CARDIAC SURGERY UNDER NORMOTHERMIC INFLOW OCCLUSION

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ABSTRACT

Isolated critical aortic & pulmonary valvular stenosis can be treated with normothermic inflow stasis technique. This was described by Varco in 1951. The study was conducted at our institution to assess the reliability and the cost effectiveness. Fourteen patients were randomly selected. Diagnosis was made by echocardiography. The patient under went valvotomy under normothermic inflow occlusion. Hypothermia and extra-corporeal circulation was not applied. The procedure was effective in all the subjects. One patient died in I.C.U. There was no notable post operative morbidity. The management was significantly shortened. Follow up at 3 months revealed all the patients functionally improved. The echocardiographic finding showed significant reversibility in the disease process. The semilunar valvotomy under the technique is feasible and cost effective. It would be considered a valid alternative to the cardiopulmonary bypass assisted procedure. PJCTS 2000; II: 24-30

INTRODUCTION

Untreated isolated critical aortic and pulmonary valve stenosis is lethal. During middle of the 20th century various techniques for the relief of obstruction were devised. Transventricular semilunar valvotomy[3,10] was introduced by Seller and Brock in 1948. Normothermic inflow stasis for pulmonary valvotomy under direct vision was described by Varco in 1951, and by Blount and associated using additional hypothermia in 1954. Mc_Goon and Kirklin[2] used extracorporeal circulation in 1958. So cardiac surgery under normothermic inflow stasis was devised for precardiopulmonary bypass era. We re-applied it to counter the unbearable cost of extracorporeal circulation.

OBJECTIVES

The basic object of this study was to evaluate the surgical results of patients with aortic and pulmonary stenosis who under went valvotomies using inflow occlusion technique. The other objective was not only to assess the reduction in pressure gradient after surgery but to analyze the post operative mortality and morbidity. Financial aspects were also evaluated at the same time. All the results were compared to another control group who under went such procedures using extracorporeal circulation.

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MATERIAL AND METHOD

This prospective study was conducted by the surgical department N.I.C.V.D. Karachi. All the patients presenting to the out patient department with the diagnosis of isolated aortic or pulmonary valve stenosis were randomly selected during June - December 1997. The records of patient undergoing cardiac surgery under this technique or cardiopulmonary bypass assisted procedure (for cost effectiveness) were analyzed. The diagnosis was made in addition to routine investigation by two dimentional echocardiography and doppler[4,7]. The systolic pressure gradient across the valve, valve area, size of the annulus, Ventricular wall thickness and cardiac function was thoroughly evaluated. The patients with any additional intracardiac pathology were excluded (Table I and Table II).

SURGICAL TECHNIQUE

Approach was standard median sternotomy. Aorta and both venae cavae snared with fine nylon-tapes. Stay-sutures were applied to the aorta or pulmonary artery for easy manuverability. Prior to inflow occlusion the patient was hyperventilated with 100% Oxygen and impending base deficit was pre-corrected with 1-2 ml / Kg sodium bicarbonate. The patient was heparinized with I mg/Kg heparin. Left ventricular and aortic pressure were taken (Pre-correction pressure gradient). The cavae were snugged at once. Heart was allowed to empty with several

Table - I

Aortic Valve-Stenosis

Pre-operative Hemodynamics (Echocardiographic)

(A) Case	Pre-Operative Age	AO (mm)	LVEDD (mm)	LVESD (mm)	EF %	IVST (mm)	LVPWT (mm)	PG (mmHg)	LV-Function
1	9 Years	19	32	18	82	7	7	140	Normal
2	12 Years	21	30	18	78	8	8	120	Normal
3	14 Years	29	36	20	83	11	12	88	Normal
4	2-Months	14	21	18	36	5	6	62	Sever LV-Function
5	22 Years	34	46	32	64	13	14	134	Normal
6	23 Years	28	34	24	56	11	12	110	Normal

AO = Aorta Root Size
LVEDD = Left Ventricular end-diastolic diameter.
LVESD = Left Ventricular end-systolic diameter.
IVST = Interventricular-septal thickness.
LVPWT = Left Ventricular Posterior Wall thickness.
PG = Pressure gradient across aortic Valve.

Table - II

Pulmonary Valve Stenosis

Pre-operative hemodynamics (Echocardiographic)

Case No.	Age	RVFWT (mm)	PV. Annulus (mm)	RV Size (mm)	EF %	PG (mmHg)	RV Function
1	12 Years	11	12	20	63	120	N
2	20 Years	12	14	17	64	95	N
3	08 Years	10	11	15	56	61	N
4	11 Years	11	13	18	59	52	N
5	12 Years	8	12	17	68	65	N
6	10 Years	12	17	17	89	160	Mild Dysfunction.
7	10 Years	11	15	22	60	71	Mild Dysfunction.
8	4 Years	10	11	16	70	98	N

RVFWT = Right Ventricular free wall thickness.
PV = Pulmonary valve.
RV = Right Ventricle.
EF = Ejection fraction (LV).
PG = Pressure gradient across Pulmonary Valve.

beats. Heart was fibrillated. Ventilation was stopped. Aorta was cross-clamped, Longitudinal (Vertrical) aortotomy performed between the stay sutures. The stenotic valve examined and commissurotomy was performed and the sub valvular region was examined. The side biting clamp applied to the aorta with help of the stay sutures. The caval snares released, defilirilation and deaeration done. Cross clamp released ventilation started. The aortotomy closed. Blood loss replaced rapidly if significant. Calcium chloride and sodium bicarbonate used if required. Time of inflow occlusion measured. The residual gradient (if any) (Table III and IV) across the valve was recorded pacing wires were placed. Pericardum was drained and closure done per routine.

RESULTS

All the patient presenting to the surgical out patient deptt. with suspected diagnosis of critical aortic or pulmonary stenosis were included in the protocol between June - December 1997. The age ranged from 02 months - 23 years. Out of fourteen patients 6 were of isolated aortic stenosis and 8 of critical pulmonary stenosis. Three patient were in NYHA - class-I. Ten patients were in class-II and one in class IV. Morphologically aortic valve was bicuspid in four and tricuspid in the other four cases. The four valves were tricuspid, 3 bicuspid and 2 had central point-hole orifice in cases of pulmonary stenosis. Post stenotic dilatation was present in five cases. The inflow occlusion time in aortic cases (Table-III) was 2 - 35 $\pm$ 0 - 35 minutes (Range 2 - 15 to 3 - 10). While in pulmonary valvotomy (Table-IV) cases it was 2 - 05 $\pm$ 0 - 35 minutes (Range 1 - 30 to 2 - 45 minutes). The pressure - gradient dropped significantly after valvotomy. The drop across the aortic valve was from 105 $\pm$ 256 (80 - 122) mmHg to 16 + 24 (2 - 40) mmHg to 18 - 22 (1-40) mmg in the pulmonary valve cases (Table-IV). One patient aged 02 months died in the I.C.U. shortly after shift (He was in NYHA-IV with severe LV-dysfunction). Only four of the eight patients who under went aortic valvotomy returned for follow up, all were asymptomatic. There was grade-II ejection systolic murmur in two patient. The pressure gradients across the valves was 20 and 26 mmHg on echocardiography (Table-V). Six of the eight patient undergoing pulmonary valvotomy were asymptomatic except one who was in NYHA class-II (3 months post operatively). On echo-evaluation he \was found to have a subvalvular VSD with Qp/Qs of 1.7:1. Mild insufficiency was present in 3 cases. The ventricular wall thickness decreased and function improved in all class. (Table-V).

DISCUSSION

The medical treatment of critical aortic and pulmonary valve stenosis is not effective and intervention has definite[1,5,12] edge. Echocardiography is instrumental in diagnosis. Cardiac cathetrization is sparingly needed, especially in cases of suspected associated pathology. Percutaneous transluminal balloon valvotomy attempted by the interventional cardiologists shows acceptable gain and mortality in pulmonary stenosis. The results of aortic balloon dilatation are not equally encouraging[13]. Surgeons performed blind valvular dilatation with various blunt and sharp instruments in the past (transventricular approach). The inflow occlusion with normothermia or hypothermia was introduced in precardiopulmonary bypass era. Keane, Bernhard and Nadas reported 24 infants who underwent valvotomy for aortic stenosis[8]. There were eight early and two late deaths in the entire group. Another report from the Medical College of South Carolina reported on seven infants undergoing aortic valvotomy with three deaths[6]. These authors documented saving in blood transfusion, operation room time and expenses when inflow occlusion was compared with Cardiopulmonary bypass for valvotomy. None of the deaths in these series was related to the technique of inflow occlusion. The blood loss was about " to ! in study group against that of control group (valvotomy done under extracorporeal assistance). So the chances of reopening for bleeding were more in control group. The amount of the blood transfused was 400 - 500 ml more in control group at an average. The operation time was nearly halved in study group. The time was saved due to direct approach against shifting patient to extracorporeal circulation. More than half of the patients were extubated at the table so anesthesia time and associated ventilatory time was much shorter in study group. The average age in study group was less than that of the control group. As the infundibular stenosis in the presence of pulmonary Valve stenosis develops secondarily. The secondarily developed infundibolar stenosis contributes

Table - III

Pressure gradient and inflow Occlusion time (Per-Operative Measurements)

AORTIC VALVOTOMY:

	Pre-Valvotomy:			Post Valvotomy:			
NO.	LV-PRESSURE (mmHg)	PO-PRESSURE (mmHg)	SYSTOLIC PRESSURE GRADIENT (mmHg)	LV-PRESSURE (mmHg)	AO-PRESSURE (mmHg)	PRESSURE GRAD (mmHg)	INFLOW OCCLUSION TIME
1	196	98	98	120	114	6	2-30
2	190	82	108	123/9	83/40	40	3-0
3	180/12	100/70	80	105/9	100/67	5	3-10
4	144/8	88/50	64	-	-	-	-
5	210	88/62	122	140	116/72	24	2-30
6	200	104/78	96	110	100/70	10	2-15.

Table-IV

Pressure gradient & Inflow Occlusion time (per-operative measurements)

PULMONARY VALVOTOMY:

	PRE-VALVOTOMY:			POST VALVOTOMY:			
NO.	RV-PRESSURE (mmHg)	PA-PRESSURE (mmHg)	PRESSURE GRADIENT (mmHg)	RV-PRESSURE (mmHg)	PA-PRESSURE (mmHg)	SYSTOLIC PRESSURE GRADIENT (mmHg)	INFLOW OCCLUSION TIME (4 Minutes)
1	112/10	22/6	100	46/6	26/4	20	1-30
2	130	30	100	46/4	25/7	21	2-15
3	85/0	20/6	65	32/0	24/8	8	1-30
4	72/8	22/10	50	24/0	23/8	1	2-0
5	68/8	22/8	46	34/2	24/6	12	2-45
6	142/10	14/8	128	64/8	24/10	40	2-45
7	-	-	-	-	-	-	-
8	110/8	20/10	90	40/2	24/8	16	1-45

Table - V

Post-Cardiographic

Post-Operative findings

(Three months after surgery)

A-Aortic Valvotomy:

CASE	LVEDD (mm)	LVESD (mm)	EF (%)	IVST (mm)	LVPWT (mm)	PG (mmHg)	INSUFICIENCY
1	36	18	72	6	6	20	NIL
2	38	16	70	6	7	26	NIL
3	40	18	80	9	10	18	NIL
4	38	20	62	8	9	NIL	MILD

P-Pulmonary Valvotomy:

CASE	RVFWT (mm)	RE-SIZE (mm)	EF (%)	PG (mmHg)	INSUFICIENCY	RV-FUNCTION
1	6	20	60	24	MILD	N
2	6	19	64	NIL	NIL	N
3	5	19	62	20	NIL	N
6	7	18	72	25	MILD	MILD DYSFUNCTION
7	5	23	56	NIL	NIL	-do-
8	4	16	72	NIL	MILD MODERATE	N

Table - VI
GROSS COST COMPARISON

	Valvotomy Under Normothermic inflow occlusion	Valvotomy Assisted by extra-Corporeal circulation.
01. Intra operative use of Surgical material during the procedure. Oxygenater,	PAK-Rs. 3800/= US- $=75/=	PAK-Rs. 23500/= US- $=410/=
02. Blood transfusion Unit/Case (Average)	(1)	(3)
03. Table extubation	9 out of 14	Nil
04. Assisted Ventilation time post operative in ICU	2	4
05. Reoperation for bleeding	2 out of 14	4 out of 14
06. Total drain (ml/case)	225 ml.	650 ml.
07. I.C.U. duration of stay (hours/patient)	30-	42-
08. Surgical floor stay day/Patient	4	6

significantly to the post operative morbidity and mortality especially in seriously ill patients. The increased incidence of infundibolar stenosis in adults suggests that time is required for its development. The obstructing infundibolar hypertrophy develop as a result of long standing enhanced right ventricular strain. The incidental finding of sub valvar aortic[11] stenosis is hazardous to proceed with inflow stasis. It is a wise decision to apply side - biting clamp & shift the patient on extracorporeal circulation. The missed diagnosis of sub valvar aortic stenosis cannot be handled in short time available in inflow stasis[14]. The total excision of pulmonary valve results in some degree of pulmonary insufficency. Infact if a pulmonary insufficiency murmur is absent. One must question the adequacy of the Valvotomy. The diagnosis was made on echocardiography. The cardiac cathetrization and angiography was needed in only four cases. Earlier studies showed greater incidence of cathetrization as the echocardiographic technique was less developed then. The valvotomy done under the inflow stasis provided excellent post operative improvement. The cardiac surgery under normothermic inflow occlusion proved to be significantly cost effective (Table IV). Morbidity and mortality is comparable to Valvotomy done under extracorporeal assistance.

CONCLUSION

The patients with aortic and pulmonary stenosis can be evaluated with advancement in echocardiography. So cathetrization and angiography is sparingly needed. The patients with isolated semivalvular stenosis can undergo surgery with normothermic inflow occlusion. The inflow occlusion is safe, reliable and very much cost effective. Mortality and morbidity are comparable to open heart surgery. The cardiac surgery with normothermic inflow stasis is very much applicable in poor countries like Pakistan.

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