Original Article

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A COMPARISON OF THREE DIFFERENT TECHNIQUES TO PERFORM BI-DIRECTIONAL GLENN SHUNT

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ABSTRACT

Objective: To compare three surgical techniques utilized to perform Bi-directional Glenn Shunt.

Study Design: Descriptive cross-sectional study.

Place and Duration of Study: This study was carried out from January 2011 to September 2013 at the Armed Forces Institute of Cardiology / National Institute of Heart Diseases, Rawalpindi, Pakistan.

Material and Methods: Patients were divided in three groups which: Cardio-Pulmonary Bypass group (Group I), Local veno-atrial by-pass group (Group II) and Clamp & sew group (Group III). Clinical outcome of the three surgical techniques was compared in terms of mean post-operative bleeding (ml), duration of vaso-active support (hours), duration of post-operative ventilation and ICU stay (hours).

Results: Mean postoperative bleeding in group III was lesser than other two groups (45 ± 15ml vs 70 ± 25 ml and 68±25 ml in group I and II, respectively). Patients in group III needed inotropic support for fewer hours (23.88±4.23 hours) as compared with group I and II (34 ± 9 and 32 ± 11 hours). Similarly, patients in group III had shorter duration of ventilatory support (6.5 ± 3.5 vs 15 ± 9 and 12 ± 6 hours). The ICU length of stay was 26 ± 11 hours in group I patients compared to 36 ± 12 hours in group I and 35 ± 9 hours in group II patients.

Conclusion: Clinical outcome of Bi-Directional Glenn shunt with clamp & sew technique is better as compared with the shunt performed with cardiopulmonary bypass or local veno-atrial bypass technique.

Keywords: Single ventricle, Bi-directional glenn shunt, Clamp & Sew technique.

INTRODUCTION:

Single ventricle anomaly comprises a large group of pediatric cardiac surgical ailments. Bi-directional Glenn shunt (BDG) is an important intermediate step surgery performed to manage children with this anomaly. Patients with single ventricle are hemodynamically very fragile owing to single functional ventricle with compromised pulmonary circulation.

Different techniques have been introduced to perform BDG. Conventionally, BDG is performed on cardiopulmonary bypass (CPB) which has got its inherent complications. We have another option of doing this surgery on local veno-atrial bypass[1] which is although less hazardous as compared with conventional CPB but still exposes blood to extra- corporeal circuit hence activating complement cascades. Moreover, it does require extra time to establish local bypass. Third option is performing this surgery by simply clamping the superior vena cava (SVC) at superior cavo-atrial junction and both ends of pulmonary artery (PA) and fashioning a side to end anastomosis in between SVC and PA[2]. The last technique is also called "clamp and sew technique", sounds quite simple, but query was if a hemodynamically unstable baby would tolerate clamping of SVC. As long as clamp is applied on SVC and PA, one third of circulation is being compromised as well as half of the oxygenation source is also taken down (ipsilateral lung which has got it corresponding PA clamped). Moreover, transient rise in venous pressure in head and neck region could have compromised the cerebral perfusion resulting in deleterious effects on brain[3]. BDG by clamp and sew technique can prove to be a safe technique if performed with good speed consuming least time and adopting certain measures to keep good cerebral perfusion pressures during the procedure.

This study was aimed at comparing three surgical techniques utilized to perform Bi-directional Glenn Shunt and to ascertain the superiority of any technique over the others.

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MATERIAL AND METHODS

This prospective comparative study was conducted from January 2011 to September 2013 at the Armed Forces Institute of Cardiology / National Institute of Heart Diseases, Rawalpindi, Pakistan, which is a tertiary care hospital. After informed written consent from the parents / guardians and approval from institution's review board and ethical committee, 54 consecutive patients of single ventricular morphology suitable for Bi-directional Glenn shunt surgery were included in the study.

Out of these studied patients, babies having pre-operative oxygen saturation less than 60% and / or requiringatrio-ventricular

Table-1: Demographic characteristics of patients.

Group	I	II	III
Total no (n)	18	12	24
Gender (M/F)	11/7	7/5	15/9
Mean Age (months)	15 ± 10	18 ± 9	14 ± 10
Range of Pre Op O_2 Saturation (%)	55- 78	66-79	66-75

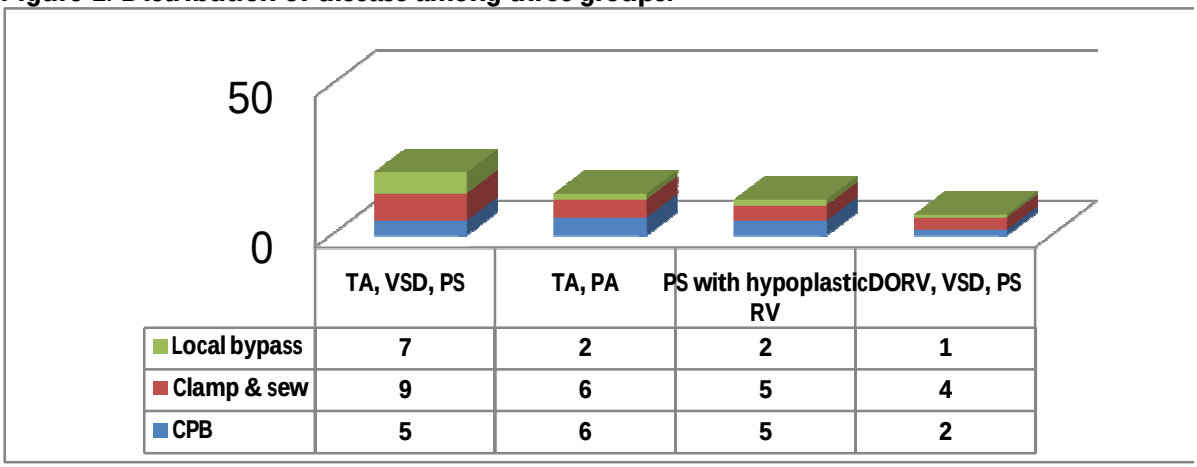
Table-2: Per operative parameters.

	Group I	Group II	Group III
Mean Internal jugular venous pressure on clamping (mmHg)	2.3 ± 1.4	8.5 ± 2.3	38.04 ± 18.15
Clamp time(min)	21.7 ± 7.1	9 ± 5	8.15 ± 1.52
SaO_2 during procedure (%)	87 ± 4	76 ± 8	64 ± 7

Table 3: Mean post operative bleeding, inotropic support requirement and ICU stay.

	Group I	Group II	Group III
Post Op bleeding (ml)	70 ± 25	68 ± 25	45 ± 15
Inotropic support (hours)	34 ± 9	32 ± 11	23.88 ± 4.23
Postopertaive Ventilation (hours)	15 ± 9	12 ± 6	6.5 ± 3.5
ICU stay (hours)	36 ± 12	35 ± 9	26 ± 11

Figure-1: Distribution of disease among three groups.



TA: Tricuspid atresia, VSD: Ventricular septal defect, PS: Pulmonary stenosis, PA: Pulmonary atresia
DORV: Double outlet right ventricle

valve repair or branch pulmonary artery reconstruction were included in group I. These patients required cardiopulmonary bypass as they were likely to desaturatewith pulmonary artery clamping.Rest of the patients, wererandomly divided in to Local Bypass (Group II) and Clamp & Sew (Group III) groups, using random number table. All the surgeries were performed by one surgeon.

A detailed echocardiographic examination and cardiac catheterization study of all patients was carried out by the Pediatric Cardiologist to evaluate cardiac anomaly in detail and measure hemodynamic variables. Pre-operative neuro-cognitive status of patients was assessed by pediatric neurologist.

In addition to routine intraoperative monitoring, a 20 G peripheral venous cannula was placed in internal jugular vein of all patients for monitoring of central venous pressure during and after the procedure. A separate triple lumen venous catheter was inserted in femoral vein for the institution of IV fluids or vasoactive drugs. After sternotomy, a visual assessment of cardiac anatomy and direct measurement of main pulmonary artery pressures was done in all patients. BDG shunt was performed only if the mean PA pressure was ≤ 16 mmHg.

In group I and II, Heparin was given in a dose of 300 IU/Kg with an aim to achieve Activated Clotting Time (ACT) of 450 seconds or more and head end of operating table was elevated at 300.

In Group III, Half dose heparin (150 IU/kg) was administered to achieve an ACT of ≥ 200 seconds. Before application of venous clamp or starting anastomosis between SVC and right PA, head end of operating table was elevated, a fluid bolus of 10–15 ml/kg was given andelective dopamine infusion was started @ 5 µg/kg/minto maintain hemodynamic stability and keep intra cerebral perfusion pressures within physiological range. Additionally, a bolus of methyl prednisolone (30 mg/kg) was also administered.

All procedures were performed by median sternotomy. Dissection was done to mobilize full length of SVC from innominate vein to cavo-atrial junction. Pulmonary artery especially right pulmonary artery (RPA) wasdissected free all around. In group I, cardiopulmonary bypass was established after aortic and bi-caval cannulation was done taking care to perform SVC cannulation as high as possible. If intra-cardiac correction was not planned, surgery was continued on a beating heart without applying aortic cross clamp. Once the clamp was applied at proximal and distal side of SVC, it was divided at cavo-atrial junction and the latter was secured with prolene suture. RPA was clamped and opened up transversely. An end to side anastomosis was made in between SVC and RPA making sure the anastomosis was complete in minimumpossible clamptime.

In addition to monitoring internal jugularvenous pressure and oxygen saturation before, during and after application of clamps on SVC; a record of clamp time and inotropic support was kept during the procedure.Patients were followed up during their stay in ICU, by monitoring BDG pressure, SaO_2, post-operative(Post Op) ventilation requirement (in hours), mean post-operative bleeding (in mls), neuro-cognitive impairment and mean duration of vasoactive support (in hours). During ICU stay, head was kept up at 300 with PEEP less than 4 cm H_2O, adequate hydration was maintained and patients were ventilated with an aim to extubate as early as possible.Once the patients were hemodynamically stable in ICU, venous cannula placed in SVC was removed. Postoperatively, bedside Echocardiographic examination was employed to ascertain the surgical repair and patency of the shunt.Heparin infusion was started in a dose of 10 IU/kg once the bleeding was found to be minimal.

Protocol was made that in case any postoperative neuro-cognitive impairment was noticed, patient would undergo a non-contrast computerized tomography scan of the head and expert help of pediatric neurologist would be sought.

RESULTS

We studied a total number of 54 patients. Patient's demographics and preoperative oxygen saturations are shown in Table-1. Distribution of disease among three groups is shown in Fig-1.

Main indication of performing BDG on CPB (Group I) was low pre-operative oxygen saturation < 60% in 14 patients (n=18) and branch PA reconstruction in 4 patients. Three patients in clamp & sew group had additional off pump atrial septectomy with inflow occlusion technique. Emergency cardiopulmonary bypass was not required in any of the patients in group II or III.

All patients had well-functioning Glenn shunt as evidenced by good postoperative oxygen saturations and postoperative echocardiography. There was no mortality ornoticeable neuro-cognitive impairment in any patient among all three groups till the patients were discharged from the hospital.

DISCUSSION

Bi-directional Glenn Shunt is the initial palliative surgical procedure done in patients having single ventricular morphology with decreased pulmonary blood flow who have to undergo staged surgeries culminating at total cavo-pulmonary anastomosis.

Since first Glenn shunt was reported by Professor William W.L. Glenn in 19584, many modifications in this palliative shunt have been suggested by various centers across the globe. Traditionally, it was performed on cardio-pulmonary bypass which has got its indigenous ill effects like increased pulmonary resistance, increased fluid sequestration and depressed myocardial function which may affect the clinical outcome of the surgery badly. Also, it is associated with higher cost owing to additional equipment and personnel required.

One of the major concerns of performing BDG without bypass is increase in cerebral venous pressure after clamping the SVC which may cause cerebral hypo perfusion, cerebral edema and possible neurological injury[3,5]. In 1990, Lamberti and his associates6 reported a new technique of preforming BDG without CPB which used a temporary veno-atrial shunt between SVC and right atrium to decompress the systemic venous hypertension when the SVC is clamped.

With growing confidence among cardiac surgeons, it was reported by few studies that clamping the SVC for very short time is relatively safe and is not associated with structural alterations in brain or neuro-cognitive impairment[7]. Careful selection of the patients, proper judgment of the surgeon that whether patient can tolerate SVC clamping, and precise planning of each and every step to be taken after clamping is key to shortening the SVC clamp time and avoiding possible neurological injury. Measures which aide in increasing cerebral perfusion pressure by increasing mean arterial pressure with the help of inotropes / intravenous fluids and decreasing central venous pressure by elevating head side of the patients and decreasing PEEP are also helpful. Additionally, attenuation of excitotoxic cascade by administration of Methyl prednisolone and slowing cerebral metabolism by lowering body temperature also protects brain duringtransient hypoperfusion.

Our study is unique in the regard that we have compared three different techniques of BDG shunt. In clamp & sew group, mean SVC clamp time was reasonably short (8.15 ± 1.52 minutes) and the rise in central venous pressure noticed in our study was moderate (38.04 ± 18.15 mmHg). Postoperative outcome in terms of postoperative bleeding, number of hours patients required mechanical ventilation, inotropic support requirement and ICU stay was significantly better in Clamp & sew technique as compared with groups of patientsin whom BDG shunt was performed on cardiopulmonary bypass or local veno-atrial bypass.

In clamp & sew technique group, there was no hemodynamic instability or significant desaturation observed in any of the patient during the SVC clamping period. Also, patency and laminar flow in the shunt was confirmed by echocardiography in all the patients, hence this technique is not associated with interference in accurate alignment of SVC to PA

anastomosis. Off pump atrial septectomy which is one of the indications of performing BDG shunt on CPB was successfully performed without CPB followed by BDG with clamp &sew technique in three of our patients. As no neuro-cognitive impairment was noticed in any of our patients, we presume with reasonable certainty that clamping SVC for short period is devoid of significant injurious effects to the brain and BDG shunt can be performed with reasonable safety without involving any central venous decompression technique.

Keeping in view the relatively few patients in our study, we suggest larger clinical trials to be conducted to prove safety and superiority of clamp & sew technique on local veno-atrial bypass technique.

CONCLUSION

Clinical outcome of Bi-Directional Glenn shunt with clamp & sew technique is better as compared with the shunt performed with cardiopulmonary bypass or local veno-atrial bypass technique. It is safe when performed carefully in suitable patients. Also, it is cost effective as any need for cardiopulmonary bypass and associated personnel is best avoided.

Conflict of Interest

This study has no conflict of interest to declare by any author.

REFERENCES

1. Lal M, Mahant TK. A modified techhnique of venoatrial bypass in bidirectional Glenn shunt. Asian CardivascThorac Ann 1996;4:23-4.
2. Bhan A. Off-pump bi-directional Glenn shunt: How I do it? Ann PediatrCardiol. 2008 Jul-Dec; 1(2): 131–134.
3. Rodriguez RA,CornelG,SemelhagoL,SplinterWM,WeerasenaNA.Cerebral effects in superior vena caval obstruction: the role of brain monitoring. Ann ThoracSurg 1997;64:1820-1822
4. Glenn WWL. Circulatory bypass of the right side of the heart. IV. Shunt between superior vena cava and distal right pulmonary artery – report of clinical application. N Engl J Med 1958;259:117-120.
5. Rodriguez RA,AudenaertSM,Austin EH III,Edmonds LH Jr. Auditory evoked responses in children during hypothermic cardiopulmonary bypass: report of cases. J ClinNeurophysiol 1995;12:168-176.
6. Lamberti JJ, Spicer RL,WaldmanJD,GrehlTM,ThomsonD,GeorgeL,KirkpatrickSE,Mathe wson JW. The bidirectional cavopulmonary shunt. J ThoracCardiovascSurg 1990;100:22-30
7. Hussain ST, Bhan A, Sapra S, Juneja R, Das S, Sharma S.The bidirectional cavopulmonary (Glenn) shunt without cardiopulmonary bypass: is it a safe option? InteractCardioVascThoracSurg 2007; 6: 77–82.