient had a minor superficial wound infection.
El Abdel Hafez et al (61)	1983	<i>n =50 (with complex heart disease)</i>	Three cases of infection were recorded
Murphy (32)	1985	-Method description	<i>A method is described for DSC that employs a temporary impermeable rubber patch sutured to the presternal fascia.</i>
Josa et al (62)	1986	<i>n=15</i>	<i>DSC was indicated for severe bleeding in 10 patients, heart compression in four patients, and severe postbypass arrhythmias in one patient</i> Thirteen of the 15 patients were long-term survivors, none of them had wound infections

Table 2: Review on Selected articles on adult DSC (Continued 1):

Author	Year	Sample Size	Important findings
<u>Milgater et al (63)</u>	1986	n =13	<p><i>DSC was performed 36-120 hours later on 10 of the patients, when their condition had stabilized.</i></p> <p><i>Nine patients are long term survivors.</i></p> <p><i>None of these patients has developed mediastinitis, wound infection, osteomyelitis or instability of the sternum.</i></p>
<u>Fanning et al (43)</u>	1987	n =57	<p><i>DSC was performed at a mean of 2.8 days</i></p> <p><i>Thirty-eight patients survived to leave the hospital.</i></p> <p><i>Superficial wound infection (3 patients), sternal osteomyelitis (1 patient), and fatal mediastinal infection (1 patient).</i></p>
<u>Mestres et al (31)</u>	1991	n =25	<p><i>DSC was performed at a mean of 2.64 days</i></p> <p>The indications were extreme cardiac dilatation and uncontrollable mediastinal hemorrhage</p> <p>Survival rate:72%</p> <p>No mediastinal or fatal infection developed and only 1 patient had late superficial wound infection</p>
<u>Furnary et al (50)</u>	1992	n =75	<p><i>DSC was performed at a mean of 3.4 +/- 0.3 days</i></p> <p><i>Survival rate:67%</i></p> <p>Baseline cardiac index improved and remained stable through DSC and late follow-up</p> <p>Sternal infection:5%</p>
<u>Tobe et al (64)</u>	1994	n = 4	<p>DSC was performed 48-72 hours later</p> <p><i>The only recognized complication was an abscess formation around the bleeding area, which was successfully treated with systemic antibiotics</i></p> <p>In two of these patients, hemodynamic instability was continued because of right ventricular outflow tract obstruction by compression of the packs which were left over the bleeding area.</p>
<u>Donatelli et al (65)</u>	1995	n =8	<p>Three patients died in hospital: 1 case of multiorgan failure; 1 cases of refractory low cardiac output syndrome; and 1 case of respiratory distress syndrome.</p>
<u>Christenson et al (7)</u>	1996	n =123	<p>DSC was performed at 2.0 ± 1.4 days (range 0.5-8 days).</p> <p>Survival rate: 78.9%</p> <p>Mortality was related to indications for open chest: low cardiac output: 38.6%, hemodynamic collapse on closure 0%, diffuse bleeding 33.3% and arrhythmias 27.3%.</p> <p>Superficial sternal wound infection occurred in 1.6% patients after DSC, mediastinitis in 1 (0.8%) and sternal dehiscence in 3 (2.4%) patients, which does not differ from a control population that had primary sternal closure.</p>

Table 2: Review on Selected articles on Adult DSC (Continued 2):

Author	Year	Sample Size	Important findings
<u>Freeman</u> et al (66)	1997	n = 45	<p>Sternal wound infection : 1.7%</p> <p>Operative mortality was 47 % but was not unexpected based on the number of urgent/emergent procedures but does not appear to be related to the technique of DSC.</p> <p>DSC appears to be a simple and safe method for treating low cardiac output syndrome following CABG</p>
<u>Shalabi</u> et al (10)	2002	n = 40	<p>Mortality rate: 10%</p> <p>The sternum was closed in 36 patients on an average of 22 ± 0.3 hours (range, 8 to 48 hours) postoperatively.</p> <p>Wound infections: 8 patients</p>
<u>Estrera</u> et al (34)	2008	n = 12	<p>In-hospital mortality : 16.7%</p> <p>Mean time to closure was 3 days (range 1-9 days)</p> <p>No patients developed mediastinitis or aortic graft infection during postoperative follow-up (mean:60 months)</p>
<u>Hashemzadeh</u> et al (12)	2008	n = 81	<p>Survival rate: 81.4% who discharged from the hospital at a mean of 15.6 ± 8.4 days.</p> <p>The most common causes of death included low cardiac output (67.2%) and multiorgan failure (26.2%).</p> <p>Superficial sternal wound infection :1.2%, mediastinitis :4.9%, sternal dehiscence : 2.4%</p> <p>New onset of acute renal failure and the presence of intraaortic balloon pump were predictive of in-hospital death.</p>
<u>Yasa</u> et al (21)	2010	n = 46 [31 men and 15 women, ranging in age from 2 to 73 years (mean 57.0 ± 7.6 years)].	<p>Bleeding (n=21), hemodynamic instability (n=16), arrest (n=5), and arrhythmia (n=4) were the reasons of DSC.</p> <p>DSC was performed at 3.48 ± 0.35 days.</p> <p>Mortality within 30 days was 23.9%</p> <p>Complications were mediastinitis (n=2), minor wound infection (n=3) and renal failure (n=5).</p>

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What's New in Cardiac Surgery?

Abstracts Selected & Summarized by: R. Baghaei M.D; Shahid Rajaei Cardiovascular, Medical & Research Center, Tehran University of Medical Sciences- Tehran- Iran

Tricuspid annuloplasty prevents right ventricular dilatation and progression of tricuspid regurgitation in patients with tricuspid annular dilatation undergoing mitral valve repair

J Thorac Cardiovasc Surg 2011;141:1431-1439

Objectives: We hypothesize that concomitant tricuspid annuloplasty in patients with tricuspid annular dilatation who undergo mitral valve repair could prevent progression of tricuspid regurgitation and right ventricular remodeling.

Methods: In 2002, 80 patients underwent mitral valve repair. Concomitant tricuspid annuloplasty was performed in 13 patients with grade 3 or 4 tricuspid regurgitation. In 2004, 102 patients underwent mitral valve repair. Concomitant tricuspid annuloplasty was performed in 21 patients with grade 3 or 4 tricuspid regurgitation and in 43 patients with an echocardiographically determined tricuspid annular diameter of 40 mm or greater. Patients underwent transthoracic echocardiographic analysis preoperatively and at the 2-year follow-up.

Results: In the 2002 cohort right ventricular dimensions did not decrease (right ventricular long axis, 69 ± 7 vs 70 ± 8 mm; right ventricular short axis, 29 ± 7 vs 30 ± 7 mm); tricuspid regurgitation grade and gradient remained unchanged. In the 2004 cohort right ventricular reverse re-

modeling was observed (right ventricular long axis, 71 ± 6 vs 69 ± 9 mm; right ventricular short axis, 29 ± 5 vs 27 ± 5 mm; $P < .0001$); tricuspid regurgitation diminished (1.6 ± 1.0 vs 0.9 ± 0.6 , $P < .0001$), and transtricuspid gradient decreased (28 ± 13 vs 23 ± 15 mm Hg, $P = .021$). Subanalysis of the 2002 cohort showed that in 23 patients without grade 3 or 4 tricuspid regurgitation but baseline tricuspid annular dilatation, the degree of tricuspid regurgitation was worse at the 2-year follow-up. Moreover, this caused right ventricular dilatation. Subanalysis of the 2004 cohort demonstrated reverse right ventricular remodeling and decreased tricuspid regurgitation in 43 patients with preoperative tricuspid annular dilatation who underwent tricuspid annuloplasty.

Conclusions: Concomitant tricuspid annuloplasty during mitral valve repair should be considered in patients with tricuspid annular dilatation despite the absence of important tricuspid regurgitation at baseline because this improves echocardiographic outcome.

Aortic valve-sparing operations in aortic root aneurysms: remodeling or reimplantation?

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Abstract

A best evidence topic was written according to a structured protocol. The question addressed was whether the reimplantation (David) technique or the remodeling (Yacoub) technique provides the optimum event free survival in patients with an aortic root aneurysm suitable for an aortic valve-sparing operation. In total, 392 papers were found using the reported search criteria, of which 14 papers pro-

vided the best evidence to answer the clinical question. A total of 1338 patients (Yacoub technique in 606 and David technique in 732) from 13 centres were included. In most series, cardiopulmonary bypass time and aortic cross-clamp time were longer for the David technique compared to the Yacoub technique. Early mortality was comparable between the two techniques (0-6.9% for the Yacoub technique and 0-6% for the David technique). There is a tendency for

a higher freedom from significant long-term aortic insufficiency in the David group than the Yacoub group, which does not necessarily result in a higher reoperation rate in the Yacoub group. In the largest series reported by David et al., freedom from a moderate-to-severe aortic insufficiency at 12 years was $82.6 \pm 6.2\%$ in the Yacoub and $91.0 \pm 3.8\%$ in the David group ($P=0.035$). Freedom from reoperation at the same time point was $90.4 \pm 4.7\%$ in the Yacoub group and $97.4 \pm 2.2\%$ in the David group ($P=0.09$). In another series reported by Erasmi et al., freedom from reoperation at a follow-up time of about four years was $89 \pm 4\%$ in the Yacoub group and $98 \pm 2\%$ in the David group. Although some

authors merely preferred the Yacoub technique for a bicuspid aortic valve, the accumulated evidence in the current review indicates comparable results for both techniques in a bicuspid aortic valve. Current evidence is in favour of the David rather than the Yacoub technique in pathologies such as Marfan syndrome, acute type A aortic dissection, and excessive annular dilatation that may impair aortic root integrity. Careful selection of patients for each technique and successful restoration of normal cusp geometry are the keys to success in aortic valve-sparing operations. **Keywords:** Aortic valve-sparing operation; Remodeling; Reimplantation; Aortic root aneurysm

High-dose tranexamic acid is related to increased risk of generalized seizures after aortic valve replacement

Eur J Cardiothorac Surg 2011;39:e114-e121.

Objective: To investigate the incidence of postoperative generalized seizures in patients undergoing aortic valve replacement (AVR) under extracorporeal circulation, who received either high-dose tranexamic acid (TXA) or epsilon aminocaproic acid (EACA) as an antifibrinolytic agent.

Methods: This retrospective analysis comprised 682 consecutive patients undergoing AVR with or without simultaneous coronary artery bypass surgery. Patients operated on before March 2008 were treated intra-operatively with TXA (100 mg kg^{-1} ; $n = 341$), patients operated on after March 2008 received EACA (50 mg kg^{-1} loading dose, followed by $25 \text{ mg kg}^{-1} \text{ h}^{-1}$, and an additional 5 g in the extracorporeal circuit; $n = 341$).

Results: Clinically diagnosed generalized seizures were observed within the first 24 h postoperatively, more frequently in patients receiving TXA compared with EACA (6.4% vs 0.6% , $p < 0.001$, difference = 5.8% , 95% confidence interval $3.1\text{--}8.5\%$). Besides the antifibrinolytic agent, three other variables differed significantly between patients with and without postoperative seizures: age (mean (SD), 77.0

(5.9) years vs 73.2 (9.0) years, $p = 0.039$), preoperative creatinine clearance (55.4 (16.5) ml min^{-1} vs 72.6 (28.5) ml min^{-1} , $p = 0.002$), and administration of recombinant activated factor VIIa (3 out of 24 patients (12.5%) vs 8 out of 658 patients (1.2%), $p = 0.005$). Logistic regression analysis demonstrated a significant impact of the antifibrinolytic drug, creatinine clearance, and the application of recombinant activated factor VIIa on the occurrence of generalized seizures.

Conclusions: Our results indicate that high-dose TXA is associated with an increased incidence of postoperative generalized seizures in patients undergoing AVR compared with EACA, especially when suffering from renal impairment. A possible association between recombinant activated factor VIIa and the occurrence of postoperative seizures needs further investigation.

Key Words: Antifibrinolytic agent , Aortic valve replacement , Seizure , Tranexamic acid

Prevalence of periodontitis and optimal timing of dental treatment in patients undergoing heart valve surgery

Heart valve; Endocarditis; Perioperative care; Infection

We investigated the prevalence, risk factors, and optimal timing of treatment for advanced periodontitis in patients undergoing elective heart valve surgery. Dental examinations were given to 209 patients (aged 65 ± 10 years) scheduled for valve surgery. Patients with no or mild periodontitis were assigned as controls ($n=105$). Patients with advanced periodontitis underwent tooth extraction and curettage ($n=104$), 68 of whom underwent tooth extraction within two weeks (short wait) and 36 of whom underwent extraction longer than two weeks, before surgery. The three groups (control, short, and long wait) were similar in age, gender, diseased valve, and type of surgery received. The average number of teeth extracted was 2.3 ± 2.3 . In both univariate and multivariate analysis, risk factors for advanced

periodontitis were history of smoking and heart failure. No complications arose from the extractions. Length of postoperative hospital stay, intrafebrile days, white blood cell count and serum C-reactive protein (assessed at postoperative days 1, 3 and 7) were similar among the three groups. During the mean follow-up period of 60 ± 16 months, no patient developed prosthetic valve endocarditis, and there were no postoperative deaths. In conclusion, we found no evidence that receipt and timing of dental treatment affected surgical success rates and postoperative course.

Key Words: Heart valve; Endocarditis; Perioperative care; Infection.

Pediatric heart transplantation: 23-year single-center experience

Eur J Cardiothorac Surg 2011;39:e83-e89.

Objective: Early and late mortality have significantly improved during recent decades in pediatric patients after heart transplantation (HTx). Nevertheless early and late morbidity and mortality are influenced by acute rejection, cardiac allograft vasculopathy (CAV), malignancy, renal failure, and graft failure. **Methods:** We evaluated our results after HTx in children under the age of 18 years with 23 years of follow-up. Perioperative characteristics, probability of survival, and time-related morbidity were retrospectively analyzed. **Results:** We included 169 pediatric HTx recipients, transplanted between 05/1986 and 05/2010. One hundred and one were males with a median age of 8.7 (0.02–23.2) years at the time of HTx. Main preoperative diagnoses were cardiomyopathy (CMP) ($n = 139$) with a median survival of 7.0 (0–23.2) years and congenital heart disease (CHD) ($n = 30$), median survival 11.3 (0–19.9) years. Overall survival at 1, 5, 10, and 15 years was 87%, 76%, 68%, and 50%, respectively. Patient survival was significantly reduced in patients with 0–1 year at the time of HTx versus 1–10 and 11–18 years: 2.3 (0–13.2) years versus 1–10 years = 8.6 (0–23.2) years; 11–18 years = 5.9 (0.003–18.5) years.

Fifty-one patients were on mechanical circulatory support as a bridge-to-HTx with increased early but not late mortality. Ten patients underwent retransplant due to acute or chronic graft failure after a median posttransplant time of 12.25 (0.3–17.45) years. Late mortality was influenced by rejection, infection, posttransplant lymphoproliferative disease (PTLD) (11.8%), or CAV with an incidence of 25% at 5 years, 50% at 10 years, and approximately 75% at 15 years. **Conclusions:** Pediatric HTx is a safe and effective treatment for terminal heart failure. In our experience, there is no adverse effect of previous cardiac assist device implantation in long-term follow-up. Virtually all anatomic malformations are amenable to orthotopic HTx. Significant progress has been achieved in controlling rejection through improved immunosuppression and noninvasive rejection monitoring.

Key Words: Heart transplantation, Pediatric, Cardiac allograft vasculopathy, Acute rejection, PTLD, Survival, 23 years.

Prolonged time between donor brain death and organ retrieval results in an increased risk of mortality in cardiac transplant recipients

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Abstract

In cardiac transplantation longer ischemic times relate to poorer outcomes. However, brain death also promotes donor organ injury. The aim of this study was to ascertain if there was an association between longer time periods between donor brain death and organ retrieval with recipient mortality. This retrospective single centre study included 157 cardiac transplants performed between February 1999 and 2009. The time between the second brain stem death test and the cross-clamp time at organ retrieval was noted in hours. This was compared with survival time in years. Cox regression analysis was performed. The following variables were included: donor and recipient sex, age and cytomegalovirus status; donor smoking

history; ischemic time and number of rejection episodes. Of the 157 transplants, 37 recipients have died. The mean follow-up was 4.1 years. The mean time between brain stem death test and cross-clamp time was 13.2 ± 3.96 hours. Considering the above variables, the most significant finding is: increased time between brain stem death test and organ retrieval cross-clamp time, predicted a greater recipient mortality [HR=1.15; 95% confidence interval (CI)=1.06-1.24; $P < 0.001$]. Longer delays between donor brain death and cross-clamp time are associated with a higher-risk of mortality in cardiac transplant recipients.

Key Words: Brain death; Donor and heart transplant .

Intracoronary levosimendan prevents myocardial ischemic damages and activates survival signaling through ATP-sensitive potassium channel and nitric oxide

Eur J Cardiothorac Surg 2011;39:e59-e67.

Objective: Levosimendan has been reported to exert cardioprotection. In this study, we have examined the cardiac effects of different doses of intracoronary levosimendan on ischemia/reperfusion injuries, and the involvement of KATP channels and nitric oxide (NO).

Methods: The experiments were performed in a total of 56 anesthetized pigs. In 21 pigs, 1.5, 5 and 12 $\mu\text{g min}^{-1}$ levosimendan was infused over 15 min into the coronary artery at the onset of 1 h reperfusion following 2-h ischemia and the effects on cardiac function, infarcted area, and on apoptosis/autophagy were examined. In addition, the activation of Akt and extracellular receptor kinase (ERK) was analyzed. The findings were compared with those obtained in a further 14 pigs where the highest dose levosimendan was infused after glibenclamide and L-nitro-arginine methyl ester (L-NAME).

Results: Intracoronary 1.5, 5 and 12 $\mu\text{g min}^{-1}$ levosimendan caused an increase of segmental shortening, dP/dt max and cardiac output of 7.8%, 22.6%, and 31.6%; 7.6%, 16.9%, and 21.6%; 2.8%, 5.9%, and 6.2%, respectively, from values measured at the end of ischemia. The beneficial effects elicited by levosimendan were still evident at the end of rep-

erfusion when the increase of segmental shortening, dP/dt max and cardiac output caused by the three doses of levosimendan amounted to 3.7%, 13.3%, and 16.5%; 1.5%, 9.4%, and 11%; 1.4%, 2.7%, and 3.9%, respectively. When doses of 5 and 12 $\mu\text{g min}^{-1}$ levosimendan were used, a reduction of infarcted area to about 69% and 67% of area at risk was observed, and was significantly different from that of about 79% measured in control animals. In addition, after intracoronary levosimendan, the inhibition of apoptosis and activation of autophagy and a dose-related increase of the level of phosphorylation of ERK and Akt were observed. These responses were completely prevented by glibenclamide and significantly reduced by L-NAME.

Conclusions: The results of this study show that intracoronary levosimendan reduces cell death induced by ischemia/reperfusion in a dose-dependent manner and activates survival signaling through KATP channel opening and NO. These findings support interesting implications for cardioprotection in interventional cardiology and cardiac surgery.

Key Words: Akt, Apoptosis, ERK, Levosimendan, NO, Potassium channels.

Alternative approaches for trans-catheter self-expanding aortic bioprosthetic valves implantation: single-center experience

Eur J Cardiothorac Surg 2011;39:e151-e158.

Objective: Trans-catheter aortic valve implantation has emerged and rapidly gained credibility as a valuable alternative to treat patients with severe aortic stenosis and no surgical option; however, these patients are often affected also by severe iliac–femoral arteriopathy, rendering the transfemoral approach unemployable. From May 2008, 92 patients with severe, symptomatic aortic stenosis and no reasonable surgical option because of excessive risk underwent trans-catheter aortic valve implantation at our center. Eighty patients (34 male) with mean age 82 ± 8 years were eligible for Core-Valve percutaneous femoral implantation. Twelve patients, mean age 81 ± 8 years, were excluded from percutaneous femoral Core-Valve implantation because of iliac–femoral arteriopathy.

Methods: These 12 patients underwent trans-catheter aortic valve implantation through the left axillary artery in six cases, the other six directly from the ascending aorta through a right anterior mini-thoracotomy. Procedures were performed by a combined team of cardiologists, cardiac surgeons, and anesthesiologists.

Results: Procedural success was obtained in 11 cases; all these patients were discharged in asymptomatic status, with midterm good prosthesis performance. Three patients required the implantation of a permanent pacemaker. One patient needed a subclavian covered stent implantation to treat a post-implant artery dissection. One patient of the direct aortic access group was converted to the femoral approach due to an extremely fragile aortic wall, but died in the intensive care unit of abdominal aortic aneurysm rupture. All discharged patients improved their New York Heart Association (NYHA) functional class and functional capacity, and echocardiograms evidenced good valve performance at 2 years.

Conclusions: Trans-catheter aortic valve implantation with surgical subclavian or direct aortic approach seems safe and feasible, offering a new attractive option to treat selected high-risk patients with severe aortic stenosis and peripheral vasculopathy, and has emerged as a valuable alternative route to trans-apical procedures.

Key Words: Aortic stenosis • Trans-catheter valve replacement • Axillary artery • Aortic valve.

Extracorporeal membrane oxygenation for acute respiratory distress syndrome: is the configuration mode an important predictor for the outcome?

Interact CardioVasc Thorac Surg 2011;12:676-680

Extracorporeal membrane oxygenation (ECMO) is increasingly applied as rescue-therapy for patients with severe acute respiratory distress syndrome (ARDS). Here, we evaluate the effect of different configuration strategies (venovenous vs. venoarterial vs. veno-venoarterial) on the outcome. From 2006 to 2008, 30 patients received ECMO for severe ARDS. Patients were divided into three groups according to the configuration: veno-venous (vv; n=11), venoarterial (va; n=8) or veno-venoarterial (vva; n=11). Data were prospectively collected and endpoint was 30-day mortality. To identify independent risk factors, univariate analysis was performed for clinical parameters, such as age, body mass index, gender, configuration, low-pH, oxygenation index (pO₂/FiO₂) and underlying disease. Thirty-

day mortality was 53% (n=16) for all comers: 63% (n=7) died in the vv-group, 75% (n=6) in the va-group and 27% (n=3) in the vva-group. Although univariate analysis could not rule out a significant predictor for the outcome, there was a trend visible to decreased mortality in the vva-group when compared to vv- and va-groups (27% vs. 63% vs. 75%; P=0.057). ECMO provides a survival benefit in patients when considering a predicted mortality rate of 80% in ARDS. The configuration mode appears to impact the outcome as the veno-venoarterial appears to further improve the survival in this subset of patients.

Key Words: Extracorporeal membrane oxygenation; Acute respiratory distress syndrome; Configuration mode.

Acute type A aortic dissection and pregnancy: a population-based study

Eur J Cardiothorac Surg 2011;39:e159-e163.

Objective: Pregnancy has been reported to be an independent risk factor for 50% of acute aortic dissections recorded in women younger than 45 years of age. The present epidemiologic study aimed to identify whether this putative association of pregnancy and acute type A dissection could be an artifact of selective reporting.

Methods: This population-based study was conducted in the City of Vienna, Austria, Europe, in an average female population of 341 381 women in the age range of 15–45 years who were followed up between 1994 and 2004 (total of 3755.195 person-years of observation). During this study, the incidence, management, and outcome of acute type A dissection were determined.

Results: Fifteen patients (mean age: 38.8 years, SD: 4.8) with acute aortic dissection were identified, and an overall incidence of 0.4 case per 100 000 person-years was esti-

mated. The prehospital mortality rate was recorded to be 53%. Six patients, including two women in late pregnancy (incidence: 0.05 cases per 100 000 person-years), were treated successfully by surgical repair during deep hypothermic circulatory arrest (in-hospital mortality rate: 6.6%). Pregnancy and aortic dissection were identified as events that were not related (RR: 3.27; 95% confidence interval (CI): 0.82–12.95; P = 0.14). Observation during long-term follow-up was uneventful.

Conclusions: Acute aortic dissection represents a rare pathology in women younger than 45 years of age; however, it is associated with a high rate of sudden death. Pregnancy may not be a risk factor for this life-threatening vascular emergency. Immediate referral to surgery, even during pregnancy, will result in a prognosis of favorable outcome.

KeyWords: Aorta, Aortic dissection, Pregnancy, Prognosis.

Antegrade Cerebral Perfusion With Mild Hypothermia for Aortic Arch Replacement: Single-Center Experience in 245 Consecutive Patients

Ann Thorac Surg 2011;91:1868-1873

Background: Aortic arch replacement remains a surgical challenge because of prolonged operative times, bleeding complications, and a considerable risk of neurologic morbidity and mortality. This study investigates our clinical results after modification of perfusion technique for cardiopulmonary bypass as well as temperature management for these high-risk patients.

Methods: Between January 2000 and January 2009, 245 consecutive patients underwent aortic arch repair during selective antegrade cerebral perfusion (ACP) with mild systemic hypothermia ($30.5^{\circ}\text{C} \pm 1.4^{\circ}\text{C}$). Mean age was 63 ± 12 years, 175 patients (71%) were men and 141 patients (58%) had acute type A dissection. Hemiarch replacement was performed in 152 patients (62%) while the remaining 93 patients (38%) underwent total arch replacement.

Results: Cardiopulmonary bypass time accounted for 168 ± 62 minutes, and myocardial ischemic time was 103 ± 45 minutes. Isolated ACP was performed for 38 ± 27 (range 12 to 135) minutes. Chest tube drainage during the first 24

hours was 563 ± 248 mL. Mean ventilation time was 44 ± 22 hours. Serum lactate levels at 1, 12, and 24 hours postoperatively rose to 19 ± 11 , 33 ± 14 , and 20 ± 8 mg/dL, respectively. We observed new postoperative permanent neurologic deficits in 14 patients (6%) and transient neurologic deficits in 12 patients (5%). The operative mortality rate was 8% (n = 20). Among patients with ACP times 60 minutes or greater (n = 28; 92 ± 29 minutes), permanent neurologic deficits occurred in 2 individuals (n = 2 of 28; 7%) and operative mortality was 7% (n = 2 of 28). At late follow-up (3.8 ± 3.2 years, 98% complete), 196 patients (80%) were still alive.

Conclusions: Selective ACP in combination with mild hypothermia offered sufficient cerebral as well as distal organ protection in our patient cohort. Thus, current data suggest that this standardized perfusion and temperature management protocol can safely be applied to complex aortic arch surgery requiring up to 90 minutes of isolated ACP times.

Up to 6-year follow-up after pulmonary vein isolation for persistent/permanent atrial fibrillation: Importance of sinus node function

J Thorac Cardiovasc Surg 2011;141:1455-1460

Objective: Sinus node dysfunction is commonly associated with atrial fibrillation. There is little information about the long-term results of pulmonary vein isolation in relation to sinus node function. The present study was conducted to investigate whether sinus node dysfunction affects the late outcome of pulmonary vein isolation in patients with persistent/permanent atrial fibrillation.

Methods: Among 76 consecutive patients with persistent/permanent atrial fibrillation who had undergone cut-and-sew pulmonary vein isolation, 66 patients without evidence of intra-atrial thrombus by transesophageal echography, and who were able to tolerate cardioversion, were enrolled. Sinus node recovery time after cardioversion was examined intraoperatively. All of the patients underwent valvular surgery concomitantly (mitral in 62).

Results: Sinus node dysfunction was detected in 18 patients. These patients had a significantly lower f wave voltage in V1 of the electrocardiogram and a larger cardiothoracic ra-

tio than patients with normal sinus node function. Hospital mortality was 3%, and 3 late deaths were observed. Follow-up was conducted for up to 72 months (mean 30 months), with a 100% complete follow-up rate. There were no significant differences in actuarial survival and freedom from cardiac events between patients with normal and abnormal sinus node function. No thromboembolic events occurred. A significantly higher proportion of patients with normal sinus node function (82%) were free of atrial fibrillation at 4 years than patients with sinus node dysfunction (25%; $P < .0001$).

Conclusions: The atrial fibrillation cure rate after pulmonary vein isolation may be influenced by sinus node function in both the early and late stages. Although further examinations are required, pulmonary vein isolation may be an adequate treatment for persistent/permanent atrial fibrillation in patients with normal sinus node function.

Ablation of Atrial Fibrillation: Comparison of Catheter-Based Techniques and the Cox-Maze III Operation

Ann Thorac Surg 2011;91:1882-1889.

Background: Catheter-based ablation is often recommended for treatment of atrial fibrillation (AF), but there are no data that directly compare late results to those of the Cox-Maze procedure. Although catheter ablation avoids operation, lack of reliable transmural ablation may reduce effectiveness. We compared clinical outcomes of the cut-and-sew Cox-Maze procedure with catheter ablation.

Methods: Between January 1993 and October 2007, 97 patients aged 25 to 80 years underwent an isolated cut-and-sew Cox-Maze procedure. Patients were matched 1:2 according to age, sex, and AF type, with 194 patients undergoing catheter-based ablation for lone AF.

Results: At last follow-up, 82% of patients who underwent the Cox-Maze procedure were free of AF and had stopped taking antiarrhythmic medications compared with 55% of patients who underwent ablation ($p < 0.001$). When ana-

lyzed as a time-related event, freedom from recurrent AF was 87% 5 years after the Cox-Maze procedure compared with 28% after catheter ablation ($p < 0.001$). Late warfarin anticoagulation was required in 12% of patients who underwent the Cox-Maze procedure compared with 55% of patients who underwent ablation ($p < 0.001$), and use of antiarrhythmic medications during follow-up was significantly higher in patients who underwent ablation (68% versus 15%, $p < 0.001$). Forty-one patients (24%) required repeated ablation procedure and 9 required a second repeated ablation.

Conclusions: Compared with catheter-based ablation, the Cox-Maze procedure results in greater freedom from AF and less medical treatment with antiarrhythmic drugs and warfarin anticoagulation during follow-up.

Off-Pump and On-Pump Coronary Artery Bypass Grafting Are Associated With Similar Graft Patency, Myocardial Ischemia, and Freedom From Reintervention: Long-Term Follow-Up of a Randomized Trial

Ann Thorac Surg 2011;91:1836-1843.

Background: The Surgical Management of Arterial Revascularization Therapies trial was conceived to rigorously compare completeness of revascularization, clinical outcomes and resource utilization in unselected patients referred for elective, primary coronary artery bypass grafting randomly assigned to undergo off-pump (OPCAB) or conventional on-pump coronary artery bypass grafting using cardiopulmonary bypass (CPB). The goal of this follow-up study was to compare long-term survival, graft patency, myocardial ischemia, and clinical outcomes among survivors who volunteered to return for clinical evaluation and imaging studies.

Methods: Two hundred unselected patients with multi-vessel coronary artery disease were randomly assigned to OPCAB or CPB coronary artery bypass grafting between March 2000 and August 2001. All-cause mortality was determined by individual patient contact and referencing the Social Security Death Master File. Of 140 survivors, 87 volunteered to return after a minimum of 6.8 years (maximum, 8.4 years; mean, 7.5 years) for assessment of graft patency (computed tomographic angiography) and myocardial ischemia (cardiac positron emission tomography and 12-lead electrocardiogram). Age at follow-up ranged from 38 to 90 years (mean, 68 years).

Results: There were 26 deaths from all causes among OP-

CAB patients and 31 among CPB patients as of March 30, 2009. Graft patency was similar between groups among 622 grafts assessed by angiography before hospital discharge (99% OPCAB versus 97.7% CPB; $p = 0.22$, Fisher's exact test), among 511 grafts assessed by angiography at 1 year (93.6% OPCAB versus 95.8% CPB; $p = 0.33$), and among 190 grafts assessed by computed tomographic angiography at late follow-up (76% OPCAB versus 83.5% CPB; $p = 0.44$). Twelve of 34 OPCAB (35.3%) and 16 of 39 CPB patients (41.0%) had any ischemia on positron emission tomography scanning ($p = 0.62$). Four OPCAB patients (11.8%) and 9 CPB patients (23.1%) had an ischemic region in excess of 10% of myocardium ($p = 0.21$). At late follow-up, recurrent angina had occurred in 11 of 43 (25.6%) OPCAB patients and 5 of 44 (11.4%) CPB patients ($p = 0.09$). Percutaneous reintervention had been performed at the discretion of blinded local cardiologists in 1 of 43 (2.3%) OPCAB patients and 1 of 44 (2.3%) CPB patients ($p = 1.0$). No patient in either group has undergone repeat CABG.

Conclusions: In this randomized trial, off-pump and on-pump coronary artery bypass grafting were associated with similar early and late graft patency, incidence of recurrent or residual myocardial ischemia, need for reintervention, and long-term survival.

Is it safe to perform coronary angiography during acute endocarditis?

Interactive CardioVascular and Thoracic Surgery 2011, doi:10.1510/icvts.2011.269035

Abstract

A best evidence topic was written according to a structured protocol. The question addressed was 'Is it safe to perform coronary angiography (CA) in acute endocarditis?' Three hundred and ninety-seven papers were found using the reported search, of which six represented the best evidence to answer the clinical question. The authors, journal, date and country of publication, patient group studied, study type, relevant outcomes, key results and limitations of these pa-

pers are tabulated. One of the papers is a case report, which reported a fatal vegetation embolism from an infected aortic valve into the left main coronary artery 14 h after angiography. The remaining five papers are cohort studies. Four of these studies were performed in 1970s-1980s before the era of echocardiography and were aimed at quantifying the severity of valvular regurgitation. No embolic complications or dislodgement of vegetations occurred in any of the five studies (186 patients). Guidelines published by

the European Society of Cardiology (ESC) in 2009 recommended CA in the context of infective endocarditis (IE) for men >40 years old, postmenopausal women, and patients with at least one cardiovascular risk factor or a history of coronary artery disease. Exceptions include patients with large aortic vegetations which may be dislodged during catheterisation, and when emergency surgery is necessary - 1) native aortic or mitral IE with severe acute regurgitation or valve obstruction, or prosthetic valve IE with severe prosthetic dysfunction (dehiscence or obstruction) causing refractory pulmonary oedema or cardiogenic shock; 2) native aortic, mitral, or prosthetic valve IE with fistula into a

cardiac chamber or pericardium causing refractory pulmonary oedema or shock. This is reiterated by the guidelines on the management of valvular heart disease published by the ESC in 2007. From the findings of the six papers, it can be concluded that coronary angiography can be performed safely in IE and should be performed if deemed necessary, unless the patients are haemodynamically unstable requiring emergency surgery, or have large vegetations of the aortic valve. This is consistent with the ESC guidelines.

Key Words: Coronary angiography; Infective endocarditis; Safety.

Tranexamic acid versus-aminocaproic acid: efficacy and safety in paediatric cardiac surgery

Eur J Cardiothorac Surg 2011;39:892-897

Objective: Tranexamic acid (TXA) and -aminocaproic acid (EACA) are used for antifibrinolytic therapy in cardiac surgery, although data directly comparing their blood sparing effect and their side effects, especially in paediatric cardiac surgical patients, are still missing.

Methods: We analysed perioperative data of 234 paediatric patients weighing less than 20 kg undergoing cardiac surgery. In a 5-month period, all patients (n = 114) received TXA (group TXA). During a second 5-month period, all patients (n = 120) were treated with EACA (group EACA). Primary outcome was blood loss at 24 h postoperatively; secondary outcome criteria were transfusion requirement, rate of revision for bleeding, postoperative complications and in-hospital mortality.

Results: All descriptive and intra-operative parameters were well comparable. There was no evidence for a difference in blood loss at 24 h postoperatively (TXA 21 ml kg⁻¹ (14–38) (median (interquartile range)) vs EACA 29 ml kg⁻¹ (14–40), p = 0.242), rate of re-operation for bleed-

ing (TXA 9.6% vs EACA 8.3%, p = 0.725) and transfusion of blood products. The incidence of postoperative complications such as seizures (TXA 3.5% vs EACA 0.8%, p = 0.203) and other neurological complications (TXA 2.6% vs EACA 1.7%, p = 0.677), renal injury (TXA 9.6% vs EACA 13.3%, p = 0.378), renal failure (TXA 1.8% vs EACA 4.2%, p = 0.447), low cardiac output syndrome (TXA 12.3% vs EACA 10.8%, p = 0.729), and vascular thrombosis (TXA 4.4% vs EACA 5.0%, p = 0.824), as well as the in-hospital mortality (TXA 2.6% vs EACA 3.3%, p > 0.999) did not show any statistically significant difference.

Conclusions: TXA and EACA are well comparable in their effect on perioperative blood loss as well as in major clinical outcome criteria. Although the fourfold risk for seizures using TXA was not significant, we currently use EACA in paediatric cardiac surgery.

Key Words: Tranexamic acid, Aminocaproic acid, Paediatric cardiac surgery, Blood loss, Outcome.

Outcomes of Surgery for Simple Total Anomalous Pulmonary Venous Drainage in Neonates

Ann Thorac Surg 2011;91:1921-1927

Background: Repair of total anomalous pulmonary venous drainage (TAPVD) in neonates remains a challenge as it

is often associated with severe obstruction. We describe a large cohort of neonates who underwent TAPVD repair at

a single institution.

Methods: From 1973 to 2008, 112 patients underwent simple TAPVD surgery during the first month of life. Data collection occurred retrospectively.

Results: Preoperative pulmonary venous obstruction (PVO) occurred in 89 (79.5%) patients. There were 12 (10.7%) early deaths. Significant risk factors were bypass time greater than 65 minutes ($p = 0.014$) and emergent surgery ($p = 0.005$). Hospital mortality was unchanged throughout the 3 eras (1973 to 1988, 1989 to 1998, 1999 to 2008), despite an increase in patients with preoperative acidosis ($p = 0.004$) and severe TAPVD obstruction ($p = 0.038$) during the recent 10 years. There were 6 (6.25%) late deaths within 2 years of repair. Survival at 20 years was 83.4% (95% confidence interval 75 to 89). Risk factors for late death were

operative weight 2.5 kg or less ($p = 0.004$) and postoperative pulmonary hypertensive crisis ($p = 0.02$). Reoperation for recurrent PVO was required in 13 patients (11.9%). Risk factors were operative weight 2.5 kg or less ($p = 0.035$) and postoperative pulmonary hypertensive crisis ($p = 0.002$). Follow-up was 96% complete and survivors ($n = 90$) were asymptomatic at a median age of 11.7 years.

Conclusions: Hospital mortality remained unchanged over the 36-year period. Survival beyond 2 years offers excellent outcome. Risk factors for mortality were the preoperative clinical status, prolonged bypass time, persisting micro-obstruction, and low operative weight. A reduction in mortality will likely require development of effective medical management for patients who have peripheral PVO not amenable to surgical repair.

Long-term results of one-and-a-half ventricle repair in complex cardiac anomalies

Objective: One-and-a-half ventricle repair is a surgical option for complex cardiac anomalies characterized by right-ventricle hypoplasia or dysfunction. The long-term result analyses or large clinical reviews are rare. The aim of this study is to evaluate the long-term functional results of this surgical procedure.

Methods: The 29 patients, who underwent one-and-a-half ventricle repair from June 1993 to June 2007, at our Institution, were included. The median age was 26 months (range 6 months to 26 years). One-and-a-half-ventricle repair was performed for volume unloading the small right ventricle (group A, $n = 18$), for work unloading in patients with chronic right-ventricle dysfunction (group B, $n = 9$), and with the acute postoperative right-ventricular dysfunction (group C, $n = 2$). The mean Z value of the tricuspid valve in group A was -3.6 ± 0.7 (range -2.6 to -4.8). The median follow-up duration of hospital survivors was 82 months (range 3 months to 16 years).

Results: There were four early deaths (two in group A and C, respectively) and no late cardiac death. During follow-up, no patient had superior vena cava (SVC) hypertension or chronic atrial arrhythmia. There was one patient with protein-losing enteropathy. Functional status was New York Heart Association Functional Class I in 21 patients and class II in three patients. Arterial oxygen saturation increased significantly after operation, compared with the

preoperative saturation (86.6 ± 9.7 – $96.8 \pm 4.0\%$, $p < 0.01$). Two patients in group B needed medications related to the cardiac function. Four patients underwent reoperation. The 10-year freedoms from late reoperation were $80.0 \pm 12.6\%$ in group A and $51.4 \pm 20.4\%$ in group B.

Conclusions: The patients with one-and-a-half ventricle repair resulted in favorable late survival in this series. During the follow-up period, most surviving patients showed good functional status without common late complications of the Fontan procedure such as, recurrent cyanosis, pulmonary arteriovenous fistulas, chronic arrhythmias, and SVC syndrome. This procedure appears to be a valid alternative to Fontan and biventricular repairs in patients with right-ventricular dysfunction or hypoplasia.

Key Words: One-and-a-half-ventricle repair, Right-ventricular hypoplasia, Right-ventricular dysfunction.

Relevance of colloid oncotic pressure regulation during neonatal and infant cardiopulmonary bypass: a prospective randomized study

Eur J Cardiothorac Surg 2011;39:886-891.

Objective: In neonatal and infant cardiac surgery with cardiopulmonary bypass (CPB), hemodilution with reduction of plasma albumin concentration and low colloid oncotic pressure (COP) are the main factors associated with tissue edema and postoperative weight gain. The aim of our study was to evaluate the influence of two different COP regulatory strategies on post-bypass body weight gain, fluid balance, and clinical outcomes.

Methods: Seventy elective patients with body weight < 10 kg underwent first-time cardiac surgery with CPB and were randomized into two groups. The standard COP group received 0.5 g kg⁻¹ of human albumin in the priming and, during CPB, albumin was added to maintain the COP > 15 mmHg. In the high COP group, albumin concentration in the priming was 5% and, during CPB, the COP was maintained above 18 mmHg. All patients were monitored before, during and until 24 h postoperatively. Data were collected on body weight gain, COP, albumin concentration, fluids transfusion, blood loss, urine production and laboratory results.

Results: Patients' demographics and operative data were comparable. Although the high COP group had perioperatively significantly higher COP and albumin concentration

than the standard COP group, no significant difference was found in the body weight gain. There were also no significant differences between the groups with respect to fluid balance, urine output and blood loss. However, the high COP group had significantly shorter postoperative duration of mechanical ventilation (10 h vs 14 h, $p = 0.02$) and lower plasma lactate concentration post operation (1.1 mmol l⁻¹ vs 1.4 mmol l⁻¹, $p = 0.046$).

Conclusions: The COP regulatory strategy for neonatal and infant CPB, based upon the 5% concentration of albumin in the priming and a COP target of 18 mmHg during bypass, better preserves the plasma albumin concentration within the physiological range and stabilizes the colloid pressure than the standard strategy (0.5 g kg⁻¹ albumin in the priming and bypass COP target at 15 mmHg). Nevertheless, only the lower postoperative plasma lactate concentration and the shorter duration of mechanical ventilation in the high COP group indicated the potential clinical benefit of this new strategy.

Key Words: Infant and neonatal cardiopulmonary bypass, Colloid oncotic pressure, Albumin concentration, Fluid balance.

Comparison of surgical and interventional therapy of native and recurrent aortic coarctation regarding different age groups during childhood

Eur J Cardiothorac Surg 2011;39:898-904.

Objective: The aim of the study was to analyze immediate results, rate of complications and re-interventions during medium-term outcome in pediatric patients with native or recurrent aortic coarctation. We focused on an age-related therapeutic approach comparing surgical and trans-catheter treatment.

Methods: This is a retrospective, single-centre, clinical observational trial including 91 consecutive patients (age: 1 day–18 years) treated for native coarctation in 67 and recurrent aortic coarctation in 24 patients. Surgical treatment was

performed in 56, trans-catheter treatment with balloon dilatation in 17, and by stent implantation in 18 patients. According to the age groups, we treated 48 children in group A (<6 months of age), 16 in group B (6 months–6 years), and 27 in group C (>6 years). A total of 41 patients in group A were operated (85%), patients in group B received either surgical or trans-catheter treatment (50% vs 50%), and 16 patients in group C were treated by stent implantation (62%).

Results: Immediate results were excellent with a signifi-

cant release of pressure gradient in all three age groups (64.7% in group A, 69.1% in group B, and 63.3% in group C). Complication rate and re-intervention rate (surgical and interventional) were both comparable between the three age groups (complications: group A 8.3%, group B 6.3%, and group C 3.7%; re-interventions: group A 16.6%, group B 18.8%, and group C 18.5%). Midterm outcome after a median follow-up period of 17.5 months was satisfactory with a re-intervention-free survival after 17.5 months of 83.4%, 81.2%, and 81.5% in group A, group B, and group C, respectively.

Conclusions: The current strategy of an age-related therapy

for native and recurrent aortic coarctation in our institution is surgery in infants <6 months (group A), either surgery or balloon dilatation in younger patients <6 years (group B), while in older children >6 years of age (group C) the trans-catheter treatment with stent implantation is an excellent alternative to surgery. Balloon dilatations showed limited results with an overall re-intervention rate of 53% and, therefore, should mainly be performed as a rescue procedure or in recurrent aortic coarctation in neonates.

Key Words: Aortic coarctation, Pediatric cardiac surgery, Stent, Trans-catheter treatment, Balloon dilatation.

The Ross Operation in Children and Young Adults: A Fifteen-Year, Single-Institution Experience

Ann Thorac Surg 2011;91:1936-1942

Background: The optimal operation for aortic valve disease in children and young adults remains controversial. The Ross operation offers avoidance of anticoagulation and the potential for growth but is technically demanding and creates double-valve disease. The goal of this study is to report our experience with the Ross operation and the need for reintervention at intermediate follow-up.

Methods: A retrospective review of Ross operations in a single surgeon experience from 1992 to 2007 was conducted. All echocardiograms were reevaluated by a single cardiologist.

Results: The cohort included 54 patients with a mean age of 13.5 years (range 0.5 to 35 years). Pulmonary autograft implantation was accomplished using root replacement (n = 43), root inclusion (n = 9), and Dacron tube root replace-

ment (n = 2). Follow-up was available for 47 patients (87%) at a mean length of 6.4 years. There were no deaths. Kaplan-Meier estimates of freedom from explantation at 10 years were 100% for the autograft and 71% for the homograft. Autograft insufficiency at latest follow-up was trivial in 37 patients (82%), mild in 6 patients (13%), and moderate in 2 patients (4%). Reintervention for the homograft included balloon dilation in 3 children and conduit change in 5 children (all 2 years old at initial operation).

Conclusions: The Ross operation can be performed in children and adults with low mortality and can provide a durable result for the aortic valve with a low incidence of aortic insufficiency. The need for homograft replacement during follow-up in our series was primarily limited to children who were age 2 years or younger at initial operation.

Hydatid Cyst of the Left Ventricle, Interventricular Septum , Liver and Lung

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Abstract:

Cardiac Echinococcosis is a rare and the most serious of all Hydatid manifestation. We report here the case of 12 year old boy who had Hydatid Cyst in the liver, lung , left ventricle & inter ventricular septum .

The patient underwent cardiac surgery after 2 months medical therapy with Albendazole.

Case Report:

A 12 year old boy presented with left side chest pain, cough and palpitation from 52 days ago . Clinical examination revealed raised of jugular venous pressure,mild hepatomegaly.

On auscultation normal s1,s2 with 3/6 murmur was heard most strongly in left sternal border & apex . ECG was normal. Hematologic investigations revealed normal ESR, eosinophilia. Chest X-Ray showed a well circumscribe lesion in upper lobe of left lung, suggested aborted cyst.

In CT of thorax & abdomen showed cystic mass in the left ventricle , interventricular septum (IVS) , left lung & small cyst in the liver .(The images of this CT were not available)

Patient was diagnosed to have hydatid cyst in liver , lung & heart . He was treated with Albendazole 400mg twice daily for 8 week. After 2 months medical therapy there was no change in cardiac cyst size, so after consultation with infectious disease service, patient referred to us and surgical therapy was recommended.

In CXR that was taken in our center typical bulging in left border of heart was seen.(Fig 1),and TEE showed two

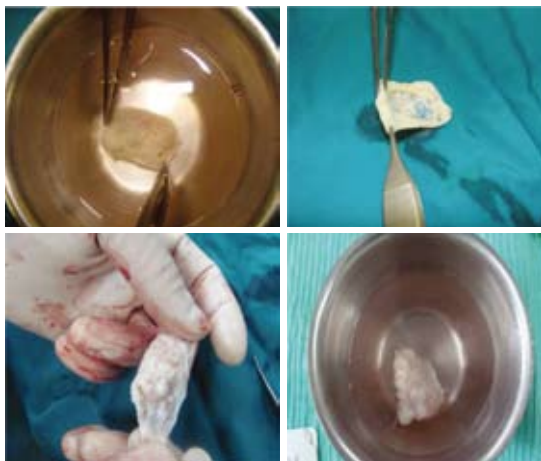
cystic space occupying lesion in IVS & LV free wall, the one in IVS was larger & elliptical(7x3.5cm).it was echolucent & had three distinct layers. The smaller cyst (3x4cm)was in midway between mitral annulus & apex in LV free wall with extension to LVPW& has similar appearance with the larger one.



Fig. 1: Chest X Ray

Through a mid sternotomy incision , after total cardiopulmonary bypass with moderate systemic hypothermia (32 °C) and cardioplegic arrest, right atrium was opened. After putting AgNo3 pad around LV,roof of cyst was opened and daughter cyst & germinal layer was removed (fig 2) , and defect was repaired by pericardial patch . Then through RA, after putting

AgNO₃ pad around cyst in IVS, large cyst was resected (fig 3), and defect was repaired. He was weaned off cardiopulmonary bypass with out problem & discharge one week after operation, and was advised Albendazole 400mg BD for two weeks.



(Fig 2,3) LV & IVS hydatid cyst

Discussion:

Echinococcosis is a widely known zoonosis caused by the larve of *Echinococcus granulosus*, where man is the accidental host, sheep is the intermediate host & dog definitive host. Human infection follows ingestion eggs passed by infected dogs.

In humans, the most frequent location of hydatid cyst of the liver (60%) & the lungs (20-30%). (1) Cardiac involvement ranges from 0.01% to 2%.

The left ventricle is most commonly involved, while the less commonly involved sites in the heart include the right ventricle, inter ventricular septum, left atrium & pericardium.(2)

Patient cardiac hydatid cyst may remain asymptomatic or have symptoms depending on the location & sizes of cysts. There are usually due to cyst perforation, pressure, arrhythmias, angina, valvular dysfunction, pericardial reaction, pulmonary or systemic embolism and anaphylactic reaction. (3,4)

Although hydatid cysts are more frequently in left ventricle, right ventricle hydatid cysts are more frequently prone to rupture leading to pulmonary embolism, anaphylactic reaction or sudden death.

Morbidity from Echinococcosis in men is 3 times higher in

women.

Solitary cysts occur in almost 60% of the cases. Echocardiography, CT & MRI are valuable diagnostic tools in the detection of cardiac hydatid cysts. Although a high & prolonged use of benzimidazol is effective in the treatment of cardiac & non-cardiac hydatosis, this cannot prevent serious complications. Therefore surgical intervention is the definitive therapy for cardiac hydatosis. (5,6)

In choosing the technique of operation, the location, number and sizes of cyst are important. (7)

Conclusion:

To conclude cardiac Echinococcosis is rare and the most serious form of all hydatid manifestations. Cardiac hydatid can now be effectively diagnosed by excellent non-invasive diagnostic imaging procedures & managed by equally effective surgical intervention.

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Cardiovascular Malformations in Congenital Rubella Syndrome: A Case Report



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Abstract:

Congenital rubella syndrome (CRS) has a wide variety of severe systemic complications. Cardiovascular defects have always been a part of the rubella syndrome. Patent ductus arteriosus (PDA) remains the most frequent cardiac anomaly. It may occur alone or accompany other heart defects. Pulmonary stenosis and septal defects have been noted with greater frequency since the earlier reports. The classic triad is hearing impairment, heart defect, and cataract.

Here we report an infant girl with classic presentations of CRS. We discuss about her malformations and compared them with other combination of manifestations in the literature.

Key words: Congenital, Rubella infection, Cardiac anomaly

Introduction:

Congenital rubella syndrome (CRS) is an ensemble of congenital malformations which results from a primary viral infection in non-immunized pregnant women (1). Rubella virus is one of the organisms responsible for intrauterine infection or TORCH syndrome. The acronym TORCH refers to toxoplasmosis, other agents (e.g. syphilis), rubella, cytomegalovirus, and herpes simplex virus types 1 and 2 (2). Congenital rubella can result in deafness, congenital heart disease (CHD), retinopathy, and neurologic abnormalities. Diagnosis is confirmed by culture and/or identification of specific immunoglobulin M within the first 2 weeks of life (2). Maternal rubella was responsible for less than 2% of CHD. The accepted risk of CHD following maternal rubella in the first trimester was considered to be about 20 to 30% and declined steadily thereafter (3). Nerve deafness is the single most common finding among infants with CRS. Unilateral or bilateral cataracts are the most serious eye finding, occurring in about 1/3 of infants. Cardiac abnormalities occur in half of the children infected during the 1st 8 week of

gestation. Patent ductus arteriosus (PDA) is the most frequently reported cardiac defect followed by lesions of the pulmonary arteries and valvular disease. Neurologic abnormalities are common and may progress following birth. Psychomotor retardation has been reported in up to 45% of cases (4).

In a prospective study by Kramer et al. 1016 infants and children with CHD were examined to detect the pattern of their additional malformations. Twenty seven had embryopathy and thirteen of these 27 embryopathies were due to rubella infection (5). In a study in USA from 1985 through 1996 one hundred twenty two CRS cases were reported to the national CRS registry. The most frequent CRS related defect was CHD (6). The literature suggests that approximately 30% of infants with CRS have PDA (7). As part of the national plan for elimination of rubella and CRS, Oman established a national registry of CRS cases. As of May 2005, the registry included 43 surviving CRS cases with a mean age of 11.9 years. Clinical examination found that 84% had ocular defects, 84% had auditory/speech defects, 70% had neurological mani-

festations, and 42% had cardiac defects (8).

In our country rubella vaccine was included in the routine immunization program of children in recent years. The sporadic cases of CRS are the off springs of young mothers who did not receive rubella vaccine in their infancy. Here we report a CRS case with the classic manifestations. Our aim is to discuss the pathogenesis of cardiac involvement, and to describe the variable combinations of congenital malformations in this syndrome.

Case report:

An 11-month old girl was admitted at pediatric cardiology ward of Shahid Modarres Hospital in June 2008. She was the full term product of her mother's first pregnancy and was delivered by normal vaginal delivery. Her 21-yr old mother had no previous history of abortion. The mother had not received rubella vaccine, and she remembered several days of nonspecific maculopapular rash in the late period of first trimester of her pregnancy. The mother had no previous history of other illnesses like diabetes mellitus or hypertension. The parents were not relatives. At birth the body weight was 2700 gram, head circumference 31 cm, and length 43 cm. The neonate developed jaundice in the 3rd day of birth and had 5 days of hospitalization for treatment.

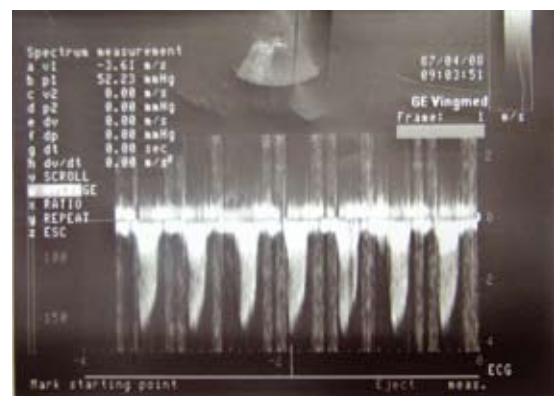
On admission in our ward the general condition was good but the patient suffered from failure to thrive. Her body weight was 7 kg, head circumference 42cm, and length 72cm. At physical examination there was leukokoria (white pupillary reflex) in both eyes [figure 1]. The cataract of right eye had been operated previously. The patient suffered from mild developmental delay. There was a failure to elicit auditory brainstem evoked responses (ABR test) indicating hearing impairment. Heart auscultation revealed a grade 4/6 harsh systolic murmur with a loud second heart sound (P2) at left sterna border. Liver was 2 cm. below costal margin. Chest X-ray showed severe cardiomegaly with biventricular enlargement, increased pulmonary blood flow with hilar engorgement. ECG showed right axis deviation with biventricular hypertrophy. Echocardiography demonstrated a large perimembranous VSD with PDA and pulmonary hypertension. Cardiac catheterization confirmed the above diagnosis and ruled out the peripheral pulmonary stenosis. Cell blood count (CBC) showed mild anemia with thalassemia minor. Serologic study at the neonatal period had shown positive rubella IgG antibody titer for both mother and child. Repeated serologic test after one month showed positive

rubella 1gM antibody titer for the child.



Figure 1: Leukokoria of both eyes are evident

The patient underwent cardiac surgery for PDA ligation and division and PA banding [figure 2]. Preoperative pressure of aorta was 80 mmHg and PA pressure was 90 mmHg. Postoperative pressure of aorta was 100 mmHg and PA pressure was 45 mmHg. The postoperative course was uneventful and the patient was discharged in good condition with treatment of congestive heart failure (digoxin, diuretic, and captopril). The patient had regular follow-up and in near future the second heart surgery for closing of VSD will be performed.



Discussion:

In the course of gestation, many bacteria, parasites, and viruses may infect the pregnant woman, but few cross the placenta to affect the fetus and fewer still affect the fetal heart. Although the incidence of fetal cardiac infection is low, the effect on the fetus is major. The pathogenesis of infection of

the fetal heart relates to the agent and to the time of gestation when the infection occurs. The agent affects the heart along one or more of three separate pathways; inhibition of cell growth, cytolysis, and interference with blood supply. Most agents cause cytolysis, stimulating inflammation and scarring. Although several agents carry the suspicion of teratogenicity, only rubella virus has been incriminated with certainly as capable of functioning along each of the three pathways with potential to serve as teratogen (9). The ductus arteriosus is present for many months of fetal life and for a short time after birth, and whatever the mechanism of final closure, it is conceivable that it could be damaged at any stage. The greater incidence of PDA in these children may thus merely reflect the longer time that this structure is at risk. In this regard the histologic structure of the ductus has been reported as abnormal in babies damaged by maternal rubella (3).

Pulmonary hypertension in our patient was due to presence of two large left to right shunts. Cardiac catheterization and angiocardiology did not show peripheral pulmonary stenosis. One of the earlier review articles about cardiovascular defects and rubella syndrome indicated that of 112 patients with CRS patent ductus arteriosus was demonstrated in 46 infants (41%). Twelve patients (10.7%) had VSD and only four (3.6%) had pulmonary stenosis (3). In a report by Spelling et al; about nine patients under five months of age with cardiovascular manifestations of the rubella syndrome, six had PDA. Three of these six also had pulmonary artery stenosis (10). Aiming to document the incidence and type of associated CHD, 20 children affected with the CRS have been evaluated during a 5-year period by Granzotti et al. CHD was detected in 45% of the cases. PDA was the most frequent finding, followed by VSD and ASD. An association of 66% was found between ophthalmic and heart lesions (11).

TORCH infection including rubella can cause multi organ lesions, such as hearing impairment, hyperbilirubinemia and liver dysfunction, impairment of neurologic system, myocardial impairment, thrombocytopenia, and CHD. Neonatal jaundice of our patient may be a manifestation of rubella infection and she had multi organ involvement such as cataract, hearing deficit, developmental delay and CHD. In a study by Givens et al on 125 cases of CRS, ocular disease was the most commonly noted disorder (78%), followed by sensorineural hearing deficits (66%), psychomotor retarda-

tion (62%), cardiac abnormalities (58%), and mental retardation (42%). Mulltiorgan disease was typical (88%). Ocular disease and hearing loss were frequently associated (53% had both). A similar association existed between ocular and cardiac disease (12). In a study in Brazil a total of 43 infants with CRS were screened for birth defects. Eye anomalies and CHD was shown to be the most appropriate sentinel, with the lowest sample size required to detect CRS in neonates (13). No specific therapy for congenital rubella infection has been established, and so treatment is primarily supportive.

In conclusion diagnosis and therapy of the cardiac complications of the rubella syndrome is possible in the first few months of life. Early recognition of cardiac defects in the young infant with the rubella syndrome permits medical management and in most instances surgical operation is indicated.

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لزوم ثبت نام مشمولین آموزش مداوم جامعه پزشکی در سامانه آموزش مداوم

سامانه آموزش مداوم جامعه پزشکی به منظور اجرای دقیق قانون آموزش مداوم جامعه پزشکی، سازماندهی، تسهیل و تسریع امور مراکز مجری و مشمولین محترم قانون، راه اندازی شد. این سامانه در مرحله اول در دانشگاه های علوم پزشکی کشور به بهره برداری رسیده است. کلیه مشمولین به منظور شرکت در برنامه های آموزش مداوم و انجام امور مربوطه، لازم است به سایت <http://www.ireme.ir> مراجعه و از لیست مراکز مجری آموزش مداوم، دانشگاه تحت پوشش خود را انتخاب و عضو سایت دانشگاه مربوطه شوند. مزایای عضویت در این سامانه به شرح زیر می باشد:

- ۱- فقط یکبار ثبت نام کنید و برای شرکت در کلیه برنامه های آموزش مداوم استفاده کنید
- ۲- رویت برنامه آموزش مداوم ارائه شده در کلیه مراکز آموزش دهنده کشور
- ۳- امکان دریافت و رویت کارنامه آموزش مداوم پزشکی توسط مشمولین قانون
- ۴- تسریع در صدور تمدید پروانه مشمولین محترم در پایان هر دوره بدون حضور و پیگیری مشمولین محترم
- ۵- امکان اطلاع رسانی مناسب در خصوص برنامه های آموزش مداوم از طریق لیست الکترونیک و پیام کوتاه
- ۶- اطلاع از آیین نامه و قوانین مربوط.

هم اکنون عضو سامانه آموزش مداوم کشور شوید.

اداره کل آموزش مداوم جامعه پزشکی