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- Cardiopulmonary Bypass
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- Cardiac Anaesthesia
- ECMO (Extra Corporeal Membrane Oxygenation)
- ECLS (Extra Corporeal Life Support)
- Mechanical Assist Devices
- Fluid Dynamics
- Blood Management
- Coagulation

IJECT also publishes a selection of editorial comments, review articles, case reports, innovations, technical challenges, invited commentary and letter to editor. This Annual journal is intended, in its publications, to stimulate innovative ideas and foster practical application from the evidence based practice and research findings.

Aim & Scope
The aim and scope of the journal is to provide an academic medium and an important reference for the advancement & dissemination of research results that support high-level learning, teaching and research in the fields of extra corporeal technology including cardiopulmonary bypass, extra corporeal life support. Original theoretical work and application-based studies, which contributes to a better understanding of extra corporeal technological challenges, are encouraged.

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**ISECTCON 2017, Bengaluru - Awards & Certificates**

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“BLAZE A TRAIL”

Since I took over as the Editor-IJECT in May 2016, a thought has been enduring my mind, to take IJECT to another level, by abstracting and indexing it in reputed international journals/publications.

Indexation of a journal is considered a reflection of its quality. Indexed journals are considered to be of higher scientific quality as compared to non-indexed journals. At present, three electronic scientific databases provides a measure of an individual's citation rate: Index Copernicus International, Scopus and Thomson-Reuters’ Researchers ID. Remarkably, Index Copernicus Scientists is the only one which calculates an individualized impact factor.

It is with great pride, enthusiasm, and anticipation, I take this opportunity to share that we have been successfully registered in the ICI World of Journals database and ICI Journals Master List, since all the requirements have been met by the Editorial Office, our IJECT journal is now ready to undergo evaluation according to the ICI Journals Master List methodology. Index Copernicus is the indexing service that most of the scientific community know about, it is provided freely to the world and consequently is the most widely used.

In addition to above, application for IJECT Selection for MEDLINE Indexing at National Library of Medicine (NLM) and Directory of Open Access Journals (DOAJ), subsequently in HINARI, has been submitted. Both MEDLINE & DOAJ takes around six months for application process and registration confirmation. Recently, HINARI has decided to work with the DOAJ Directory of Open Access Journals and will list only journals that have been accepted for inclusion by the DOAJ.

As IJECT passes its first milestone, I would like to thank our editorial team and all reviewers who helped to maintain the journal standard; our authors who submitted their best work to the journal; and, most important, our readers for your continuing support.

I request all ISECT members to support IJECT by increasing submission of all types of articles and by encouraging colleagues and trainees to submit manuscripts.

I will be looking forward to your valuable feedback and suggestions.

Mukta Tiwari
Editor - IJECT
MESSAGE

Dear Colleagues

Greetings to you all

On behalf of Indian Society of Extra Corporeal Technology and Organizing Committee of ISECTCON 2018, Visakhapatnam, it’s a great pleasure to invite you all in our forthcoming 18th Annual Conference on 2nd and 3rd February, 2018 at Visakhapatnam.

Visakhapatnam Organizing Committee offers you excellent scientific papers on innovative techniques in the field of clinical perfusion, Culture and Hospitality so please attend the Conference in large number.

On behalf of Members of ISECT I wish to congratulate Ms Mukta Tiwari - Editor for publication of IJECT. I wish the Conference and the publication of Journal all success.

The success of the conference depends on participants and I hope you all from all over the world will come to Visakhapatnam to make the conference a grand success.

I look forward to see you all in ISECTCON 2018 Visakhapatnam.

With best regards

Dr. Kamla Rana
President - ISECT
MESSAGE

On behalf of our colleagues and Indian Society of Extra Corporeal Technology (ISECT) I extend a warm invitation to the 2018 Annual Scientific Meeting i.e. ISECTCON2018 Visakhapatnam which will be held in Visakhapatnam from 2 to 3 February 2018 and includes prompt keynote presentations, Oral talks, Poster presentations and Exhibitions.

Our aims is to aggregate researchers, academicians and scientists from the perfusionists community and create an avenue towards robust exchange of information on technological advances, new scientific achievements and the effectiveness of various regulatory programs towards perfusion. Bringing together the professors, researchers and students in all areas of cardiac surgery and to provide an international forum for the dissemination of original research results, new ideas and practical development experiences which concentrate on both theory and practices.

The focus of this year’s meeting is set firmly on the exciting and challenging future ahead for our specialty. The main focus this year is number of teaching hospitals and universities (both government and private) are offering Perfusion Training Programs but without any set standards on eligibility, number of seats, facilities, quality of teaching etc. There is also a mismatch between supply and demand. Hence it was resolved that a set of guidelines for Perfusion Training should be sent to all those institutions offering Perfusion Training Programs with a request that minimum standards should be met. Life Members were cautioned not to take up teaching assignments in such institutes which do not maintain quality.

I am happy to meet you all through “Indian Journal Of Extra Corporeal Technology” (IJECT). This is the second Journal coming out in this tenure of 2016-2019. Thanks to our Editor Ms. Mukta Tiwari & Editorial board doing excellent job and also to our perfusionists who send articles, papers, advertise etc. My humble request to all perfusionists that please collect research papers, articles for our IJECT and send to our Editor for publications. All paper presenters in ISECTCON2018 Visakhapatnam should also send manuscript along with abstract for publications in IJECT.

We look forward to seeing you at the ISECTCON2018 Visakhapatnam……

Mr. Chhipa Usmangani Y.
General Secretary ISECT
MESSAGE

It is with great pride, enthusiasm, and anticipation that I invite you to read this issue of Indian Journal of Extra Corporeal Technology (IJECT).

An enormous amount of work has gone into the development of this journal and I believe you will see that effort reflected in this edition and in the impact it will have on the field.

As we look at IJECT, it is important to keep in mind that it represents the collective thinking of entire perfusion society and we want IJECT to be an academic vehicle of ISECT, to reach all perfusion community members.

Transformation and change. These words cause uneasiness. Our endeavor will be no different. As we dare to be a new kind of scholarly journal, questions will arise about our rigor. We are prepared to answer those questions. Be assured IJECT, like all quality scientific journals, uses blind peer review with rigorous evaluation criteria fully vetted through an editorial board. As you examine the board’s makeup you will see a remarkable breadth of disciplines, experiences, and backgrounds. Without the guidance, support, and feedback of the board, its editing and publishing has made this issue a reality.

Also, I would like to congratulate our Editor, Mukta Tiwari, for the prestigious achievement of publishing a chapter in a text book “Cardiology Update 2017” (Chapter 88, Surgical Option for the 'No -Option' Coronary Artery Disease).

I hope many delegates across country and overseas will come to ISECTCON 2018 at Vishakhapatnam and make it a grand success.

With best wishes and warm regards

Thanks,

Dr. Vishvanath Sharma
Vice President, ISECT
President, Rajasthan Society of Extra Corporeal Technology
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Cannulation of the right axillary artery for acute type-A aortic dissection surgery: indirect versus direct cannulation with the optisite arterial cannula.

Roberto Carozza, Armando Pietrini, Daniela Scarano, Diego Fazzi, Carlo Aratari, Giuseppe Rescigno
Unit of Cardiopulmonary Perfusion & Division of Cardiac Surgery, Ospedali Riuniti, Ancona, Italy

Abstract

Background: Cannulation of right axillary artery is a common technique for delivering cardiopulmonary bypass inflow in acute type A aortic dissection surgery, which offers some advantages over the traditional femoral artery cannulation. Cannulation of right axillary artery is usually indirect, through a vascular graft anastomosed to the artery, but also direct, with an arterial cannula. We reviewed our experience with these two types of cannulation.

Methods: From the 31 August 2012 to the 31 August 2016, 76 patients were operated upon for acute type A aortic dissection, 61 patients had an indirect right axillary artery cannulation and 15 a direct cannulation using the Optisite arterial cannula. Patients were followed up for three months.

Results: Although there was an element in hypo perfusion in the direct cannulation group, it was significant only in the period of normothermia at the beginning of cardiopulmonary bypass, with no apparent consequences for the patients. The were no other differences between the two groups in terms of preoperative, operative and outcome data.

Conclusion: Considering that direct cannulation is simpler and faster than indirect cannulation, if technically possible, we recommend it in this kind of surgery, whenever RAA cannulation is the choice.

Key words: right axillary artery cannulation, aortic dissection, Optisite arterial cannula, hypothermic CPB arrest, antegrade cerebral perfusion.

Introduction

Femoral artery (FA) cannulation is the traditional and fastest approach to deliver cardiopulmonary bypass (CPB) inflow in patients with acute type A aortic dissection (ATAAD) and it is still the first choice if the patient is unstable. FA cannulation is not always possible in presence of obstructive disease or dissection of the vessel itself. Besides, it provides aortic retrograde flow, which perfusing the false lumen may cause organ hypoperfusion and cerebral embolism. The cannula itself may obstruct distal limb perfusion. To achieve antegrade cerebral perfusion (ACP) during periods of CPB arrest, necessary to perform open aortic anastomosis, FA cannulation requires separate cannulation of both the innominate and left carotid arteries.

Finally, to obtain antegrade aortic flow, when resuming systemic CPB flow, FA cannulation always necessitates the connection of a CPB inflow secondary line to a side branch of the aortic vascular graft. Currently cannulation of right axillary artery (RAA) is a more common approach in stable patients. The RAA is exposed surgically through an 8 cm horizontal incision, 1 cm below the medial third of the right clavicle. RAA cannulation is usually indirect, through the interposition of an 8 to 10 mm Dacron vascular prosthetic conduit anastomosed end to side to the RAA and then joined to
Cannulation of the right axillary artery for acute type-A aortic dissection surgery: indirect versus direct cannulation with the Optisite arterial cannula.

In this retrospective study, we compared our experience with indirect cannulation (IC) and direct cannulation (DC) of RAA in ATAAD patients.

Materials and Methods

In our Institution, from the 31 August 2012 to the 31 August 2016, 105 patients underwent ATAAD surgery performed by four surgeons. In 76 patients (72.4%) RAA cannulation was the choice and they represent the object of this study. Each patient on admission had signed a written informed consent to allow the necessary care and the treatment of sensitive data for scientific purposes.

For the RAA cannulation, three surgeons always used the IC, whereas a forth one always managed to use the DC with the Optisite arterial cannula without guidewire. The assignment of patient to surgeon was always casual. Eventually of the 76 patients with RAA cannulation, 61 were operated upon with the IC and 15 patients with the DC.

The usual preparation of these patients include the placement of bilateral radial arterial lines for pressure monitoring and probes for monitoring vesical, rectal and nasopharyngeal temperature. Our CPB circuit is usually composed of a Terumo Advanced Perfusion System 1-CPB pump (Terumo Cardiovascular System Corporation, Ann Arbor, MI, USA), with their custom pack (Capiox RX 25, Hollow Fiber Oxygenator plus Capiox X-Coating tubing circuit set) and a Sarns centrifugal pump (Terumo) as master pump. For venous return, we use either a two stage right atrial cannula (Medtronic, Minneapolis, MN, USA) or a femoral cannulation with a Biomedicus cannula (Medtronic) with assisted venous drainage.

For the left ACP we use the Terumo Cerebral Perfusion Set and the Retrograde Cardioplegia Catheter, (Edwards Lifesiences LLC, Irvine, CA, USA) in the size 14 Fr x 32 cm. Table 1 shows an overview of the entire CPB circuit.

The ACP circuit begins with the devoted roller pump. Its inlet is connected with a connector ¼ - ¼ inch to the arterial shunt of a standard CPB circuit, whereas at the outlet there is a ¼ inch Y connector. One arm is for a shunt connected to the oxygenator reservoir used for the circuit priming and the other arm is joint through quick connectors to the circuit for the ACP, which ends with the left common carotid artery line and a second line which is not used and clamped. Cerebral perfusion pressure is continuously monitored. The pre-assembled circuit for ACP is fitted with inlet / outlet connectors which allow it to be installed anytime during the surgical procedure, either before or during CPB. These characteristics make this circuit easy to assemble and prime and safe to run. The main concern during ACP is to guarantee an adequate flow of 10 ml/Kg: 5 ml/Kg flow supplied by the roller pump plus 5 ml/Kg flow by the centrifugal pump. The centrifugal pump flow varies on the base of systemic peripheral resistances and therefore it must be adjusted according to the right arterial pressure and right cerebral perfusion. The CPB pump is equipped with safety systems related to the pump modules, and it is necessary to set the devoted roller pump specifically for cerebral perfusion. Myocardial protection is obtained with either a cold crystalloid solution (Custodiol) or an isothermal haematic solution (St. Thomas), both infused directly into the coronary ostia. CPB flows for both groups were kept at cardiac index of 2.4 l/min, and they were slightly reduced during hypothermia. At the temperature of 26 – 28°C CPB systemic circulatory arrest was established to maintain only the ACP. During ACP, flows were kept at 5 ml/kg/min for the right ACP and at 10 ml/kg/min for the bilateral ACP. Perfusion pressure was monitored through the right radial artery line, and directly from the cannula for the left carotid ACP. Cerebral saturation was continuously monitored with the INVOS system (Medtronic).

For these patients we recorded intraoperatively haematocrit, CPB flows and mean arterial pressure for three body temperature intervals (T1 = 36 -33 °C; T2 = 32.9 - 30°C; T3 = 29.9 - 26 °C), maximum and minimum arterial gradient at the site of cannulation, the plasmatic lactate concentration and cerebral saturation at different phases of the surgical procedure. We did not record the length of time required to establish the RAA cannulation. Despite DC is obviously faster, the statistical analysis would have been biased by the non - randomization of the surgeons. Patients were followed up for three months.
**Table 1: patients’ characteristics and technical details**

<table>
<thead>
<tr>
<th></th>
<th>IC group</th>
<th>DC group</th>
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<tbody>
<tr>
<td>number of patients</td>
<td>61</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>age</td>
<td>69.4 ± 8.8</td>
<td>66.6 ± 11.1</td>
<td>0.28</td>
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<tr>
<td>male / female</td>
<td>37 (61%) / 24 (39%)</td>
<td>8 (53%) / 7 (47%)</td>
<td>0.77</td>
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<tr>
<td>BSA</td>
<td>1.9 ± 0.2</td>
<td>1.8 ± 0.2</td>
<td>0.09</td>
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<tr>
<td>Redo</td>
<td>6</td>
<td>4</td>
<td>0.1</td>
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<tr>
<td><strong>arterial cannulation (number of cases)</strong></td>
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<tr>
<td>8 mm vascular graft</td>
<td>52</td>
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<tr>
<td>10 mm vascular graft</td>
<td>9</td>
<td>-</td>
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<tr>
<td>16 Fr. Optisite arterial cannula</td>
<td>-</td>
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<td>18 Fr. Optisite arterial cannula</td>
<td>-</td>
<td>10</td>
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<tr>
<td><strong>venous cannulation (number of cases)</strong></td>
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<td>32/40 Fr. Two stage atrial cannula</td>
<td>15</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>36/46 Fr. Two stage atrial cannula</td>
<td>39</td>
<td>4</td>
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<tr>
<td>23 Fr. Femoral vein cannula</td>
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<td>21 Fr. Femoral vein cannula</td>
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<tr>
<td>19 Fr. Femoral vein cannula</td>
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<td>V A VD technique</td>
<td>6</td>
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<tr>
<td>KV AD technique</td>
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<tr>
<td><strong>Type of cardioplegia (number of cases)</strong></td>
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<tr>
<td>Custodiol</td>
<td>27</td>
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<td>haematic St. Thomas</td>
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<td><strong>Cerebral perfusion (number of cases)</strong></td>
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<tr>
<td>Bilateral ACP</td>
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<td>Right ACP</td>
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<td><strong>Times of CPB perfusion and arrest (min)</strong></td>
<td></td>
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<tr>
<td>CPB time</td>
<td>159.7 ± 81.9</td>
<td>162.4 ± 47.2</td>
<td>0.9</td>
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<tr>
<td>aortic X clamp time</td>
<td>87.4 ± 35.7</td>
<td>101.3 ± 25.3</td>
<td>0.16</td>
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<tr>
<td>CPB arrest time</td>
<td>38.7 ± 28</td>
<td>31.5 ± 16.7</td>
<td>0.48</td>
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</table>

BMS = body mass surface. V A VD = vacuum-assisted venous drainage. KV AD = kinetic-assisted venous drainage. ACP = antegrade cerebral perfusion
Cannulation of the right axillary artery for acute type-A aortic dissection surgery: indirect versus direct cannulation with the optisure arterial cannula.

Results

There were no significant differences between the IC and DC groups in terms of demographic characteristics, operative and outcome data except for a difference in mean T1 CPB flows, which was significantly inferior in the DC group (Table 1-2).

During CPB, the DC group showed persistently lower flows, but the significant difference in the mean T1 flows was partially explained by the fact that when these two flows where compared with their respective predicted flows, mean T1 flow was slightly superior in the IC group and slightly inferior in the DC group, but not significantly in either case (Table 2). Besides DC group had a smaller mean body mass surface and therefore a lower predicted mean T1 flow to start with. In any case, when CPB hypothermia is required, as in case of ATAAD, during cooling the phase of T1 flow usually lasts only for few minute, whereas during rewarming at T1 there is already some cardiac output to compensate for the lower CPB flow.

No patient developed local complications such as vascular or brachial plexus injuries, hematomata or infection of the subclavian incision. No patient developed left hemiparesis or other left sided neurologic disorders. There were two deaths in DC group (13.3%) and six in IC group (9.8%) (p= 0.6), all of them caused by multi organ failure and sepsis. Three patients (20%) in DC group and 10 patients in IC group (16.4%) developed postoperatively acute renal failure which required temporary dialysis (p=0.7).

Discussion

RAA cannulation is a common approach to establish CPB arterial flow in case of ATAAD surgery. It supplies a more physiologic antegrade flow from the very beginning, thus reducing the risk of organ hypo perfusion and cerebral embolism, and there is no risk of distal limb hypo perfusion. RAA cannulation perfuses directly the right carotid artery and only the separate cannulation of the left carotid artery, supported by a dedicated pump module, is required to complete the bilateral ACP.

Occasionally, in case of common origin of the carotid arteries from the innominate artery, RAA cannulation alone guarantees global ACP during periods of CPB arrest. In this case only the master pump is used, with no need of further modules.

Despite the lack of randomized trials, RAA cannulation seems to give better short-term mortality and neurological dysfunction rates than FA cannulation [3].

RAA IC does not impairs the right upper limb perfusion and, tailoring the vascular graft as a patch at closure, it avoids stenosis of the RAA. In IC, the vascular graft anastomosed to the RAA might also be used to place an Impella heart pump (Abiomed, Danvers, MA, USA) at the end of the procedure as a ventricular assist device if needed. The IC drawbacks are that is time consuming, creates a flow perpendicular to a narrow lumen, which could damage the vascular wall, and leaves at the end of the procedure a stump of a foreign body which, creating a cul-de-sac, could be a source of peripheral embolization and, in case of wound infection, it would represent a serious problem. The DC of RAA, technically similar to an open femoral artery cannulation, is quite faster, in situations where minutes could save lives. DC provides a coaxial antegrade flow and, at the end of the procedure, it does not leave any gross foreign body in the wound. The concerns of DC are distal occlusion of the RAA lumen by the presence of the cannula itself, similarly to what may happen with FA cannulation, with possible hypoperfusion of the right arm.

When inserting the arterial cannula into the RAA great care must be paid not to push it too deeply inside the vessel. The cannula may occlude the right vertebral artery and, above all, reaching the innominate artery, the cannula may also obstruct the origin of the right carotid artery, causing a major stroke. Finally, the cannula insertion may injure the RAA and tying the purse string after its removal may damage the artery wall or make it stenotic, with possible subsequent thrombosis. All these complications are more likely if the RAA is of small calibre [4].

Keeping these tips in mind, in our experience none of the complications occurred due to local problems with the cannula.
Table 2: Group variables object of the study

<table>
<thead>
<tr>
<th></th>
<th>IC</th>
<th>DC</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CPB flow (ml/min)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>predicted T1</td>
<td>4516 ± 420</td>
<td>4314 ± 481</td>
<td>0.1</td>
</tr>
<tr>
<td>T1</td>
<td>4525 ± 475</td>
<td>4200 ± 395</td>
<td>0.01</td>
</tr>
<tr>
<td>predicted T1 vs (observed ) T1</td>
<td>p = 0.8</td>
<td>p = 0.08</td>
<td></td>
</tr>
<tr>
<td>T2</td>
<td>4346 ± 611.5</td>
<td>4157 ± 436</td>
<td>0.28</td>
</tr>
<tr>
<td>T3</td>
<td>3988 ± 666</td>
<td>3831 ± 454</td>
<td>0.52</td>
</tr>
<tr>
<td><strong>Haematocrit %</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>26.6 ± 4.1</td>
<td>25.2 ± 3.8</td>
<td>0.21</td>
</tr>
<tr>
<td>T2</td>
<td>24.4 ± 2.8</td>
<td>23.8 ± 3.4</td>
<td>0.51</td>
</tr>
<tr>
<td>T3</td>
<td>24 ± 3.8</td>
<td>24.2 ± 1.90</td>
<td>0.88</td>
</tr>
<tr>
<td><strong>Arterial pressure (mmHg )</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>63.5 ± 10.9</td>
<td>69.2 ± 11.7</td>
<td>0.07</td>
</tr>
<tr>
<td>T2</td>
<td>64 ± 14.2</td>
<td>62.3 ± 9.2</td>
<td>0.69</td>
</tr>
<tr>
<td>T3</td>
<td>61.9 ± 11.1</td>
<td>70.6 ± 12.8</td>
<td>0.53</td>
</tr>
<tr>
<td><strong>Right cerebral saturation (%)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pre CPB</td>
<td>61.7 ± 11.1</td>
<td>57.1 ± 6.1</td>
<td>0.2</td>
</tr>
<tr>
<td>pre ACP</td>
<td>62.8 ± 10</td>
<td>61.62 ± 8.5</td>
<td>0.76</td>
</tr>
<tr>
<td>during ACP</td>
<td>63.3 ± 11.5</td>
<td>59.1 ± 10.8</td>
<td>0.36</td>
</tr>
<tr>
<td>post ACP</td>
<td>60.4 ± 9.3</td>
<td>65.9 ± 7.9</td>
<td>0.13</td>
</tr>
<tr>
<td>post CPB</td>
<td>64.6 ± 10.1</td>
<td>64.1 ± 5.6</td>
<td>0.88</td>
</tr>
<tr>
<td><strong>Left cerebral saturation (%)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pre CPB</td>
<td>60.1 ± 13.5</td>
<td>58 ± 7</td>
<td>0.63</td>
</tr>
<tr>
<td>pre ACP</td>
<td>60 ± 11.5</td>
<td>61.2 ± 8.3</td>
<td>0.77</td>
</tr>
<tr>
<td>during ACP</td>
<td>64.1 ± 11.7</td>
<td>57.4 ± 10.8</td>
<td>0.18</td>
</tr>
<tr>
<td>post ACP</td>
<td>60.3 ± 11.5</td>
<td>63.4 ± 10.1</td>
<td>0.5</td>
</tr>
<tr>
<td>post CPB</td>
<td>64.1 ± 9.7</td>
<td>62.7 ± 7.6</td>
<td>0.66</td>
</tr>
<tr>
<td><strong>Plasmatic lactate concentration (mmol/l)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pre CPB</td>
<td>2.4 ± 2.9</td>
<td>1.1 ± 0.6</td>
<td>0.86</td>
</tr>
<tr>
<td>inta CPB</td>
<td>4.5 ± 4.6</td>
<td>2.4 ± 2.3</td>
<td>0.82</td>
</tr>
<tr>
<td>post CPB</td>
<td>6.9 ± 8.1</td>
<td>3.2 ± 3.4</td>
<td>0.09</td>
</tr>
<tr>
<td><strong>Circuit gradient (mmHg)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>max</td>
<td>239 ± 54.1</td>
<td>270.2 ± 91.3</td>
<td>0.29</td>
</tr>
<tr>
<td>min</td>
<td>172 ± 31.8</td>
<td>196.9 ± 94.1</td>
<td>0.35</td>
</tr>
<tr>
<td><strong>Outcome</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital mortality</td>
<td>6</td>
<td>2</td>
<td>0.6</td>
</tr>
<tr>
<td>Renal failure and Dialyses</td>
<td>10</td>
<td>3</td>
<td>0.7</td>
</tr>
</tbody>
</table>

T1 = 36 - 33 °C. T2 = 32.9 - 30°C. T3 = 29.9 - 26 °C. ACP = antegrade cerebral perfusion.
the above complications has occurred. In particular, we did not record cases of stroke and evidence of hypoperfusion, systemic or of the right arm, but we cannot exclude that in case of a prolonged or normothermic perfusion, such as for a subsequent ECMO, some problems may arise.

The number of patients enrolled in this study was rather small to assess any fine difference between DC and IC, considering that the outcome of these patients may vary greatly on the base of their preoperative conditions (comorbidities, extension of dissection, degree of cardiac tamponade on arrival, etc.). Therefore we focused our analysis only on few gross parameters.

In our study there were no real significant differences between the DC and IC group data. DC has shown no complications or remarkable underperformance. If the RAA has a good calibre, DC with the Optisite cannula is a reliable and faster alternative to IC, a good compromise between simplicity and flow. If feasible, we recommend its use in ATAAD surgery whenever RAA cannulation is required.

Declaration of conflicting interests and funding

The Authors declare that there is no conflict of interest. This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

References

Abstract

Background
Since the advent of cardiopulmonary bypass, many efforts have been made to avoid the complications related with CPB. Any component of the pump participates in occurrence of these adverse events, one of which is the type of prime solution. Cardiopulmonary bypass priming solution and volume are of special importance since it directly affects post op organ. Functions, extubation time, bleeding and blood product usage. In this study, I aimed to compare the effects of Plasmalyte-A with Cocktail prime (0.9% Normal Saline, Halfnor (0.45% Normal Saline) and 6% voluven, on post-op outcomes following CABG and Valve replacement.

Methodology
100 patients undergoing elective CABG (On pump) and single valve replacement were prospectively studied. The patients were randomized in to two groups,
- 25 CABG & 25 Valve replacements were primed with Plasmalyte-A (group 1),
- 25 CABG & 25 Valve replacements were primed with Cocktail prime (0.9% Normal Saline, Halfnor (0.45% Normal Saline) and 6% voluven. The postoperative outcomes of the patients were studied.

Results
With a mean patient age of 56.44±10.24 years for Plasmalyte-A (group 1), 60.96± 7.37 years for cocktail prime (group 2). The genders were 65 male/ 35 female patients. Both groups didn't have any detrimental effects on renal function. In group 1, less postoperative blood loss, less amount of blood and fresh frozen plasma used but in group 2, there was a statistical significant bleeding at 4th to 8th hour post operatively (p value=0.04), There was a significant blood transfusion in group 2 than group 1 (p value = 0.02), There was no significant difference of extubation time in two groups.

Conclusion
As per my study conclusion there was not much significant when used Plasmalyte-A (group 1), Cocktail prime (group 2) as a CPB prime, but in CABG cases the bleeding was significantly high in Cocktail prime (group 2) compared to Plasmalyte-A (group 1). There was significant amount of blood and blood products (FFP & Platelets) were used in Cocktail prime (group2) compare to PLASMALYTE-A (group1). Based upon the statistical data and results we conclude that PLASMALYTE-A IS SUPERIOR TO COCKTAIL PRIME as a CPB prime solution.

Keywords
Cardio pulmonary bypass, CABG, Valve replacement, Plasmalyte-A, Cocktail prime, Halfnor.
Group comparison study of cocktail prime versus plasmalyte-A as a CPB prime - it's effect on patient outcome

Introduction
Cardio Pulmonary Bypass is essential part of cardiac surgery. Conducting of Cardio Pulmonary Bypass is done by Cardiac Perfusionist, selecting the priming fluid for the cardio pulmonary bypass circuit make key role for every Perfusionist, hence, it affects outcome of the patient physiological changes. An ideal priming solution should have the same tonicity, electrolyte composition and pH as that of plasma. Of these ideal properties the most important is that of “tonicity,” in order to avoid red cell lysis and the fluid shifts from the extracellular to the intracellular compartment that occurs with hypotonic solutions. Fluid shifts may occur in any organ or tissue, but the organs most vulnerable to fluid accumulation are the brain and lungs. Intracellular fluid gain causes cerebral or pulmonary edema and impairs organ function. Present study is to know the effect of two different primes PLASMALYTE-A (group 1),Cocktail prime (0.9%Normal Saline, 0.45% Normal Saline and 6% voluven (group 2)) - on patient hemodynamics, renal function, post CPB bleeding and amount of blood products usage. This all parameters directly or indirectly affect patient outcome, morbidity and mortality.

Methodology
There was randomized double blind cross sectional study was conducted in adult cardiothoracic surgery unit of KLES Dr. Prabhakar Kore hospital during march 2016 to February 2017. After obtaining institutional ethical committee clearance and informed consent, 100 adult patients undergoing open heart surgery on elective cardiopulmonary bypass, in this study we perfectly categorize each group into 2 sub-groups. Finally there were 4 subgroups. Each subgroup contains 25 patients. 50 patients are primed with Plasmalyte-A (25 CABG, 25 Valve replacement cases), and 50 patients are primed with Cocktail prime (0.9%Normal Saline, 0.45% Normal Saline and 6% voluven(25 CABG, 25 Valve replacement cases).

Including criteria was all adult patients who were under gone single valve replacement and on pump - CABGs, age between 18 to 70yr old, weight between 30kg to 95kg, there was no gender specification. Patients, who were above 70yrs and below 18 yrs. old, patients who were undergone for off-pump CABG and emergency CABG cases were excluded from this study. Complete data obtained from perfusion data sheets and Pre Anesthetic Chart and ITU patients chart. The priming volume is 1400±70 ml and 1450± 40 ml for CABG and valve cases respectively. As per institute protocol Hct was maintained above 21% during CPB and wean off Hct above 24%. Full flows maintained at BSA * 2.4 @ 37°C.

Inter group comparison of Demographic Variables (gender):
Graph 1.

Graph 1 : Our data and results on the table shows us the patients average age of 46 to 61 yrs., age and the gender is not considered while selecting prime fluid. My data shows the female gender is extremely less prone to CABG surgery (7 females/43 males) and vice versa in valve replacement cases; the female gender is more prone to VALVE cases (28 females/22 males) than male patients.

Graph 2 : in CABG and Valve replacement cases there was no difference in lactate level in both groups on CPB & Post OP (p > 0.05),

Inter group comparison of Demographic Variables (lactate level):
Graph 2.

Lactate level ( meq/l)

<table>
<thead>
<tr>
<th></th>
<th>CPB LACTATE</th>
<th>POST OP LACTATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLASMA (CABG)</td>
<td>3.68</td>
<td>1.88</td>
</tr>
<tr>
<td>COCKTAIL (CABG)</td>
<td>3.30</td>
<td>2.045</td>
</tr>
<tr>
<td>PLASMA (VALVE)</td>
<td>6.80</td>
<td>2.98</td>
</tr>
<tr>
<td>COCKTAIL (VALVE)</td>
<td>6.40</td>
<td>2.50</td>
</tr>
</tbody>
</table>
**CABG**: On CPB, lactate in group 1: 1.88, group 2: 2.04 (p value 0.20), and Post op lactate in group 1: 3.60, group 2: 3.3. (p value 0.86),

**VALVE REPLACEMENT**: On CPB, lactate in group 1: 2.9, group 2: 2.5 (p value 2.51), and Post op lactate in group 1: 6.8, group 2: 6.4. (p value 2.03)

The table of pre and intra op characteristics of two groups

<table>
<thead>
<tr>
<th></th>
<th>CABG CASES</th>
<th>VALVE CASES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>PLASMALYTE- A</strong></td>
<td><strong>COCKTAIL PRIME</strong></td>
</tr>
<tr>
<td></td>
<td>AVG</td>
<td>STD</td>
</tr>
<tr>
<td>AGE (YEARS)</td>
<td>56±</td>
<td>10</td>
</tr>
<tr>
<td>SEX (MALE/FEMALE)</td>
<td>19M/16F</td>
<td>M24/1F</td>
</tr>
<tr>
<td>WEIGHT (Kg)</td>
<td>63±</td>
<td>13</td>
</tr>
<tr>
<td>BSA (m^2)</td>
<td>1.69±</td>
<td>0.15</td>
</tr>
<tr>
<td>DIABETIC (count)</td>
<td>14DM</td>
<td></td>
</tr>
<tr>
<td>PRIME VOL (ml)</td>
<td>1350±</td>
<td>0</td>
</tr>
<tr>
<td>CPB TIME (min)</td>
<td>107±</td>
<td>28</td>
</tr>
<tr>
<td>AOX CL TIME (min)</td>
<td>34±</td>
<td>0</td>
</tr>
<tr>
<td>HYPOTHERM(°C)</td>
<td>36.5±</td>
<td>0.41</td>
</tr>
<tr>
<td>REWARM TO (°C)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**LACTATE LEVELS mmol/l**

<table>
<thead>
<tr>
<th></th>
<th>Plasmalyte-A (CABG)</th>
<th>Cocktail prime (CABG)</th>
<th>P-Value</th>
<th>Plasmalyte-A (Valve replace)</th>
<th>Cocktail Prime (Valve replace)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON CPB</td>
<td>1.88</td>
<td>2.04</td>
<td>0.20</td>
<td>2.9</td>
<td>2.5</td>
<td>2.51</td>
</tr>
<tr>
<td>POST OPERATIVE</td>
<td>3.60</td>
<td>3.3</td>
<td>0.86</td>
<td>6.8</td>
<td>6.4</td>
<td>2.03</td>
</tr>
</tbody>
</table>

**Graph 3**: Post-operative chest drain bleeding is one of the important factors which is to be considered for the selection of CPB prime. In CABG comparison between two groups There was a statistical significant bleeding at 4th to 8th hour post operatively through the chest drain tubes (p value 0.04), bleeding level in first 2nd hour of post op, in group 1: 56.4 ± 84.8 ml and group 2: 82 ± 86 ml (p =0.33), 4th hour of post op there was no difference, group1: 65.6 ± 59.16ml, in group 2: 69± 69.99 ml. 8th hour of post op, group1: 54.8 ± 48.4ml, in group 2: 84± 67 ml.(p = 0.04)

In valve replacement cases, in both groups 2nd, 4th and 8th hour bleeding is not significant (24 ml, 50 ml and 50ml for Group 1, as well as 63ml, 41ml, and 50ml for group2).
Comparison of total drainage (bleeding) in Post op:

Graph 3

<table>
<thead>
<tr>
<th></th>
<th>8th hour</th>
<th>4th hour</th>
<th>2nd hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>COCKTAIL(VALVE)</td>
<td></td>
<td>39</td>
<td>50</td>
</tr>
<tr>
<td>PLS-A(VALVE)</td>
<td></td>
<td>24</td>
<td>50</td>
</tr>
<tr>
<td>COCKTAIL(CABG)</td>
<td></td>
<td></td>
<td>69</td>
</tr>
<tr>
<td>PLS-A (CABG)</td>
<td></td>
<td></td>
<td>54</td>
</tr>
</tbody>
</table>

Graph 4: More chest tube drainage caused reduction of hemoglobin level (Hct <25%), where we required transfusion of blood and blood derivative products to keep patient in hemodynamically stable condition. Otherwise mild to severe instability occurs to the patient.

In CABG: The results which are derived from my study indicates there was significantly packed RBCs used in group 2 patients (20 units) in CABG than Group 1, there was significant difference between two groups, group 1(9 units) and group 2 (20 units) blood transfusion in post-operative (p value <0.05).

In Valve replacement: This study indicates that significantly packed RBCs were used in group 2 than group 1. There was significant difference between the two groups, Group 1 patients transfused 4 units of packed RBCs and Group 2 patients transfused 13 units of packed RBCs in post-operative ITU (p value <0.05).

Comparison of Total blood (PCV) in units transfused in 24 hours between the two groups.

Graph 4

<table>
<thead>
<tr>
<th>Blood units infusion</th>
<th>CPB</th>
<th>POST CPB</th>
<th>POST OP (ITU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLS-A(CABG)</td>
<td>2</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>COCKTAIL (CABG)</td>
<td>4</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>PLS-A(VALVE)</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>COCKTAIL(VALVE)</td>
<td>1</td>
<td>6</td>
<td>13</td>
</tr>
</tbody>
</table>
### The table of post-op ITU characteristics of two groups

<table>
<thead>
<tr>
<th>CABG CASES</th>
<th>VALVE CASES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PLASMALYTE-A</strong></td>
<td><strong>COCKTAIL PRIME</strong></td>
</tr>
<tr>
<td><strong>MEAN± SD</strong></td>
<td><strong>MEAN± SD</strong></td>
</tr>
<tr>
<td><strong>ON CPB</strong></td>
<td></td>
</tr>
<tr>
<td>RBS (Mg/dl)</td>
<td>158±38.6</td>
</tr>
<tr>
<td>Na (mmol/l)</td>
<td>137±2.5</td>
</tr>
<tr>
<td>K (mmol/l)</td>
<td>4±1.8</td>
</tr>
<tr>
<td><strong>POST-OP</strong></td>
<td></td>
</tr>
<tr>
<td>RBS (Mg/dl)</td>
<td>173±46</td>
</tr>
<tr>
<td>Na (mmol/l)</td>
<td>140±2.47</td>
</tr>
<tr>
<td>K (mmol/l)</td>
<td>3.6±0.35</td>
</tr>
<tr>
<td>LACTATE(CPB)</td>
<td>1.88±1.1</td>
</tr>
<tr>
<td>LACTATE(ITU)</td>
<td>3.68±2.62</td>
</tr>
<tr>
<td>BLEEDING(2hr) ml</td>
<td>56.4±84.8</td>
</tr>
<tr>
<td>BLEEDING(4hr) ml</td>
<td>65.6±59.1</td>
</tr>
<tr>
<td>BLEEDING(8hr) ml</td>
<td>54.8±48.4</td>
</tr>
<tr>
<td>URINE O/P(ml)</td>
<td>443±366</td>
</tr>
<tr>
<td>URINE O/P (ml)</td>
<td>2432±390</td>
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<tr>
<td>HEMOFILTRATION</td>
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<tr>
<td>PLATELET COUNT DECREASE(x1000)</td>
<td>106±53</td>
</tr>
<tr>
<td>CREATININE</td>
<td>0.17±0.14</td>
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<td>REEXPLOPRATION</td>
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<tr>
<td>2ND CPB</td>
<td>2</td>
</tr>
<tr>
<td>AUTOLOGOUS</td>
<td>10</td>
</tr>
<tr>
<td>EXUTATION</td>
<td>1.36±0.7</td>
</tr>
<tr>
<td>MORTALITY</td>
<td>1</td>
</tr>
<tr>
<td><strong>DRUGS (ml/kg/hr)</strong></td>
<td></td>
</tr>
<tr>
<td>ADRENALIN</td>
<td>0.16±0.55</td>
</tr>
<tr>
<td>NOR ADR</td>
<td>3.08±1.13</td>
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Observation and Results

Data was collected from 50 CABG cases, 50 Valve replacement cases. Among them 25 CABG cases used Plasmalyte -A and 25 CABG cases used cocktail prime. 25 Valve replacement cases used Plasmalyte -A and 25 Valve replacement cases used cocktail prime as a cardio pulmonary bypass prime. The on CPB, post CPB and post-op ITU clinical characteristics for each group are presented in table. There was no re-exploration done, the data obtained was analyzed statistically using the Microsoft excel version 2007. Descriptive analysis was done to summarize qualitative data by using mean and standard deviation. The intergroup, sub group comparison of explanatory variables was done and analyzed with “t - test”. P value of <0.05 was considered as significant. P <0.001 was considered as highly significant. P >0.05 was considered non-significant.

Conclusion

As per this study conclusion there was not much significant for the patients when used Plasmalyte-A (group 1), Cocktail prime (group 2) as a CPB prime, but in CABG cases the bleeding is significantly high in Cocktail prime (group 2) compared to Plasmalyte -A (group 1). There was significant amount of blood and blood products were used in Cocktail prime group compared to PLASMALYTE-A group in CABG and Valve Replacement cases which causes blood transfusion reactions to patient, financial burden on hospital and patient. Based upon the statistical data and results we conclude that PLASMALYTE-A IS SUPERIOR TO COCKTAIL PRIME as a CPB prime.

References

Normovolemic hemodilution prior to cardiopulmonary bypass: an approach to autologous blood transfusion reduces post-operative homologous blood requirement

Pritam Nandy, Kamal Das, Nripendra Kr. Tiwari, Tuhinsubhra Medda, Sudipta Patra, Tarapada Das
R G Kar Medical College, Kolkata

Abstract:
Cardiac surgery requires large amount of blood transfusions. Homologous blood transfusion is the commonest method to procure the blood loss, which may lead various complications (endotoxemia, septicemia, and transfusion related lung injury) throughout the perioperative period. Normovolemic hemodilution (a type of autologous blood transfusion) may avoid this type of complications.

The concept of withdrawing a percentage of blood and leaving the patient anemic and normovolemic, is intended to minimize the loss of red blood-cells during surgery [1,2,3].

As the hemoglobin concentration is reduced through dilution, the blood that is lost during surgery will contain less hemoglobin, and at the same time autologous blood components can be preserved. We found in our study, autologous blood transfusion is also effective to reduce the homologous blood substitute (like platelets) and post-operative drainage which helps in early recovery.

Keywords: Autologous blood transfusion, normovolemic hemodilution, blood conservation, blood loss, adult cardiac surgery.

Introduction
Cardiac valve surgery is considered a major surgery with a high chance of hemorrhage and extracorporeal circulation dilution [4] Normovolemic hemodilution is a type of autologous blood transfusion i.e., percentage of blood volumes withdrawn from the patient and infusion of a cellular fluids in order to maintain the volume and retransfuse back the same amount in same patient [5,6]. This procedure will make the patient anemic; although patient will remain normovolemically and hemodynamically stable [7]. With the exception of extreme hemodilution situations, the capacity for tissue oxygen supply and demand will not be affected [8].

During allogenic blood transfusion a patient receives large number of allogenic donor leucocytes and these are recognized as foreign cells by the recipient who leads to immunosuppression, hemolytic reaction, and allergic reaction. Homologous blood transfusion may also cause infectious complication, endotoxemia, septicemia [9], transfusion related lung injury [10]. The innovation in equipments like cell saver, preoperative normovolemic hemodilution techniques in cardiac surgery eliminates these types of complication by using the autologous blood transfusion. In contrast to cell saver only washed RBCs can be obtained but with this normovolemic hemodilution technique RBCs, as well as
all other blood components i.e. fresh plasma, platelets can be obtained and it is simple method and cost effective.[11]

**Materials Methods**

In this study 30 consecutive adult patients were prospectively randomized in a non-blinded manner into two groups: Group-A, ANH group (15) patients blood was withdrawn before systemic heparinization and replaced with acellular solution, and a control group, Group-B (15 patients), where no blood withdrawn was performed, underwent elective open heart surgery like closure of Atrial Septal Defect, Mitral valve replacement, Coronary artery bypass grafting off pump/on pump under general anesthesia, moderate hypothermia (28-32°C) and alpha-stat pH management. Prior to induction blood was collected from the central venous catheter in a CPD bag(s) and at the same time the volume was replaced with acellular fluid. *i.e. for each 1 ml of blood removed; 3 ml of crystalloid solution was infused* [12]. Lactated Ringer solution is preferable because it has a lower incidence of acidosis, (a larger charge of chlorine in the saline solution tends to cause hyperchloremic metabolic acidosis) [13,14]. The bag(s) should be gently agitated to ensure adequate mixing. Target Hb Prior to cardiopulmonary bypass was fixed 11 gm/dl in all cases to prevent massive hemodilution. Preoperative exclusion criteria for normovolemic hemodilution were age less than 18 years, left ventricular ejection fraction (LVEF) less than 50%, preoperative hematocrit less than 36% or hemoglobin less than 12 g/dl, history of hematologic diseases, chronic renal insufficiency (plasma creatinine 2 mg/dl), and history of hepatic diseases (*e.g.*, active hepatitis or cirrhosis). Preoperative treatment with aspirin or subcutaneous low molecular weight heparin was not a contraindication to enrollment of this study. Packed red blood cells (PRBC) were transfused, during CPB if hemoglobin value was less than 6 gm/dl and hematocrit value was less than 18%. Pump was primed with 1300-1500 ml of RL, heparin 1000-2500IU/ Litter of prime [15]. Ante grade venous blood priming and retrograde arterial blood priming in cardio pulmonary bypass was performed with the replacement of crystalloid priming solution just prior to initiate bypass to prevent massive hemodilution and ischemic insult of various organ. Bolus dose of Nor-adrenaline (conc. - 2mg/50ml) was administrated to maintain mean arterial pressure 50-70mm Hg. Conventional ultra filtration and modified ultra filtration was performed whenever feasible because in some cases crystalloid cardioplegia was used. After successful weaning from heart lung machine the same blood was retransfused within 4-6 hours [7, 16] in reverse order because the first unit collected and the last to be reinfused will have the highest hematocrit and platelets [17], after full neutralization of heparin with protamine. Blood loss was recorded during the first 24 h. Reinfusion of shed mediastinal blood was not performed during postoperative period. Antifibrinolytic drugs such as tranexamic acid were used prophylactically, depending on bleeding risk. [18]

**Calculation:** [19]

**STEP 1:**
- Calculate the ideal/ estimated body weight
  - IBW = 50 kg for male (or 45.5 kg for females) + 2.3 kg for each inch > 60 inches
  - Example: 90 kg male (actual body weight)
  - 70 inches (height)
  - IBW = 50 kg + (2.3 kg x 10) = 73 kg

**STEP 2:**
- Calculate the patient's Estimated Blood Volume (EBV)
  - EBV = (75 ml/kg of IBW in males or 70 ml/kg of IBW in females)
  - Example: 73 kg male (IBW)
  - EBV = 75 ml/kg X 73 kg = 5,475 ml

**STEP 3:**
- Calculate the maximum amount of blood to be removed (discovered by GROSS in 1983)
  - BV = EBVX(Hbi or Hcti – Hbd or Hctd)/ Average Hb or HCT
  - Average Hb=(initial Hb or Hct+desired Hb or Hct)/2
  - Hbi/Hcti=initial hemoglobin/ hematocrit
  - Hbd/Hctd=desired hemoglobin/hematocrit

For the patient body weight below 45.5 kg the maximum amount of blood can be withdrawn 20% of actual body weight. We kept the desired hemoglobin 11 gm/dl fixed in all cases, due to 1100-1300 ml of priming volume otherwise excessive lower hematocrit may cause anemic hypoxia to the end organs.
Calculation of adequate priming volume:[20]
C1VI = C2V2
C1=Patient initial hematocrit
V1=Patient initial blood volume
C2=Patient desired hematocrit
V2=Patient's estimated blood volume+CPB prime volume+pre-CPB intravenous fluid volume

One CPD bag contains 49 ml of CPD, which is adequate for 301 ml of whole blood, so the blood should be in adequate amount, 1 ml of whole blood weighs 1.06 gm.[19] So 301 ml of whole blood weighs 319.06 gm.

Monitoring: Hemodilution to a hematocrit of 33%  
Continuous monitoring: ECG monitor (lead II and V5) - On-line ST-segment analysis  
Invasive arterial pressure  
Pulse oximetry  
Urine output  
Intermittent monitoring
i. Central venous pressure  
ii. Arterial blood gas analysis  
Additional monitoring - Facultative
i. Noninvasive cardiac output measurements  
ii. Continuous cardiac output measurement (pulmonary or arterial catheter)  
iii. Continuous mixed venous O2 saturation (SvO2) measurement  
iv. Transesophageal echocardiography

A=empty CPD bag B=Bag is connected to central venous line and blood is being withdrawn=weighing of during blood collection=Retransfusion of autologous blood
Normovolemic hemodilution prior to cardiopulmonary bypass: an approach to autologous blood transfusion reduces post-operative homologous blood requirement

### Group-A: Autologous Normovolemic hemodilution group

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<th>SL No.</th>
<th>Age/Sex</th>
<th>Procedure</th>
<th>Pre-op Hb (gram/dl)</th>
<th>Blood withdrawn (unit)</th>
<th>Cross clamping time (minutes)</th>
<th>Post-op Hb (gram/dl)</th>
<th>Homologous blood req.</th>
<th>ACT (sec) at immediate post op in ITU</th>
<th>Post-operative drainage (first 24 hrs)</th>
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<td>32/M</td>
<td>MVR</td>
<td>14</td>
<td>03</td>
<td>112</td>
<td>10</td>
<td>NIL</td>
<td>110</td>
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<tr>
<td>8</td>
<td>43/M</td>
<td>On pump CABG</td>
<td>14</td>
<td>03</td>
<td>120</td>
<td>10</td>
<td>NIL</td>
<td>120</td>
<td>300 ml</td>
</tr>
<tr>
<td>9</td>
<td>45/M</td>
<td>Off-pump CABG</td>
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<td>11</td>
<td>NIL</td>
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<td>250 ml</td>
</tr>
<tr>
<td>10</td>
<td>22/M</td>
<td>OS-ASD closure</td>
<td>13</td>
<td>02</td>
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<td>250 ml</td>
</tr>
<tr>
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<td>35/M</td>
<td>MVR</td>
<td>14</td>
<td>03</td>
<td>117</td>
<td>11</td>
<td>NIL</td>
<td>124</td>
<td>400 ml</td>
</tr>
<tr>
<td>12</td>
<td>52/F</td>
<td>Off Pump CABG</td>
<td>13</td>
<td>02</td>
<td>—</td>
<td>10</td>
<td>NIL</td>
<td>118</td>
<td>300 ml</td>
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<tr>
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<td>38/F</td>
<td>MVR</td>
<td>12</td>
<td>01</td>
<td>140</td>
<td>9</td>
<td>01 PRBC</td>
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<tr>
<td>14</td>
<td>25/F</td>
<td>OS-ASD closure</td>
<td>13</td>
<td>02</td>
<td>33</td>
<td>11</td>
<td>NIL</td>
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<td>250 ml</td>
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<tr>
<td>15</td>
<td>29/M</td>
<td>OS-ASD closure</td>
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<td>02</td>
<td>30</td>
<td>11</td>
<td>NIL</td>
<td>120</td>
<td>250 ml</td>
</tr>
</tbody>
</table>
### Group-B: Control group - Homologous blood transfusion

<table>
<thead>
<tr>
<th>SL No.</th>
<th>Age/Sex</th>
<th>Procedure</th>
<th>Pre-op Hb (grm/dl)</th>
<th>Post-pump Hb (grm/dl)</th>
<th>Cross clamp time (Minutes)</th>
<th>Homologous blood req.</th>
<th>ACT (sec) at immediate post op in ITU</th>
<th>Post-operative drainage (first 24 hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>25/M</td>
<td>OS-ASD</td>
<td>13</td>
<td>8</td>
<td>40</td>
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<td>120</td>
<td>600 ml</td>
</tr>
<tr>
<td>2</td>
<td>40/M</td>
<td>MVR</td>
<td>14</td>
<td>8.4</td>
<td>90</td>
<td>3 PRBC, 4 FFP, 4 Platelet</td>
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</tr>
<tr>
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<td>12</td>
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<td>120</td>
<td>600 ml</td>
</tr>
<tr>
<td>4</td>
<td>60/M</td>
<td>On-Pump CABG</td>
<td>12</td>
<td>8</td>
<td>90</td>
<td>2 PRBC, 4 FFP, 4 Platelet</td>
<td>110</td>
<td>550 ml</td>
</tr>
<tr>
<td>5</td>
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<td>13</td>
<td>8</td>
<td>32</td>
<td>2 PRBC, 2 FFP, 2 Platelet</td>
<td>115</td>
<td>500 ml</td>
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<tr>
<td>6</td>
<td>35/M</td>
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<td>13</td>
<td>9</td>
<td>98</td>
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<td>120</td>
<td>500 ml</td>
</tr>
<tr>
<td>7</td>
<td>45/F</td>
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<td>9</td>
<td>—</td>
<td>1 PRBC, 1 FFP, 0 Platelet</td>
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<td>400 ml</td>
</tr>
<tr>
<td>8</td>
<td>32/M</td>
<td>MVR</td>
<td>12</td>
<td>7</td>
<td>115</td>
<td>4 PRBC, 4 FFP, 4 Platelet</td>
<td>120</td>
<td>550 ml</td>
</tr>
<tr>
<td>9</td>
<td>26/M</td>
<td>OS-ASD closure</td>
<td>12</td>
<td>9</td>
<td>34</td>
<td>1 PRBC, 1 FFP, 2 Platelet</td>
<td>120</td>
<td>400 ml</td>
</tr>
<tr>
<td>10</td>
<td>23/F</td>
<td>OS-ASD closure</td>
<td>12</td>
<td>8</td>
<td>38</td>
<td>2 PRBC, 2 FFP, 2 Platelet</td>
<td>118</td>
<td>500 ml</td>
</tr>
<tr>
<td>11</td>
<td>56/M</td>
<td>Off pump CABG</td>
<td>12</td>
<td>9</td>
<td>NIL</td>
<td>1 PRBC, 2 FFP, 0 Platelet</td>
<td>115</td>
<td>400 ml</td>
</tr>
<tr>
<td>12</td>
<td>37/F</td>
<td>MVR</td>
<td>13</td>
<td>8</td>
<td>160</td>
<td>4 PRBC, 4 FFP, 4 Platelet</td>
<td>130</td>
<td>650 ml</td>
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<tr>
<td>13</td>
<td>28/M</td>
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<td>2 PRBC, 2 FFP, 2 Platelet</td>
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</tr>
<tr>
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<td>50/F</td>
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<td>9.5</td>
<td>—</td>
<td>1 PRBC, 3 FFP, 0 Platelet</td>
<td>119</td>
<td>500 ml</td>
</tr>
<tr>
<td>15</td>
<td>36/M</td>
<td>MVR</td>
<td>14</td>
<td>9</td>
<td>150</td>
<td>2 PRBC, 4 FFP, 4 Platelet</td>
<td>125</td>
<td>650 ml</td>
</tr>
</tbody>
</table>

Time (66.6 minutes) was same in both groups. Post-operative average Activated clotting time (119.8 sec) after transfusion of blood was same in both groups.

### Conclusion

Pre-operative normovolemic hemodilution of autologous blood transfusion is desirable in attempt to reduce or eliminate homologous blood transfusions. No morbidity and mortality has occurred due to this procedure. So cardiac surgery may be successfully performed without the administration of blood or blood products using autologous blood transfusion (pre-operative normovolemic hemodilution) with good surgical outcome.

### Financial support and sponsorship
Nil.

### Conflicts of interest
There are no conflicts of interest.

### References


15. Cardiopulmonary Bypass Edited by Sunit Ghosh,Florian Falter,David J.Cook Chapter 3: Priming solutions for CPB circuits Table 3.2, Page 39


19. Department of Anesthesiology and Perioperative Medicine, Clinical Guidelines: Acute Normovolemic Hemodilution Guidelines for Cardiac Surgery‡ Date: 12-30-2012


23. Alireza Mahoori, Farhad Heshmati, Heydar Noroozinia;et.al. Intraoperative Minimal Acute Normovolemic Hemodilution In Patients Undergoing Coronary Artery Bypass Surgery


Retrospective analysis of ECMO for acute fulminant viral myocarditis – our institutional experience

Selvakumar Rajamani, P.V.S. Prakash, Sam Immanuel, Lavanya R, Cousigan V, Dr Varun Shetty
Narayana Hrudayalaya, Bangalore.

Abstract

Background
The inflammation or degeneration of the heart muscle called myocarditis may be fatal. This disease often goes undetected. It may also disguise itself as ischemic, valvular, or hypertensive heart disease. Here we report 8 cases of acute fulminant viral myocarditis suffering from low cardiac output, ARDS (Acute respiratory distress syndrome) formation and successfully treated by ECMO.

Management
All the cases were admitted in the emergency coronary care unit with severe respiratory distress and poor hemodynamics and ECHO examination revealed low LVEF (15-20%). Patients were electively ventilated and consent taken for instituting peripheral VA ECMO. VA ECMO was initiated with femoro-femoral cannulation with distal limb perfusion. On ECMO support the hemodynamics were stabilized, with no Inotropic support. The heart and lungs were given adequate rest time for recovery by maintaining total cardiac output on ECMO. The average ECMO support was 84.2 Hours ± 4hours. Maquet Quadrox PLS / Sorin Dideco ECMO oxygenators with rotaflow centrifugal pump were used. Delta pressure, pre pump pressures were continuously monitored. NIRS monitoring and online venous saturation were used to optimize perfusion adequacy.

Results
Out of the eight cases put on VA ECMO for viral myocarditis seven were successfully weaned off and were discharged (Success rate of 87.5%). Soon after the initiation of ECMO the SaO2 reaches to normal levels. The serum lactate levels which were high (>6mmol/L) prior to initiation of ECMO remarkably came down to <2mmol/L after 24 hours. Seven patients were weaned off and decannulated in the Operating Room. One patient required LV decompression by Balloon Atrial Septostomy in the Hybrid OR and was successfully weaned off after 48 hours. One patient succumbed due to continuous low cardiac output which was irreversible with full blown septicemia and was not responding to ECMO and medications.

Conclusion
Peripheral VA-ECMO support is very effective in optimizing myocardial recovery for the treatment of refractory acute fulminant viral myocarditis when maximal conventional supports are ineffective.

Keywords
Extracorporeal membrane oxygenation, Fulminant myocarditis, Troponin, ARDS
Introduction

Acute fulminant viral myocarditis is a condition precipitates as heart failure preceded by symptoms of viral infection. The condition can be worse sometimes that it requires immediate mechanical circulatory support ECMO due to the deprived LV function. The inflammation or degeneration of the heart muscle myocarditis may be fatal. This disease often goes undetected. It may also disguise itself as ischemic, valvular, or hypertensive heart disease. Inflammatory processes in the myocardium can directly lead to fluctuations in membrane potential that can trigger recurrent arrhythmias (Complete AV Block, VT/VF). ECMO is a life saving treatment for these types of acute emergencies and has yielded better results in the recent past. The high flow ECMO provides full heart lung support for conditions of low cardiac output and severe respiratory failure ensuring optimal Oxygen delivery to all vital organs. During the ECMO, minimal mechanical ventilation setting and inotropic medications can be stopped so as to avoid further barotrauma and myocardial damage, and active treatment targeting the primary disease can be provided which are vital for heart and lung recuperation. VA ECMO is shown to be effective in treating refractory acute fulminant myocarditis. Timely initiation of VA ECMO is a novel option in treating acute viral myocarditis and we have an experience of 8 cases.

Methods and Patients

Case details

From the period of April 2008 eight cases were admitted in the emergency coronary care unit with severe respiratory distress with poor hemodynamics (SBP ≤ 90 mm of Hg) and ECHO examination revealed low LVEF (15-20%). Five males and three females aged 18 to 36 years (median 23 years) and weighing 49-85 kg (mean 67.3 kg) were included. On examination they had a varied HR in the range of 110-155bpm. Four patients had cool clammy skin with tachypnea. In addition, laboratory data also revealed increased levels of cardiac biomarkers (Creatine kinase MB > 37.0 U/l; Troponin-I > 15.0 ng/ml) and leukocytosis (WBC > 11000/mm3) with mild increased C-reactive protein (CRP > 7.5mg/L). All patients were administered large doses of inotropic support drugs including adrenaline (0.2-1 µg/kg min), and/or Dobutamine (10-20 µg/kg min) prior to ECMO initiation.
Retrospective analysis of ECMO for acute fulminant viral myocarditis – our institutional experience

Treatment

Patients were electively ventilated and consent was taken for instituting peripheral VA ECMO. VA ECMO was initiated with femoro-femoral cannulation with distal limb perfusion. After systemic heparinization 2mg/Kg, ECMO was established at a dose maintaining the activated clotting time (ACT) between 180 and 220 seconds. On ECMO support the hemodynamics were stabilized, with no Inotropic support. The heart and lungs were given adequate rest time for recovery by maintaining total cardiac output on ECMO. The average ECMO support was 84.2 Hours ± 4 hours. Maquet Quadrox PLS (4 cases) / Sorin Dideco ECMO (4 cases) oxygenators with rotaflow centrifugal pump were used. Heparin coated circuit was used in four cases where we used Maquet Quadrox PLS and remaining 4 cases we used non-coated circuit. Peripheral cannulation was achieved with 24 Fr Bard with 8mm hemashield or 20Fr Edwards femoral arterial cannula with 10 Fr distal limb perfusion cannula for arterial cannulation. Monitoring of the pedal temperature, mid calf circumference, color of the limb and hourly Doppler study of the cannulated limb was performed to ensure distal limb perfusion. Venous access was established with 24 Fr long femoral venous cannula. Delta pressure, pre pump pressures were continuously monitored. Routine monitoring during ECMO treatment is vital for the better prognosis of the patients. The routine tests on a daily basis include echocardiography, chest radiography, blood gas analysis, blood coagulation parameters, LFTs, Serum Lactate, Fibrin degradation products, D-Dimers, renal function tests. NIRS monitoring and online venous saturation were used to optimize perfusion adequacy. NIRS was mandatory in all the cases since we didn't want to miss any episode of Harlequin/North south syndrome. Once the cardiac function improved over a period of time (ejections seen on the monitor) ventilator settings were optimized and the ECMO flows are decreased proportionately. Heparin flows are increased as the ECMO flows are brought down. After documenting recovered LVEF > 30% by Echocardiography and the Troponin biomarker starts to descend the decision to wean off ECMO is taken. Two patients were extubated before complete weaning and decannulation of ECMO.

Results

The heart rate, blood pressure, clinical parameters and tissue oxygen saturation significantly improved after ECMO. The average ECMO support was 84.2 Hours ± 4 hours. (48-138 hours). The key results/outcome of instituting VA ECMO in this clinical condition are depicted in graph 1. One patient had LA hypertension for which he had to undergo Balloon atrial Septostomy (BAS). After the BAS procedure his condition improved. Three patients required IABP just before weaning off from ECMO. Out of eight patients, seven patients were successfully weaned from ECMO and survived to hospital discharge, resulting in an 87.5% (7/8) survival rate. One male patient succumbed due to continuous low cardiac output which was irreversible with full blown septicemia not responding to ECMO and medications. During the follow-up period cardiac function was found within the normal range in six patients. One patient who underwent BAS had a mild LV dysfunction with LVEF=42%, with Mild MR. The post ECMO LVEF is depicted in graph 2. There were no other associated co-morbidities found in this particular patient. Four patients developed supraventricular tachyarrhythmia's which was tackled by administering cardarone. Complete One year follow up showed that seven patients are doing well clinically and have resumed their respective professional career. All of the survived seven patients possessed normal neuro cognitive behavior.
Discussion

ECMO offers a very good supportive therapy and a life saving option in these acute emergencies like fulminant viral myocarditis. Timely initiation of the ECMO provides sufficient rest for the heart and lungs to recuperate from the cardiogenic shock triggered by this acute viral myocarditis. The decision to initiate immediate mechanical circulatory support (ECMO) plays a vital role in these scenarios as they are clinically and hemodynamically deteriorating. Early after initiation of VA-ECMO, LV Decompression promotes myocardial recovery and the ECMO flows/cardiac output should be targeted towards maintaining end organ perfusion which can be achieved revolutions per minute on the circuit in order to maximize perfusion. Endomyocardial biopsy is not routinely performed in patients because of the risks of the procedure in patients in critical condition. We have no experience in initiating VAD for these circumstances as most of the cases that were presented to us had early signs of ARDS.

ECMO contributes for the early recovery of myocardium by reducing myocardial wall tension, increasing coronary perfusion pressure, and providing adequate systemic perfusion. During ECMO support, the dose of inotropes can be decreased to prevent overload on the myocardium in the acute stage. Recurrent supra ventricular arrhythmias are frequently seen in these conditions which are encountered with cardarone. Klein et al found that inflammatory processes in the myocardium can directly lead to fluctuations in membrane potential. Ectopic pacemakers, late potentials, and re-entry as a result of inhomogeneous stimulus conduction can develop because of fibrosis and scaring of myocardial tissue, and secondary hypertrophy and atrophy of myocytes. Furthermore, left ventricular dysfunction may aggravate wall tension, increase myocardial oxygen consumption, and diminish coronary reserve, increasing the risk of arrhythmias. ECMO reduces the incidence of recurrent arrhythmias in these conditions by preserving the myocardial reserve.

One patient was suffering from LA Hypertension on the second day of ECMO for which he required Balloon atrial Septostomy. His condition remarkably improved after the BAS and we were able to wean him off on the Sixth day of ECMO. On his one year follow up he was found to have mild LV dysfunction with LVEF>42%, mild MR with no signs and symptoms of heart failure.

Proper ECMO monitoring and periodic assessment of these patients on ECMO has yielded positive results in this critical condition. During the course of ECMO striking a balance between bleeding and Thrombosis is an important aspect of ECMO management. Fluid management is one of the key features in managing these patients on ECMO in order to avoid pulmonary edema, fluid retention and electrolyte imbalances. During the weaning process serial venous blood gases were performed second hourly to assess the mixed venous saturation (>65%) that ensured the adequacy of perfusion. The serum lactate levels which were high (>6mmol/L) prior to initiation of ECMO remarkably came down to <2mmol/L after 24 hours.

Conclusion

VA-ECMO support is very effective in optimizing myocardial recovery for the treatment of refractory acute fulminant viral myocarditis when maximal conventional supports are ineffective.

References


A comparative observational study to assess the effects of three different balanced crystalloid priming solutions on the perioperative parameters and outcome variables in adult patients undergoing cardiac surgery on cardiopulmonary bypass

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Abstract

Background

As the cardiopulmonary bypass system developed, priming solutions were modified and changed with time. Earliest CPB prime was blood, now balanced crystalloid solution is being used by most of the cardiac centers in the world. Balanced crystalloids are the simple isotonic solutions which mimic osmolarity and electrolytes contains of plasma. Balanced crystalloids also contain anions for bicarbonate production like lactate, acetate, maleate, gluconate etc. These anions play a major role in blood pH management by reducing acidosis. Hemodilution with balanced crystalloid solution results in improved capillary blood flow and oxygen delivery and decreased exposure to donor blood.

Methods

This study was performed on ninety (90) patients having coronary artery disease who underwent CABG with cardiopulmonary bypass. Patients were randomly divided into three equal groups of 30 patients each, group A (priming solution was Ringer's lactate), group B (balanced crystalloid solution containing acetate and maleate (Sterofundin)) and group C (balanced crystalloid solution containing acetate and gluconate (Plasmalyte-A)). Arterial blood samples were analyzed and recorded before, during and after the surgery in all three groups. Serum osmolarity, urine output, requirements of blood products, inotropic support, RFTs and LFTs were recorded and compared between the groups.

Results

Group B (Sterofundin) showed higher bicarbonate level (27.26±3.14) and base excess (2.47±2.90) during the perioperative period and had less metabolic acidosis as compared to group A (Ringer's lactate) and group C (Plasmalyte-A). In Group C calcium levels during perioperative period was significantly lower as compared to both group. Lactate levels were higher in Group A and it was found to be normal range in Group B and Group C. RFTs, LFTs, inotropic support and blood requirement showed non-significant difference between the groups.

Conclusion

All three balanced crystalloid solutions are safe to use as priming solutions in adult patients undergoing cardiopulmonary bypass. Balanced crystalloid solution containing acetate and maleate (Sterofundin) or acetate and gluconate (Plasmalyte-A) are more effective in bicarbonate production during perioperative period. Hence, there is no need to add sodium bicarbonate as prime additive when acetate, maleate and gluconate containing solutions are used as priming solution. However caution should be taken for serum calcium levels when priming with Plasmalyte-A.
Introduction

Fluid which is used for de-airing of the CPB circuit is called the priming solution. The priming solutions which are widely used now days are balanced crystalloid solutions. They are called balanced crystalloid because their composition and osmolarity are similar to blood plasma. Priming has many other purposes besides de-airing. To provide sufficient hemodilution. To check leakage in the circuit. To keep the volume level of the reservoir towards the safe side while on CPB. Advantages of hemodilution using crystalloids include, decreased blood viscosity results into improved end organ perfusion and decreased exposure to donor blood.

An ideal priming solution should have the same tonicity, electrolyte composition and pH as that of plasma. “Tonicity” is most important in order to avoid red cell lysis and the fluid shifts. Organs which are most vulnerable to fluid accumulation are the brain and lungs. Intracellular fluid gain causes cerebral or pulmonary edema. Priming solutions can be classified into two categories, i.e. crystalloids and colloids. The former consists of dextrose, balanced crystalloid fluids, and mannitol, and the latter consists of albumin, dextran, gelatins, and hydroxyethyl starch. Crystalloids can be used as clear priming solutions resulting in effective hemodilution but they lack oncotic activity. On the contrary, colloids have the advantage in maintaining the colloid oncotic pressure and reducing tissue edema. However, colloids have been associated with increased incidence of anaphylactic reactions and clinical coagulopathy.

Ringer’s lactate has an osmolarity of 273 mOsm/L. The lactate is metabolized into bicarbonate by the liver, which counteract metabolic acidosis. It is useful in long bypass because lactate has long term buffering capacity. Advantage of acetate over lactate: Acetate is metabolized widely throughout the body, is not reliant entirely on hepatic metabolism and is metabolized more rapidly than lactate [1].

Acetate metabolism does not result in changes in glucose or insulin concentrations, whereas exogenously administered lactate can be converted to glucose via gluconeogenesis resulting in hyperglycemia [2].

Table 1: Showing Constituents of balanced crystalloid solutions compared to plasma. (mmol/L) [3]

<table>
<thead>
<tr>
<th>Electrolyte</th>
<th>Plasma</th>
<th>Ringer’s lactate</th>
<th>Plasma-Lyte A</th>
<th>Sterofundin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium</td>
<td>140</td>
<td>131</td>
<td>140</td>
<td>140</td>
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<tr>
<td>Potassium</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>4</td>
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<tr>
<td>Chloride</td>
<td>100</td>
<td>111</td>
<td>98</td>
<td>127</td>
</tr>
<tr>
<td>Calcium</td>
<td>2.2</td>
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<td>Magnesium</td>
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<td>Bicarbonate</td>
<td>24</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Lactate</td>
<td>1</td>
<td>29</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Acetate</td>
<td>0</td>
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<td>27</td>
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</tr>
<tr>
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<td>0</td>
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<td>23</td>
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</tr>
<tr>
<td>Maleate</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Osmolality</td>
<td>285</td>
<td>273</td>
<td>294</td>
<td>309</td>
</tr>
<tr>
<td>pH</td>
<td>7.35</td>
<td>6.5</td>
<td>7.4</td>
<td>5.9</td>
</tr>
</tbody>
</table>
Methods

This study was performed on 90 adult patients of either sex undergoing Coronary artery bypass grafting (CABG) in the range of 51 to 70 years of age with weight not less than 50 Kg. The patients were randomly divided into three groups A, B and C, each containing 30 patients.

In group A (n=30), the solution for priming the CPB circuit was Ringer's lactate.

In group B (n=30), the solution for priming was a balanced crystalloid solution containing acetate and maleate (Sterofundin).

In group C (n=30), the solution for priming was a balanced crystalloid solution containing acetate and gluconate (Plasmalyte-A).

Intra venous (IV) fluid was same according to the group.

Exclusion criteria

- Patients with prior surgery.
- Patients having any renal dysfunction (patient with blood urea > 30 mg/dL and/or creatinine > 1.6 mg/dL).
- Patients having preoperative hepatic dysfunction (elevated serum bilirubin or elevated SGOT, SGPT).
- Patients with very low preoperative hematocrit (Hct<25%).
- Patients with low left ventricle ejection fraction (LVEF < 30%).

Conduct of bypass

The induction and maintenance of anaesthesia was standardized. The same general anesthesia protocol was followed for both the groups.

CPB was performed with amembraneoxygenator (Capiox-SX18) manufactured by TERUMO cardiovascular group 6200 (Jackson Road Ann Arbor, MI 48103-9300 USA) with a non-pulsatile flow 2.0 L/min/m² (hypothermic) to 2.4 L/min/m² (normothermic) using a twin roller pump (Sarns, 8000 USA) heart lung machine at mild hypothermia (32-35°C).

Additives to the prime were mannitol (1g/kg body weight), Heparin (500 units/100 ml of priming solution), Sodium bicarbonate (1ml/kg body weight).

Priming volume of the circuit was 1200 mL to 1500 mL. Use of homologous blood was avoided as much as possible. Haemofilter was used in cases to remove excess water, to correct hyperkalemia and also used in long bypass.

Activated clotting time (ACT) of more than 480 seconds and hemoglobin of 9 to 10 g/dl were maintained throughout the CPB in all three groups. The myocardial preservation consisted of cold blood delNido solution based blood: crystalloid cardioplegia and hypothermia.

Arterial blood sample were done 15 min before CPB, after 5 minutes of applying aortic cross clamp, after 5 minutes of release of aortic cross clamp and 15 min of bypass.

After the surgery, the patients were rewarmed to nasopharyngeal temperature of 35°C. Surgical hemostasis was achieved before the administration of protamine sulphate. At the termination of CPB, anticoagulation was reversed with protamine sulphate to obtain a baseline ACT of <125 seconds. Dose of protamine sulphate was 1.3 mg for every 100 U of heparin administered.

Table 2: Showing demographic data

<table>
<thead>
<tr>
<th></th>
<th>Group A (n=30)</th>
<th>Group B (n=30)</th>
<th>Group C (n=30)</th>
<th>p-value</th>
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<tr>
<td></td>
<td>(Ringer’s lactate)</td>
<td>(Sterofundin)</td>
<td>(Plasmalyte-A)</td>
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<tr>
<td>Age (years)</td>
<td>61.20±6.33</td>
<td>60.1±5.58</td>
<td>59.76±5.77</td>
<td>0.621</td>
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<tr>
<td>Weight (Kg)</td>
<td>61.27±9.42</td>
<td>65.96±13.01</td>
<td>67.33±8.33</td>
<td>0.072</td>
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<tr>
<td>BSA (m²)</td>
<td>1.61±0.14</td>
<td>1.69±0.19</td>
<td>1.71±0.17</td>
<td>0.088</td>
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<tr>
<td>Priming volume(ml)</td>
<td>1446.20±75.51</td>
<td>1427.58±28.61</td>
<td>1443.44±71.67</td>
<td>0.473</td>
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<tr>
<td>Cardioplegia volume(ml)</td>
<td>1217.24±144.09</td>
<td>1228.33±165.92</td>
<td>1303.33±135.14</td>
<td>0.058</td>
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</tbody>
</table>

*mean±standard deviation values are taken for analysis, p-value<0.05 is statistically significant BSA-body surface area
Analysis

The following pre-operative, peri-operative and post-operative parameters were recorded.

**Pre-bypass** - Hematocrit, Body Surface area, Arterial blood pressure, Right atrial pressure, Blood gas values (pH, pO2, pCO2, spO2%, K+, Na+, Ca2+, Hct, Hb, lactate), Renal function test (RFT), Liver function test (LFT), osmolarity.

**On-bypass** - Bypass time & aortic cross clamp time, Hematocrit, Mean Perfusion Pressure, Right atrial pressure, Heart rate, Blood gas values (pH, pO2, pCO2, spO2%, K+, Na+, Ca2+, Hct, Hb), Blood product requirements, Sugar, lactate, osmolarity, Urine output.

**Post-bypass** - Mean arterial pressure, right atrial pressure, heart rate, blood gas values (pH, pO2, pCO2, spO2%, K+, Na+, Ca2+, Hct, Hb), Blood product requirements, Sugar, lactate and urine output at an interval of 1, 6, 12 and 24 hours in ICU.

Liver function tests (LFTs) (albumin, transaminase, bilirubin test), renal function tests (RFTs) (creatinine test, blood urea test) on day 1 of ICU stay.

Inotrope supports, Ventilation time, Number of packed RBC, FFPs and platelet transfusion up to 24 hours of ICU stay.

**Statistical analysis**

Data was analyzed by statistical software “IBM SPSS Statistics 20”. Qualitative data expressed as frequency and percentage and quantitative data expressed as mean ± SD or median (min-max) as appropriate. RM-ANOVA followed by bonferroni was used to compare change among the groups. One way ANOVA was used followed by bonferroni. P<0.05 considered as significant. Table 2 showing all demographic data were found to statistically non-significant between the three groups.

![Figure 1: Showing variation in the pH with respect to time between the groups](image)

*Ph0- Baseline, PH1- at 5 minute after cross clamp, PH2- at 5 minute after release of cross clamp, PH3- at 15 minute after bypass, PH4- at 1st hour in ICU, PH5- at 6th hour in ICU, PH6- at 12th hour in ICU, PH7- at 24th hour in ICU

Figure 1 shows lower pH in the case of group B after bypass compared to group A and B. Lower pH in group B after bypass might be because of acidic nature of sterofundin solution.
Figure 2: Showing variation in the bicarbonate level with respect to time between the groups

**Figure 2**: Showing variation in the bicarbonate level with respect to time between the groups

*BIC0- Baseline, BIC1- at 5 minute after cross clamp, BIC2- at 5 minute after release of cross clamp, BIC3- at 15 minute after bypass, BIC4- at 1st hour in ICU, BIC5- at 6th hour in ICU, BIC6- at 12th hour in ICU, BIC7- at 24th hour in ICU

Figure 2 shows bicarbonate level were higher and maintained during perioperative period in group B and C. During perioperative period group B showed higher bicarbonate levels compared to group A and C. During postoperative period, bicarbonate level were similar in all group, group A showed lower bicarbonate level compared to group B and C.

Figure 3: Showing variation of calcium (mmol/L) with respect to time

**Figure 3**: Showing variation of calcium (mmol/L) with respect to time

*Ca2+0- Baseline, Ca2+1- at 5 minute after cross clamp, Ca2+2- at 5 minute after release of cross clamp, Ca2+3- at 15 minute after bypass, Ca2+4- at 1st hour in ICU, Ca2+5- at 6th hour in ICU, Ca2+6- at 12th hour in ICU, Ca2+7- at 24th hour in ICU

Figure 3 shows decreased level of calcium in group C during perioperative period and at 15 minute after bypass. Calcium levels were normal and maintained in group A and B.

Calcium level was significantly lower in group C might be because of Plasmalyte-A (priming fluid in group C), which is a calcium free solution.
Results
Three groups were comparable in terms of the demographic data of age, weight, BSA, priming volume and total cardioplegia volume.

Figure 4 showing that there were significantly increased level of lactate in both perioperative and postoperative period up to 24th hour in group A.

From graph, we can see that lactate level tend to increase from onset of bypass to end of bypass. The graph showed, lactate level is also increased in group B and C but that is insignificant.

Higher lactate levels raised in group A might be because of sodium lactate which is used for bicarbonate production in Ringer's lactate solution.

Discussion
This study showed that the solution containing acetate and maleate (Sterofundin) and the solution containing acetate and gluconate (Plasmalyte-A) both are effective with respect to bicarbonate level during perioperative period. But solution containing acetate and maleate (Sterofundin) showed higher level of bicarbonate compared to solution containing acetate and gluconate (Plasmalyte-A).

Balanced crystalloids are isotonic solutions contain either hydrochloric acid or sodium hydroxide to normalize pH. They contain large amount of unmeasured anions in the form of Acetate (27 mEq/L) and Maleate (4mEq/L) in Sterofundin and Acetate (27 mEq/L) and Gluconate (23 mEq/L) in Plasma-Lyte A. These anions create high strong ion difference (SID) value. Crystalloid with SID > 24 mEq/L will lead to a progressive alkalotic state after start of bypass.

Alston RP et al. [4] in his study he found that the metabolic acidosis developing during CPB is partially the result of iatrogenic decrease in strong ion difference (SID) rather than hypoperfusion, as estimated by lactate concentration, or haemodilution.

In our study, after 10 minutes of bypass, base excess levels (2.72±1.75) were more in group B (Sterofundin). This showed better bicarbonate production in group B (Sterofundin) during perioperative period. This is because bicarbonate production from lactate occurs only in liver but bicarbonate production from acetate occurs at sites other than liver also for example in skeletal muscles. So lactate requires more time to metabolize into bicarbonate than acetate.

From this study, we can say that there is actually no need of adding sodium bicarbonate in priming in which solutions containing acetate and maleate (Sterofundin) or solutions containing acetate and gluconate (Plasmalyte-A) are used as priming fluid. They avoid the development of acidosis at the start of bypass.

(Plasmalyte-A) is beneficial with respect to bicarbonate level and maintaining pH but on the other way, it can cause bleeding issue, can hamper hemostasis in postoperative period because from this study it was observed that there were significantly low level of calcium (0.89±0.16) after bypass in patients who received (Plasmalyte-A) in priming solution, and normal serum calcium levels are important for clotting to occur.

In our study, calcium levels in Group B (Sterofundin) were found to be in normal range and maintained during perioperative period.
Chakraborty A et al. [5], has found that patients who received Sterofundin (solution containing acetate and maleate) maintained adequate calcium levels during bypass.

In our study, it was observed that patients who received Ringer's lactate as priming solution showed significantly increased level of lactate from perioperative to postoperative period.

Serum osmolarity of patients in group A patients who received Ringer's lactate were found to be lower during perioperative period and early postoperative period of one hour. This is because lower osmolarity of Ringer's lactate solution. Serum osmolarity in group B (Sterofundin) and C (Plasmalyte-A) were found to be in the normal range.

Others parameters like inotropic support, RFTs, LFTs and blood products (packed RBC and FFP) required during postoperative period of 24 hours were found non-significant.

Platelet transfusion was less in group B patients who received Sterofundin in priming solution showed good platelet conservation and better hemostasis.

**Conclusion**

All three balanced crystalloid solutions- Ringer's lactate, solution containing acetate and maleate (Sterofundin), solution containing acetate and gluconate (Plasmalyte-A) are safe to use as priming solution for cardiopulmonary bypass in adult patients.

From this study, it is found that the calcium and bicarbonate levels were better and maintained in the group having a solution containing acetate and maleate (Sterofundin).

Metabolic acidosis was comparatively less in Group B and Group C having Sterofundin and Plasma-Lyte A respectively.

Sterofundin is beneficial with its buffering capacity, gives good bicarbonate level during perioperative period and does not require addition of sodium bicarbonate in priming.

(Plasmalyte-A) also showed normal bicarbonate but lower calcium levels during perioperative period because it is a calcium free solution, so it can cause increased bleeding during postoperative period. Care should be taken after priming with Plasma-Lyte solution with concern for serum calcium levels in adult patients.

Lactate levels were significantly increased in group A patients who received Ringer's lactate during perioperative period and postoperative period. Care should be taken in patients with diabetes because increased lactate can be converted into glucose by Cori cycle and can worsen the hyperglycaemia in diabetic patients.

**References**

5. Chakraborty Aet. al, A comparison of Ringer' lactate with acetate and maleate containing crystalloid for priming in adult patients undergoing cardiopulmonary bypass, IJECT, 2015:2231-0673
Descending thoracic aortic aneurysm repair using distal perfusion technique - a case report

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Abstract
Aneurysmal disease of aorta accounts for 1-2% deaths in India. 40% of patients are asymptomatic. Open repair of the descending thoracic aorta and thoracoabdominal aorta remains a challenging procedure. In our center, we had performed 15 descending thoracic aortic aneurysm repair in the last 1 year. Challenges related to perfusion support of descending thoracic aortic repair includes maintenance of distal aortic perfusion, rapidity of fluid resuscitation, avoidance of hypothermia and hemodilution. So, we had chosen ON PUMP BEATING heart procedure with normal temperature range for most of the procedures. This technique required oxygenators and heparinization. Clearing the problematic knots of perfusion will help to decrease the morbidity and mortality rate of descending thoracic aortic aneurysm repair.

Key Words
Crawford classification, descending thoracic aortic aneurysm surgeries, distal perfusion technique, hemodynamic management.

Introduction
Aneurysm, widening of an artery that develops from the weakness or destruction of medial layer of the blood vessel. Aortic aneurysm are site dependent. Hereby, descending thoracic aortic aneurysm incident rate is about 35%. Crawford classification - type 1 involves most of the descending thoracic aorta from the origin of the left subclavian to the suprarenal abdominal aorta; type 2 is the most extensive, extending from the subclavian to the aorta iliac bifurcation; type 3 involves the distal thoracic aorta to the aorta iliac bifurcation; type 4 are limited to the abdominal aorta below the diaphragm; type 5 , which extends from the distal thoracic aorta including the celiac and superior mesenteric origins but not the renal arteries . Aim of the surgical treatment is to replace the aneurysmal aorta with normal sized prosthetic graft, preserving and restoring distal perfusion. Intraoperative hemodynamic management is onerous and exemplifies the high risk content. Partial cardiopulmonary bypass helped us to maintain the cerebral perfusion and arterial cannula in the femoral artery provided distal perfusion to the lower extremities, spinal cord, and splanchnic viscera.

Case History
47/ female, presented with chest pain for 2 months.
Comorbid illness: type 2 diabetic mellitus (not on drugs).
Pulse rate-100/min, blood pressure -120/80 mmHg.
Drugs taken: Atorvastatin, Envas, Metoprolol.

Investigations
Blood group – O POSITIVE,
Hb-11.6 g/dl,
Random blood sugar-130 mg/dl, blood urea- 20, serum creatinine-0.5

ECHO reports
AR mild / no aortic stenosis.
No PHT
No pericardial effusion / clot
• Normal left ventricular systolic function.
• EF- 68%
• Descending thoracic aorta dilated – 57*51 mmHg (A4C)

CT Angiography

Aneurysm involving the distal arch and descending aorta measuring a maximum of 9.6 (antero posterior) x 8.7 cm (transverse) x 15 cm (cranio caudal) with partial thrombosis in the mid and distal descending aorta causing 50-60% occlusion. There was no involvement of aortic valve, coronary arteries, and pericardium.

This case was presented with type 1 Crawford classification which involves most of the descending thoracic aorta from the origin of the left subclavian to the suprarenal abdominal aorta. Open aneurysm repair with Dacron graft was done for this patient. Invasive monitoring sites - right radial artery, right femoral artery, pulmonary artery catheter. Intraoperative management included one lung ventilation by right endobronchial tube and CSF drainage.

Extracorporeal circulation with cardiopulmonary bypass for distal perfusion was proceeded. 18 fr femoral arterial cannula and 32/40 Fr dual stage single venous cannula were used. On pump beating heart procedure was followed with mild hypothermia (30 degree Celsius). Preload to the heart was maintained by clamping the venous line intermittently so that adequate cerebral perfusion was ensured. Simultaneously, the arterial blood flows were adjusted according to the venous return to the reservoir.

Maintained Pressures

Proximal arterial pressure- 50 -70 mmhg, distal arterial pressure- 50 -60 mmhg, pulmonary wedge pressure – 25-30 mmhg.

Hematocrit was maintained around 23%. Drugs such as sodium bicarbonate (to correct the acidosis), furosemide and mannitol limited the renal dysfunction. Inotropes and vasodilators were used. There was adequate urine output during the procedure.

Discussion

• Extracorporeal circulation during thoracoabdominal aortic aneurysm repair for all extents of Crawford classification can be done with this distal perfusion technique. This form of cardiopulmonary bypass in conjunction with deep hypothermic circulatory arrest may be necessary to repair descending thoracic aortic aneurysm that involve the aortic arch. In this case, distal arch was not repaired or replaced (surgeon's concern) so we maintained the temperature of 30 degree throughout the procedure. This temperature range prevented ventricular fibrillation and several other complications.

• Fluid resuscitation problems can be overcome by the use of cell savers. Heparinization requirement can be reduced by using the heparin coated circuits for extracorporeal circulation. Distal perfusion technique along with cerebrospinal fluid drainage helped us to decrease the distal organ damage and decrease the rate of neurologic deficits respectively. Inspite of CPB complications, all the vital organs such as brain, liver, kidneys were well protected by this distal perfusion technique and it was periodically assessed throughout the procedure. We consciously corrected the metabolic acidosis to prevent further other complications. As there was high risk of cardiac arrest, purse strings were taken on the aorta as a safety measure. Venous drainage was obtained using dual stage single venous cannula placed in right atrium, thereby venous return was adequate to the reservoir. Femoral arterial cannulation was made for distal perfusion and hemodynamic changes were encountered as such follows:

Conclusion

This profile set up will help in all types of descending thoracic aortic aneurysm with maximum extents of Crawford classification 1 and 2. Additional cannulas can be inserted and incorporated with a y connector to provide perfusion to the renal, celiac and superior mesenteric arteries separately. It provides complete control for all the scenarios which may appear during the complications.
### References

1. Nienaber CA, Von Kodolitsch Y, Nicolas V. The diagnosis of thoracic aortic dissection by noninvasive imaging procedures.
3. Shenaq SA, Svensson LG. Paraplegia following aortic surgery.
5. O’Connor CJ, Rothenberg DM. Anesthetic considerations for descending thoracic aortic surgery: part II.

### Table

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<tr>
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<th>PULMONARY WEDGE PRESSURE</th>
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<td>decreases</td>
<td>decreases</td>
<td>decreases</td>
<td>Volume; increase pump flow</td>
</tr>
<tr>
<td>decreases</td>
<td>decreases</td>
<td>increases</td>
<td>Increase pump flow</td>
</tr>
<tr>
<td>increases</td>
<td>increases</td>
<td>decreases</td>
<td>Volume; vasodilator</td>
</tr>
<tr>
<td>increases</td>
<td>increases</td>
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<td>Vasodilator; diuretic; maintain pump flow; hold volume in pump reservoir.</td>
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<th>PULMONARY WEDGE PRESSURE</th>
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<td>decreases</td>
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<td>decreases</td>
<td>Volume; look for partial occlusion of arterial cannula.</td>
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<tr>
<td>decreases</td>
<td>decreases</td>
<td>increases</td>
<td>Increase pump flow; inotrope</td>
</tr>
<tr>
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<td>increases</td>
<td>increases</td>
<td>Decrease pump flow; inotrope; diuretic</td>
</tr>
<tr>
<td>decreases</td>
<td>increases</td>
<td>decreases</td>
<td>Decrease pump flow; may need volume.</td>
</tr>
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### Diagram

![Diagram of blood flow and pressures](image-url)
International aeromedical transportation of adult VV-ECMO: case report

Niranjan Yeslur Chandrashekar, Ibrahim Fawzy Hassan, Ibrahim, Irshad Ehsan
Hamad General Hospital, Doha, Qatar

Abstract
Refractory severe hemodynamic or respiratory failure and referral transplant patient may require extracorporeal membrane oxygenation (ECMO). Some patients are too sick to be transported safely to a referral ECMO center and referral transplant unit on conventional transportation due to time and distance. The experiences of some ECMO transport teams have already been reported, including air and international transport. We report the first Qatar adult international VV-ECMO transport by air ambulance. This case shows that a long distance of the adult VV ECMO transport team is safe, even in an international setting.

Keywords: ECMO, ARDS, ILD.

Introduction
Refractory severe hemodynamic or respiratory failure and referral transplant patient may require extracorporeal membrane oxygenation. However, we report our first experience on international aero medical transport of adult VV ECMO case. The patient was transported from Doha Qatar. The total distance was 3300 km and total time of journey was 08 hours from hospital to hospital.

Case History
A 48 year old Pakistani male Patient known case of Interstitial Lung Disease (ILD) and waiting to perform lung Transplant in India. However he developed shortness of breath and admitted in emergency, Diagnosed as Left Sided Pneumonia thorax and Acute Respiratory Syndrome (ARDS). He was intubated and mechanical ventilation initiated. The patient was started empirically on antibiotic and steroids, despite all measures adapted by conventional ventilation, including prone position the patient was persistently having severe respiratory acidosis and increased CO2. Hence a decision was made to initiate ECMO.

The patient was heparinized systemically with 5000 iu before cannulation and cannulated with 25 fr multi stage cannula on right femoral vein as access and 23 fr multi hole cannula on left femoral vein as return. The patient supported on ECMO by using Cardio help(Maquet) HLS machine with coated circuit. Patient stabilized hemodynamically and the ECMO flow maintained 4 L/min, RPM 2700, access pressure 61, Trans membrane pressure 19, sweep 5 liter and 100% FiO2. Membrane function confirmed by checking the pre and post oxygenator ABG. X–Ray was done to confirm the position of the cannula. Hb maintained more than 10, platelet count >50000, PTT more than 1.5 time than normal range. Ventilation setting minimal support of pressure control ventilation with rate of 10 / min, pressure control 10 cm H2O, PEEP 10 cm H2O & Fio2 21 %. The patient supported on ECMO for 44 days in Hamad General Hospital.

The ECMO circuit was changed two times within 44 days of support in Hamad general hospital. The first time was changed on 23 days of ECMO support, because of membrane failure. Immediately after changing the circuit we noticed the technical problem of new
membrane (access pressure -186 mmHg, pre membrane pressure 38 mmHg, post membrane pressure 139 mmHg & trans membrane pressure -101) i.e. membrane pressure sensor defect. So we decided to monitor pressure manually by using x2 monitor (Philips) for pre & post membrane, access pressure by Medtronic monitor system. Second time changed on 43 days of ECMO support before transporting the patient.

Patient stabilized hemodynamically & decided to transport the patient to Apollo hospital Chennai, India. Arranged air ambulance from flight ambulance service international, Germany (a member of aviation group) dedicated air ambulance service. Preparation before transporting the patient included selection of team. The team included ECMO Consultant, Perfusionist, Respiratory therapist, ECMO Nurse & CCP. Calculation of transportation time (08 hrs) & Distance (3300 km) from hospital to hospital. Oxygen requirement calculation (fig.1), preparation of patient emergencies i.e.; CPR (Lucas chest compression system), external defibrillator, emergency medication & blood products. Preparation of circuit emergencies i.e.; membrane failure, console failure, air embolism in the circuit, electric failure. (Fig.2)

The patient was transported from hospital to airport by wheel ambulance. Before transporting from the hospital we confirmed with HMC aeromedical transportation checklist. (Table.3). During transport patient was sedated, the ECMO flow maintain 3.7 L/min, rpm 2600, sweep 2 l/min, access pressure -60 & trans membrane pressure 19 mmHg. Oxygen supply was by using the E tank oxygen cylinder.

<table>
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<tr>
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<th>PRESSURE (PSI)</th>
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<td>500 (RESERVE)</td>
<td>750</td>
</tr>
<tr>
<td>1</td>
<td>140</td>
</tr>
<tr>
<td>2</td>
<td>70</td>
</tr>
<tr>
<td>3</td>
<td>46</td>
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E - Cylinder (O2) Estimated Tank Duration in Minutes (0.28 x PSI/LPM)

Perfusionist Checklist For Aeromedical Transport

<table>
<thead>
<tr>
<th>MACHINE CHECKLIST</th>
<th>TROUBLE SHOOT CHECKLIST</th>
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<tbody>
<tr>
<td>Cardio help console &amp; power cable</td>
<td>Membrane &amp; ECMO circuit</td>
</tr>
<tr>
<td>Hand crank</td>
<td>Priming plate</td>
</tr>
<tr>
<td>Gas blender with adaptor &amp; oxygen cylinder</td>
<td>Priming check list</td>
</tr>
<tr>
<td>ACT &amp; ABG machine, cartridge &amp; power cable</td>
<td>Normal saline 1000 ml, 2 pcs</td>
</tr>
<tr>
<td>Electrical extension</td>
<td>Heparin</td>
</tr>
<tr>
<td>Tie gun &amp; cable tie</td>
<td>50 cc syringe, 20 cc syringe</td>
</tr>
<tr>
<td>ECMO record sheet</td>
<td>Pigtails, Smart site</td>
</tr>
</tbody>
</table>
Estimated O2 Tank Duration Calculation.

Oxygen Cylinder Conversion Factors

- D Tank = 0.16
- E Tank = 0.28
- G Tank = 2.41
- H/K Tank = 3.14
- M tank = 1.56

Duration of Flow = Oxygen Tank Conversion Factor x Remaining Tank Pressure (psi)
Continues Oxygen Flow/ min

Challengers during transport.
Many challengers faced to transport the patient.

- During preparation we couldn't visit the air ambulance service settings because of airport safety. We confirmed the availability and settings of air ambulance by telephonic communication and proceed transport preparation.
- The air ambulance oxygen supply connection was different than air oxygen blender used in ECMO console. So we couldn't use the central oxygen supply of air ambulance, instead of that we used E tank oxygen cylinder for transport.
- Electric plug in air ambulance was different than the power cable used in ECMO machine, so we connect the electric supply with help of plug adaptor.
- During take-off, ECMO access pressure was too low between 0 to -5 due to elevation of the patient Head and venous pooling to the lower extremity leading to increase in ECMO flow for few minutes without affecting hemodynamics.
- During the flight, in spite-of high altitude we didn't experience any changes in the PO₂ and PCO₂ due to fully atmospheric control aircraft.
- During landing ECMO venous pressure was high between -80 to -120 due to venous drainage towards upper extremity. Due to fluctuation in the flow, slight changes were noticed in the arterial and venous saturation for a few seconds.
- Due to Chennai Intl. Airport Policy, all small private aircraft are diverted to domestic terminal once wheels down. This posed challenges for immigration formalities.

Conclusion

Undertaking our first air ambulance VV-ECMO international transport, demonstrated that the success in treatment, transportation and continuity of care is in part down to the makeup and utilization of the ECMO team model. Despite the numerous challenges and unknown factors involved in the patient transportation, we were able to successfully complete the patient transportation from ICU to ICU, between two countries. Aeromedical transportation of ECMO patient can be safely performed, if adequately pre planned & well prepared with the presence of a well-trained team.

Key messages

Any vehicle / aircraft must have appropriate electrical & oxygen supply capability for ECMO and all other equipment for the duration of the mission.

References

5. Guide line for ECMO transport by Extracorporeal Life Support Organization updated on may 2015.
Perfusion strategy for acute type-A aortic dissection while performing hybrid procedure like concomitant bentall operation with aortic arch replacement with modified frozen elephant trunk procedure

Mrinal Mandal, Dr Jyoti Prasad Kalita, Prof Manuj Kumar Saikia, Dr Akash Handique, Dr Intekhab Alam
Department of CTVS, NEIGRIHMS, Shillong

Abstract

Background

The concomitant Bentall operation [1] and aortic arch replacement combined with frozen elephant trunk (FET) procedure for Stanford Type-A [2] aortic dissection remains a surgical challenge because of its complexity in operative techniques, cardiopulmonary bypass and cardiac anesthesia management which includes optimum cerebral perfusion, hypothermia and myocardial preservation. This hybrid procedure potentially allows a single stage repair of this complex disease avoiding classical two stage operation for the same pathology and possible further complication [3]. A study on this case series aimed to evaluate the safety and effectiveness of modified surgical anesthesia and perfusion strategies for hybrid technique repair of Type-A aortic diseases [4].

Methods

From November 2016 to January 2017, 3 patients (3 males, mean age 43 years) were operated upon. The collapsed endoprosthesis was deployed in the descending aorta through the opened aortic arch and later it was positioned appropriately with the help of TEE and X Ray). The four branched graft segment allowed the replacement of the aortic arch and arch branches individually. Concomitant Bentall procedures were performed in all cases.

Results

The hybrid procedure was successful in all cases. There were no intraoperative death. One patient developed transient neurological deficit. No patients developed paraplegia or paraparesis. The mean CPB time was 260± 20 min, aortic cross clamp time was 180 ± 10 min and lower body ischemia time was 25 ± 5 min. Unilateral SACP time (during the anastomosis of LCCA) and bilateral SACP time were 20± 5 min and 100 ± 15 minutes respectively.

Conclusion

This hybrid surgical procedure demonstrates the superiority over conventional two stage procedure related morbidity and mortality which involves in each stages [5]. The encouraging surgical results could enable this procedure to become the new "standard" therapy for type-A dissection involving repair of the aortic arch and descending aorta.

Key words: Hypertension; Hybrid; Dissection
Introduction

Standford type-A aortic dissection is a lethal condition and remains a surgical challenge. It involves concomitant surgery of the aortic root, ascending aorta, aortic arch, and descending aorta and placement of stent, results in high morbidity and mortality. Several surgical techniques have been introduced, but the optimal approach for these patients still not conclusive.

Three patients with type-A aortic dissection extending to descending aorta have undergone total replacement of the aortic root, ascending aorta and aortic arch combined with transaortic endovascular stented elephant trunk implantation (Frozen Elephant Trunk). Cardiopulmonary bypass (CPB) with moderate hypothermic circulatory arrest (MHCA) was adopted and selective bilateral antegrade cerebral perfusion (SACP) was established for cerebral protection. In this case series study, we report our experience and evaluate the efficacious management strategy.

Materials and methods

From October 2016 to January 2017, three consecutive patients underwent concomitant Bentall procedure with aortic arch replacement with four branched vascutek (Gelweave, Terumo) graft combined with modified frozen elephant trunk repair for Stanford type-A aortic dissection in our institute. All patients were male with an average age of 43 years.

The clinical presentations were anterior retro sternal chest pain, exertional dyspnea and light headedness. One patient had hoarseness of voice probably due to recurrent laryngeal nerve palsy and another patient had numbness and tingling in extremities. All three patients had long history of uncontrolled hypertension.

The routine preoperative investigations of blood including blood sugar, electrolytes, and renal and liver function tests were normal in all patients. Transthoracic echocardiography (TTE) was the initial diagnostic test and all three patients had severe aortic regurgitation with dilated ascending aorta and arch with varying amount of dissecting flap. Trans Esophageal Echocardiography (TEE) was not performed in any patient. As an institute protocol we prefer ECG gated computed tomographic angiography (CT angiography) of heart and great vessels as the next line of investigation. A dual energy and 128-slice multidetector CT machines (Simens) was used and three dimensional “cine” reconstructed images were produced. The definitive diagnosis of aortic dissection were made on identification of two distinct flow lumens separated by an intimal flap. One patient had findings of compression of the true lumen by the false lumen. All three patients had displaced intimal calcification and thrombosed false lumen. One patient had intimal tear at arch and other two had just distal to left subclavian artery. The limit of distal dissection was above the celiac axis in all cases. The average diameter of ascending aorta at Sino tubular junction was 5.8 cm and 6.2 cm at just distal to subclavian artery origin respectively.

Surgical technique

The planned procedure was a hybrid approach in which Bentall procedure for root replacement with SJM Master series Aortic valve Graft, Aortic debranching and 4 Branched plexus graft (Gelatin Impregnated, woven vascular prosthesis) placement for arch with anastomosis of arch vessels to the branches of the graft and endo-vascular stent graft (Zenith dissection endovascular nitinol stent graft) deployment at transected aorta just distal to the subclavian artery.

Anesthesia was induced and maintained according to accepted standard procedures. Standard invasive arterial blood pressure monitoring line and a jugular bulb catheter was introduced. Near-infrared spectroscopy sensors were placed for assessing adequacy of brain perfusion. A median sternotomy was performed. A 8 mm Gore-Tex graft was anastomosed to axillary artery and another end of the graft was connected with 3/8 inch arterial line via 3/8-¼ inch straight connector. Two stage single venous cannulation, and the left ventricle was vented through the right superior pulmonary vein and through mitral valve. Routine CPB was established and selective right SACP were obtained. The arterial line was bifurcated; one line was used for the right axillary artery and the other line was bifurcated into two branches for antegrade cerebral perfusion through left common carotid (LCC) artery and perfusion through side branch of the four-branch plexus graft respectively.

The ascending aorta was clamped and proximal ascending aorta was longitudinally opened, and antegrade custodial cardioplegia solution[6] was infused at coronary ostia. The Bentall operation was performed with 25mm aortic valve conduit and cooling was started. The patient placed in the Trendelenburg position. Innominate artery was proximally clamped and started
SACP through RCCA at the flow rate of 30% of CO at MHCA (nasopharyngeal temperature 24-25°C).

The arch was opened longitudinally. Bilateral SACP were initiated through left common carotid artery by cannulating with 4 mm Endotracheal tube with cuff at the flow rate of 40 % of CO with SACP pressure at 60 to 80 mmHg. Cerebral perfusion flow rate was adjusted based on NIRS value of +/- 20 % of base line value and rSO2 is maintained around 60 % to 80 %. The protocol followed for optimum cerebral and myocardial protection is standardized (Table 1).

We used the Zenith Dissection Endovascular Nitinol covered Stent Graft which is composed of self-expanded metal stent and graft, sizes of 26 mm in diameter, and 20 cm in length. The size was determined by surgeons and radiologist appropriately according to the preoperative CT images. Initially a guide wire was inserted through left femoral artery to the true lumen of aorta with the guide of C-arm image scanning intensifier. Once it was inserted into the aimed position, a pulling rod was pulled and the covered stent expands by itself. The proximal end of the prosthetic graft was firmly anastomosed to the transected aortic wall (adventitia and pruned intimal flap), incorporating the stented graft using the “open” aortic procedure without pledgets or Teflon-felts. The distal end of the stented graft ends just above the celiac artery. During this anastomosis lower body perfusion was initiated through 18G Foley’s catheter and continued the perfusing through the side limb of the four-branch prosthetic graft with half of the normal flow immediately following the distal anastomosis.

Then the sequence of anastomosis to the prosthetic graft was carried out from the distal (prosthetic graft to stent graft), proximal (prosthetic graft to aortic valve graft), left subclavian artery, left common carotid artery and innominate artery. After the distal and proximal anastomosis, myocardium was perfused as well as lower body perfusion though side branch of plexus graft. The brain was perfused bilaterally selectively. CPB gradually resumed to its normal flow and rewarming was started. Deairing was done through aortic root vent and after appropriate hemostasis, electrolyte acid base balance and appropriate ventilation came off from CPB.

Perfusion equipments & techniques:
- Heart Lung Machine – Maquet Hi20
- Continuous Autotransfusion System - Fresenius CATS
- TCM – Sarns
- NIRS Machine – Casmed (For-esight)
- Oxygenator – Maquet Quadrox-I Adult
- Cardioplegia Device – Myotherm (Medtronic)
- Hemoconcentrator – Nippro

These following measurements are the main indicator of adequacy of perfusion and ultimately improve the quality of life.

1. MAP was maintained 60-70 mmHg
2. Urine output was measured frequently, total urine output during CPB was 2.3 lit.
3. Serum Lactate was maintained at less than 3 mmol/L
4. Hemoconcentration was done and final output was 2.1 lit.
5. Venous oxygen saturation was measured every 45 minutes interval through ABG machine and it was maintained at average range of 65-75 %.
6. NIRS value was kept at the range of 60-80 %.
7. Balanced Priming volume -1 Lit (RL-500ml, 6% Hydroxy-ethyl starch-250 ml, Manitol-100ml, Paracetamol-100ml, Sodium Bicarbonate-50ml)

Picture 1:
A. Showing dissecting intimal flap in ascending aorta.
B. Selective antegrade cerebral perfusion through left common carotid artery with 4mm endotracheal tube.
C. Four limb plexus graft (Green arrow) in situ after distal anastomosis with establishment of CPB with a side graft for lower body.
D. Plexus graft in situ after completion of the procedure.
Results
The hybrid procedure involving stent graft deployment was successful in all cases. There were no intraoperative deaths. Postoperatively, one patient developed transient neurological deficit. No patients developed paraplegia or paraparesis. The mean CPB

<table>
<thead>
<tr>
<th>Cerebral Protection</th>
<th>Myocardial protection</th>
<th>CBF &amp; CPP</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Unilateral SACP flow-30% of CO</td>
<td>• Custodial</td>
<td>• CBF = 50ml/100g/min (Avg. adult brain weight 1400g.)</td>
</tr>
<tr>
<td>• Bilateral SACP flow-40% of CO</td>
<td>• Ischemia tolerance : 180 mins</td>
<td>• CBF is 700ml/min (15% of the resting CO)</td>
</tr>
<tr>
<td>• SACP Pressure-60 to 80 mmHg</td>
<td>• Perfusion time: 6-8 mins</td>
<td>• CMRO2 -3.3ml/100g/min</td>
</tr>
<tr>
<td>• NIRS value of +/- 20 % of base line value</td>
<td>• Perfusion volume: 1.5 liter</td>
<td>• CPP = MAP – ICP (ICP is 0-13mmHg, CPP, normally 80mmHg)</td>
</tr>
<tr>
<td>• rSO2 is maintained around 60 % to 80 %</td>
<td>• Perfusion pressure : 110 -120 mmHg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Temperature of solution : 5 to 8 c</td>
<td></td>
</tr>
</tbody>
</table>

Table 2: CPB data

<table>
<thead>
<tr>
<th>Total number of patients</th>
<th>(n = 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procedure performed</td>
<td>Bentall procedure + four limb plexus graft placement + endovascular stenting of descending thoracic aorta</td>
</tr>
<tr>
<td>Cardiopulmonary bypass time (CPB)</td>
<td>260± 20 min</td>
</tr>
<tr>
<td>Aortic cross-clamp time (X-clamp)</td>
<td>180 ± 10 min</td>
</tr>
<tr>
<td>Unilateral SACP time</td>
<td>20 ± 5 min</td>
</tr>
<tr>
<td>Bilateral SACP time</td>
<td>100 ± 15 min</td>
</tr>
</tbody>
</table>
time was 260± 20 min, aortic cross clamp time was 180 ± 10 min and lower body ischemia time was 25 ± 5 min. Unilateral SACP time (during the anastomosis of LCCA) and bilateral SACP time were 20 ± 5 min and 100 ± 15 minutes respectively (Table 2). The mean follow up period was 6 months.

Discussion

Complex thoracic aortic disease involving the ascending aorta, the aortic arch and the descending aorta still represents a challenge for the cardiothoracic surgeon and surgical team includes physicians and all other allied health staff including x-ray tech, nurses and perfusionists. In patients with extensive aortic aneurysms and dissection, classically, a two-stage operation was performed [7]. In the first stage, the ascending, as well as the aortic arch, was replaced through a median sternotomy. In the second stage, the descending thoracic aorta was replaced through a lateral thoracotomy. In 1982, Dr. Hans-Georg Borst introduced the 2-stage elephant trunk technique, which has greatly facilitated surgical treatment of this special pathologic entity.[8] A significant disadvantage of this approach was the need for two operations with their associated mortality and morbidity and risk of rupture of the untreated segment of the aorta before second operation. A single-stage operation either through a clamp-shell incision or a combined median sternotomy and a lateral thoracotomy to repair the aortic arch as well as the ascending aorta is quite invasive for the patient and technically difficult for the surgeon and as such has been followed only by few centers[9,10].

The endovascular stent graft technology introduced by Dakeet al. in 1998 has facilitated the treatment of the descending aorta[11]. A combination of the classic 'elephant trunk' technique and the endovascular stent technology resulted in the so-called frozen elephant technique[12,13]. The inventor of the classic elephant trunk technique, Hans-Georg Borst, named this approach the Frozen Elephant Trunk (FET), which has been increasingly in use since the late 1990s. The ascending aorta along with the aortic arch is replaced conventionally and an endovascular stent graft is placed into the descending aorta in the antegrade manner through the open aortic arch. In the classic elephant trunk technique, the graft portion forming the ‘elephant trunk’ in the descending aorta floats freely in the descending aortic lumen so that there is little or no thrombus formation between the graft and the aortic diseased wall. In the FET technique, the stented segment allows for progressive thrombus formation in the perigraft space up to the level of the landing site. This reduces the wall stress on the aorta and thus helps in preventing the subsequent growth of the aortic diameter. Initially, such operations were performed with a home-made 'hybrid prosthesis' with a stented and a non-stented segment[14].

Dr Kazui who first used branched aortic grafts to facilitate supraaortic vessel anastomosis, which was initially regarded as cumbersome and time-consuming, considering that arch vessel reconstruction has to be done under circulatory arrest [15]. His hypothesis was that the branched aortic arch graft would avoid pitfalls with the conventional island technique (aortic segment carrying the 3 supraaortic vessel ostia), such as bleeding during surgery and dilatation during follow-up.

The proposed advantages of 4-finger plexus graft are: (1) CPB, myocardial and lower body ischemic time is reduced as after completing the distal and the proximal anastomosis of plexus graft, the myocardial and lower body perfusion can be resumed through 4-finger graft. (2) As pathological regions of the aortic arch can be totally resected, the cerebral emboli risk may be reduced by the replacement of complete proximal aorta (3) Anastomoses can be to supraaortic vessels where dissection has not extended to (4) Hemostasis is easier at the individual arch vessel anastomoses.

The implantation of the stented portion of the graft into the proximal descending aorta is simple and can be done under direct surgical vision. Additionally, the grafts were available in different sizes and lengths. The fact that the proximal unstented and distal stented portions are available in different sizes excludes the necessity of having to replace the aortic arch with a large-sized graft when treating a large descending aorta. Although technically demanding, this procedure is reproducible, with low mortality in experienced hands.

Conclusions

With growing experience in patients with aneurysms and dissections in the arch and proximal descending aorta, the frozen elephant trunk (FET) technique has been shown to be safe and effective, and has achieved favorable short to mid-term outcomes. As the FET technique is gaining wider acceptance, there is a growing
need for versatile, technically simple, and highly durable open stented grafts involving less complicated deployment mechanisms enabling use in various indications. Modified CPB management and innovative organ protection technique and concept are essential for a successful outcome. The encouraging surgical results could enable this procedure to become the new "standard" therapy for type-A dissection involving repair of the aortic arch.

References
1. Bentall Procedure: A Systematic Review and Meta-Analysis Aart Mookhoek, MD, Nelleke M. Korteland, Bardia Arabkhani, MD, Isabelle Di Centa, MD, Emmanuel Lansac, MD, PhD, Jos A. Bekkers, MD, PhD, Ad J. C. Bogers, MD, PhD, and Johanna J. M. Takkenberg, MD, PhD Erasmus University Medical Center, Rotterdam, The Netherlands; Hospital Foch, Suresnes, France; and Institut Mutualiste Montsouris, Paris, France.
3. One-stage hybrid surgery for acute Stanford type A aortic dissection with David operation, aortic arch debranching, and endovascular graft: a case report Lulu Liu, Chaoyi Qin, Jiangleq Hou, Da Zhu, Bengui Zhang, Hao Ma, Yingqiang Guo Department of Cardiovascular Surgery, West China Hospital, Sichuan University, Chengdu 610041, China Correspondence to: Yingqiang Guo, MD. Department of Cardiovascular Surgery, West China Hospital, Chengdu 610041, China. Email: dgruoq@hotmail.com.
4. Hybrid Treatment for Type A Acute Aortic Dissection With Multiorgan Malperfusion Kyou Tanaka, Genta Chikazawa, MD, Taichi Sakaguchi, MD, Toshinori Totsugawa, MD, Kentaro Tamura, MD, and Hidenori Yoshitaka, MD Department of Cardiovascular Surgery, The Sakakibara Heart Institute of Okayama, Okayama, Japan.
6. Custodiol for myocardial protection and preservation: a systematic review J. James B. Edelman1,2, Michael Seco2, Ben Dunne3, Shannon J. Matzelle4, Department of Cardiothoracic Surgery, Sir Charles Gairdner Hospital, Nedlands, Australia; 2 The Baird Institute; Sydney Medical School, University of Sydney, Sydney, Australia; 3 Department of Cardiothoracic Surgery, Royal Perth Hospital, Perth, Australia; 4 Department of Anaesthesia, Sir Charles Gairdner Hospital, Nedlands, Australia; 5 Cardiothoracic Surgical Unit, Royal Prince Alfred Hospital, Sydney, Australia; 6 Australian School of Advanced Medicine, Macquarie University, Sydney, Australia; 7 Notre Dame Medical School, Fremantle, Australia Corresponding to: J. James B. Edelman. Department of Cardiothoracic Surgery, Sir Charles Gairdner Hospital, Nedlands, Western Australia; The Baird Institute, Sydney Medical School, University of Sydney, Sydney, Australia. Email: jbedelman@gmail.com.


Case of pulmonary artery thromboendarterectomy using cariopulmonary bypass under moderate hypothermia and flow modulation for sub massive pulmonary artery embolism

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Abstract
After acute or chronic pulmonary embolism, pulmonary hypertension develops in most patients. Pulmonary thromboendarterectomy is the definitive treatment especially if thrombolysis is contraindicated. Here we have a patient with a chronic thrombus in the pulmonary artery that required thromboendarterectomy on cardiopulmonary bypass with moderate hypothermia and low flows. After removal of thrombus there was dramatic clinical improvement.

Keywords
Pulmonary artery embolism, pulmonary Thromboendarterectomy, Hypothermia, pulmonary CT angiography

Introduction
Pulmonary artery embolism brings an acute emergency. The incidence rate is low but the associated mortality is very high. Cardiopulmonary bypass with moderate hypothermia and low flows was used to aid in the surgical removal of pulmonary artery embolism. This requires clear collaboration of cardiothoracic surgeon, anesthesiologist and Perfusionist.

Case Report
A 25 yrs. old man was admitted with breathlessness on walking and weakness of both lower limbs since one month. He had a history of trauma over head and leg a month ago. Clinical examination revealed pulse rate of 71 beats /mt, respiratory rate 20 per minute and blood pressure of 130/90mmhg. Blood investigation revealed Hb-15.1gm/dl, TLC9100, platelet count 3.34 lac, total bilirubin 6.4, SGOT-29, SGPT -24, coagulation profile showed PT 18 sec .INR was1.2.

Oxygen saturation on room air was 85%, on 5 liter of oxygen flow saturation achieved 94%.

Chest X-ray shows CTR increased 0.60 and oligemic right sided lung field and hyperemic left side.

Echo cardiograph revealed a large echo density (thrombus)in right pulmonary artery causing almost total occlusion of right pulmonary artery, reduced RV function, moderate TR, LVEF-55%.

CT Angiography was done which revealed
Acute pulmonary thromboembolism involving RPA with extension into lobar branches. Patient was not thrombolysed in view of recent history of trauma.

Partial pulmonary thromboembolism involving left lower pulmonary artery. Elective surgery was planned. After induction with protocol, fentanyl and muscle relaxants, intravenous heparin 3mg/kg was administered. Patient height 153 cm, weight 63 kgs, BSA 1.56 m2 and calculated blood flow was 3.7 liter /minute. Aortic Cannulation with 24fr RMI cannula, Bicaval SVC, IVC cannulation was done. Cardiac pulmonary Bypass was initiated. Aortic cross clamp was applied, antegrade crystalloid cardioplegia was given. Patient was gradually cooled down to 22 degree Celsius. Injection methyl prednisolone 1 gm, Inj thiopentone 2 gm was given. Ice packs were applied over head of the patient. The current surgical technique for PTE involves the use of deep hypothermia and circulatory arrest at 18 degrees. We decided to use an alternative strategy which consists of avoiding deep hypothermia and subsequent circulatory arrest by using moderate hypothermia at 22-degree C and maintain a bloodless field. This can be achieved by means of negative pressure in the left heart chambers and appropriate pump flow modulation. (flow modulation ranges between 0.5 to 1.5 ltr /minute at 22-degree Celsius)

<table>
<thead>
<tr>
<th>Temperature degree Celsius</th>
<th>Blood flow Litre/minute</th>
<th>MAP mm/hg</th>
</tr>
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<tbody>
<tr>
<td>34</td>
<td>3.0</td>
<td>75</td>
</tr>
<tr>
<td>30</td>
<td>2.0</td>
<td>60</td>
</tr>
<tr>
<td>26</td>
<td>1.8</td>
<td>41</td>
</tr>
<tr>
<td>22</td>
<td>0.5 to 1.5</td>
<td>40</td>
</tr>
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</table>

Main pulmonary artery was opened and large embolus was protruding from Right at confluence. Left pulmonary artery was inspected small embolus was taken out otherwise no abnormality was detected. Embolus from right pulmonary was taken out then RPA was opened behind SVC after retracting SVC and aortic in opposite direction. RPA was full of clots. Clots in the RPA was removed. Since the branch opening of RPA was still not visible, both pulmonary artery pulmonary Endarterectomy was done and even segmental arteries were cleared of thrombus, and opening of lobar and segmental arteries branches were visible then lungs were inflated twice to bring out small fragments. First pulmonary artery then pulmonary arteriotomy was repaired, after deairing. The patient was rewarmed gradually and the temperature was brought to 37 degree celsius. By decreasing the flows gradually the patient weaned off bypass with mild inotropic support. The BP came to 120/75 and Inj protamine 300 mg after double dilution started. Hemostasis was done and sternum was closed after the ACT read 110 sec. After surgery PA pressure reduced from 85mmhg to 30mmhg.The post-operative stay in the hospital uneventful and patient was discharged from the hospital on 9th post-operative day with oral anticoagulation and regular check for prothrombin time.

Discussion

Pulmonary artery embolism is a blockage of the main artery or its branches by an embolus which has come mainly from deep vein thrombosis of the lower extremities. The thrombus breaks and lodges in the arteries. Other causes of embolization are air, fat or amniotic fluid. Because of obstruction of blood flow in the lungs there is a back pressure on the right ventricle and right atrium of the heart that leads to chest pain, difficulty in breathing, cough etc. Clinical signs include a decrease in oxygen saturation, cyanosis, increased respiratory rate and increase in heart rate.

The basis of diagnosis is clinical findings, laboratory tests, imaging tests like CT pulmonary angiography. Treatment includes starting of anticoagulants like warfarin and heparin, thrombolytic drugs such as tissue plasminogen activator and also surgical intervention like
in this case via pulmonary thrombo Embolectomy using cardiopulmonary bypass under moderate hypothermia and low flows.

Conclusion

We conclude that adequate removal of pulmonary artery obstruction can also be achieved with operative procedure that avoids or reduces the use of DHCA while allowing a bloodless field during PEA interventions. This technique may limit well known adverse effect of DHCA due to organ hypo perfusion improving the post-operative recovery of the patient.

References


Multiorgan perfusion using three arterial pumps in abdominal aortic aneurysm repair undergoing cardiopulmonary bypass

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Abstract
A 55 years old female patient diagnosed with abdominal aortic aneurysm repair underwent Cardiopulmonary bypass CPB. Three different arterial pumps were used to perfuse four different sites of the aorta and its branches. This case report includes circuit planning, complications, aneurysm repair during CPB and its management.

Introduction
One of the developmental techniques of CPB involves perfusion to multiple organs simultaneously using separate arterial pumps in order to provide effective flow to each organ. This strategy may lower the prevalence of splanchnic ischemia and ischemia to other visceral organs associated with CPB in these patients. Perfusionists are responsible for safely conducting CPB, thus avoiding and overcoming the incidence of perfusion related accidents. Circuit planning and perfusion strategy should be such that the perfusionists would be able to assemble as well as handle it alone conveniently.

Case Report
A 55 year old female patient weighing 44kg (BSA-1.4m²) diagnosed with abdominal aortic aneurysm (juxta-diaphragmatic to aortic bifurcation) of atherosclerotic etiology, contained rupture (infra-renal aorta), with moderate tricuspid regurgitation, mild aortic regurgitation and H/O Pott's Spine. She was clinically evaluated and planned for aneurysm resection with interposition PTFE graft placement for abdominal aortic aneurysm on beating heart normothermic CPB.

Circuit Planning
Based on the requirement of controlled perfusion for the proximal thoracic aorta, distal thoracic aorta and the renal arteries due to aneurysm in the abdominal segment of the aorta, the circuit planned has been shown in the diagram (Fig-1) and described in brief below.

Planned cannulation site:
Three different arterial pump setups were planned for the controlled perfusion strategy. Blood drained from the venous line was pumped into the oxygenator and via Y connector into two different arterial lines i.e. one into the proximal thoracic aorta via arterial filter 1 (21 Fr Routine Aortic cannula directed towards ascending aorta) i.e. Pump 1 and the other passing through a different roller pump into the Femoral artery for distal thoracic aorta via arterial filter 2 (17 Fr Percutaneous femoral arterial cannula) i.e. Pump 2. The significance of using the second roller (generally used for cardioplegia delivery whose flow is actually synchronized with main arterial pump flows and can be operated when main arterial pump is working) was to determine the flow of the distal thoracic organ perfusion and manipulate the flows in case if needed. The third arterial line was used for renal perfusion in which the oxygenated blood was withdrawn from the recirculation line using a Y connector and placed into the third roller pump i.e. in Pump 3 and desired flows were delivered through % inch line tube which was further bifurcated via Y connector for two different renal arteries. Thus, distal perfusion pump and renal perfusion pump showed the exact flows that were perfused but the main pump which will be responsible for proximal thoracic aorta perfusion is showing flow which is actually the sum of the proximal thoracic aorta flow and femoral artery perfusion pump flow. Therefore, Flow to Proximal thoracic aorta = (Main Pump Flow (pump-1)–femoral artery perfusion pump flow (Pump2)). For venous return 21 Fr Percutaneous femoral venous cannula was selected to get adequate drainage.

Hemofilter was placed and the circuit was primed with a total of 1500 ml of Prime solution containing Ringer's Lactate - 20 ml/kg, Starch (hydroxyethyl starch)-10 ml/kg, Mannitol-5 ml/kg, NaHCO3 1 ml/kg and Heparin 200-300 IU.

**Cannulation strategy:**

Femoral artery was cannulated first by pushing the prime volume for tubing-cannula connection by clamping the proximal thoracic arterial line and simultaneously running the main pump (Pump1) and the Femoral artery perfusion pump (Pump2) at the exact same speed. This was done to ensure that the volume pushed by the main pump from reservoir to oxygenator was sucked up by the (Pump2) and pushed the volume via arterial filter 2 into the femoral artery. Femoral vein were cannulated and went on Femoro-femoral bypass to check the integrity of the bypass circuit and the adequate return.

**Problem:** It is the safety feature of cardioplegia pump (femoral artery perfusion pump (Pump2)) whose flow is due to synchronized with main arterial pump flows and can be operated only when the main arterial pump (Pump1) is working and maintaining exact equal flows on the main pump (Pump1) and cardioplegia pump (Pump2) to institute only femoro-femoral bypass was a difficult situation. A rise in pressure was observed as the flow of the main pump (Pump1) exceeded the femoral artery perfusion pump (Pump2). If the flows of the second roller would have exceeded, negative pressure would have been created which may have lead
to air-emboli in the tubing. Using the cardioplegia pump (Pump2) for femoral artery perfusion provided us a means of automatic shutdown of both the pumps whenever there was pressure build up inside the main pump (Pump1).

**Solution:** To overcome pressure buildup within the circuit, femoro-femoral bypass was stopped for a moment by clamping arterial and venous line as well and the tubing of the femoral artery perfusion pump (Pump2) was taken out from the raceway track of the cardioplegia pump and its flows were regulated using tube clamps and flows were monitored using flow probe based on spectrophotometry which is generally used in centrifugal pump. CPB was initiated again. The flow passing through the main pump was completely diverted to the femoral artery perfusion pump (Pump2) via arterial filter2 and at that time the arterial line i.e. one into the proximal thoracic aorta via arterial filter1 was clamped with tube clamp which is shown in Fig-2.

Proximal thoracic aorta was cannulated afterwards by slightly opening the tube clamp placed just prior to the arterial filter 1 so as to push the fluid in forward direction for tubing-cannula connection and the flows were then maintained. For instance, if the main pump was running at a flow of 3.0 litres per minute and the flow diverted to distal thoracic aorta was 1.0 LPM, suggested that only 2.0 LPM flow was traversing through the proximal part.
Relevance of Pump Flows with Surgical Procedure:

Heart was ejecting blood as it was not arrested. At the same time, the proximal thoracic aortic cannulation was providing flows in the direction of aortic arch and the distal thoracic aortic cannulation was providing flows in the direction of mesenteric artery. A clamp was placed on the proximal and thoracic aorta by reducing the flows for few seconds and afterwards abdominal aorta below diaphragm was surgically dissected. This exposed the aneurysmal segment as well as renal arteries. The graft of appropriate size was sutured and by the time, the renal arteries were perfused using two different retrograde cardioplegia cannula for each kidney with a constant flow of 30ml/min each which was equally bifurcated by 1/4*1/4*1/4 Y connector and the lower body perfused using femoral cannula at a flow of approx. 1000ml/min. The upper body was perfused at varying rate of 1200-2000ml/min depending on the blood pressure and the arterial line pressure. Once the proximal aortic graft was sutured, the proximal thoracic clamp was removed and the graft was cut longitudinally and sutured with the dissected aneurysmal wall. The cannula supplying the renal arteries were removed and now the renal arteries were being perfused by the flow of the blood ejected by the heart and the flow provided through proximal thoracic cannula i.e. Pump1 during the period of anastomosis between the distal end of graft to the abdominal aorta up to the aortic bifurcation. After completion of surgical procedure de-airing was done. The femoral aortic perfusion stopped and cannula was removed and the flows were restricted through the proximal thoracic aorta via arterial filter 1 (i.e. Pump1).

To maintain the hematocrit, hemofiltration was done continuously along with addition of packed RBCs. Weaning process was initiated and the flows were reduced partially and finally weaned off.

Conclusion

Although the ascending aorta is the most common site of arterial cannulation for CPB, the presence of an abdominal aortic aneurysm extending from juxtadiaphragmatic to aortic bifurcation may make ascending aortic cannulation difficult. The femoral artery is the most common alternative site of arterial cannulation in these situations. However, concomitant peripheral vascular disease, the associated risk with visceral organ ischemia and extension of the aortic dissection into the abdominal artery may make this approach undesirable.

In summary, we have found multiorgan perfusion through multi-artery cannulation to be an effective and safe method of arterial cannulation for CPB in patients with extensive arterial vascular disease. It may decrease the risk of visceral organ ischemia associated with CPB in this high-risk group of patients.

References

3. R Chiesa, Y Tshomba, G Melissano, EM Marone, L Bertoglio, F Setacci, ...Journal of vascular surgery 45(6), 1128-1135
Failure of gas blender during CPB-a task to understand

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Abstract

Now a days Procedures on cardiopulmonary bypass are very safe but sometimes accidents can happen. So Perfusionist must be alert & vigilant all the time during the procedures. Here we are presenting the accidental case of failure of oxygenation during cardiac surgery due to fault in gas blender of cardiopulmonary bypass.

A 21 year female patient with Rheumatic heart disease Sev MR & Mod AR Mild TR posted for Double Valve Replacement Surgery. Gas blender was blocked & oxygenation to the oxygenator stopped due to moisture in gas supply line.

Presence of availability of oxygen cylinder & assistant perfusionist in Operation Theater, we could manage the patient well within time & continue with Cardiopulmonary Bypass. There were no immediate or late Post Operative complications & patient was discharged as a routine.

Case Description

A 21year female presented withRheumatic heart disease, Sev MS, Mod AR ,Mild TR for Double valve replacement. Pre Operation work up was within range.

Case Management

The Extracorporeal circuit was prepared in a routine fashion according to the pre-bypass checklist and primed with 1200ml Plain Ringer compound. 250ml Mannitol 20%, 50mg Heparin (25000 IU)& 50ml sodium bicarbonate. After induction of satisfactory general anesthesia and insertion of monitoring lines, the patient was prepared and draped in a routine sterile fashion. Standard cannulation was performed with 22 fr ( DLP) aortic cannula according to flows & for venous drainage angled 24fr (Edwards)for SVC & 32 fr ( DLP) for IVC . Aortic Root Cannula with Vent line of 7fr ( DLP) is inserted for root venting. After heparinization and verification of an activated clotting time of 541 seconds, CPB was initiated with adequate temperature 35.5°C.

Immediately after initiating the bypass before cross clamping the Aorta, suspicion arose as the colour of blood in arterial & venous line was not as expected. Even after running full oxygen flow to the blender it was not delivered to oxygenator which was indicated to us by colour of arterial line. We followed CPB protocols, to rule out other reasons before deciding the blender was at fault, like reverse connection of oxygenator inlet and outlet etc. and when all such parameters were negative, So we immediately reverted back to full ventilation which could correct it &started searching for the reason. The blender gas line connections were assessed at the perfusion side and found to be intact at Oxygenator gas inlet .Gas line with filter connected with gas cylinder shows no obstruction in filter. No leakage in hoses. But than we found there was lot of water in gas blender's water trap which blocked oxygen delivery to oxygenator. Furthermore, the blender did not raise alarm to indicate a pressure differential and possible disconnection. Immediately we connect the oxygen cylinder direct to oxygenator with full ventilation & problem was corrected with bright colour in arterial line. After discussion with anesthetist and the surgeon, a decision was made to transfer another blender apparatus with the existing oxygenator. After transfer of a different blender apparatus, achievement of good oxygenation & change
in arterial blood colour with perfect blood gases allowed completion of the procedure.

The aortic cross-clamp was applied, and the Double Valve was replaced successfully with following routine steps. The remainder of the case was uneventful, with a Total CPB time of 326 minutes and total aortic cross-clamp time of 235 minutes.

The postoperative course was uneventful, with no identifiable neurocognitive sequelae. The patient was discharged in routine manner after surgery.

**Discussion**

While entering in Operation Theatre, its our routine to check everything from our CPB Checklist. Because of the course of events, assistant perfusionist was asked to contact Biomedical to evaluate the equipment and situation. The blender apparatus was tested and found there was a lot of moisture in water trap/filter which blocked the transfer of gas to oxygenator. The whole line of gas supply was checked by the gas manifold person & dried the gas line to prevent from the another mishappenings.

On ruling out the blender, the only other equipment in-line between the blender and oxygenator was a sevoflurone vaporizer. Although the vaporizer was working properly, it can leak gas if either improperly seated on the holder or if the fill cap is not properly tightened. The vaporizer can be bypassed by turning to the “off” position. In our case it was perfect.

Although our pre-bypass checklist had contained a parameter involving a back-up oxygen cylinder, this is somewhat impractical because we are often tasked to apply CPB in cardiac suites in an emergent fashion. All of our anesthesia machines contain a back-up oxygen cylinder with flow meter that is rarely, if ever, used with patients that are intubated.

**Conclusion**

A collaborative fundamental understanding of the basic resources needed to perform routine tasks by all team members will not only improve continuity but may also reduce liability and medical mishaps. The continued process of advancing patient safety and risk reduction measures in health care are the foundation of successful teams, facilities, and organizations.

**References**

1. J Extra Corpor Technol. 2007 See; 39(3): 188-191. David P. Webb, MS, CCP, LCP, † Robert J. Deegan, MD, PhD, FFARCSI, ‡ James P. Greelish, MD,* and John G. Byrne, MD*
Invited Commentary

Minimally invasive cardiac surgery perfusion guidelines

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Department of Cardiothoracic Surgery

Rajiv Gandhi Government General Hospital, Chennai

Abstract:
Minimally invasive cardiac surgery is a safe and broadly applicable technique for performing a wide range of complex heart procedures. We have been doing Minimally Invasive Cardiac Surgeries in our institution for the past few years and the results are extremely good.

In our institution (Rajiv Gandhi Government General Hospital), over the past one year, we have done about 25 cases of minimally invasive cardiac surgeries, including a spectrum of pathologies from atrial septal defects to Mitral and Aortic valve diseases, which had good short term clinical outcomes and with no perioperative morbidity and mortality. Based on perfusion guidelines we had followed, femoral arterial and venous cannulation was done by Seldinger’s technique. In most cases, Right Internal jugular vein cannulation was also done to achieve adequate venous return. Chitwood clamp was used for aortic cross clamping through right third or fourth intercostal space at mid axillary level. Antegrade root cardioplegia was given at the pressure of 100-150mmHg. The average cross clamp time was about 80 minutes and average bypass time was about 130 minutes. The patients were weaned of from bypass with no difficulty. Patients were extubated in 6-8 hours. They had received lesser blood transfusion and showed accelerated recovery. Patients had no CPB associated morbidities. MICS is safe, feasible and we have found that it reduces blood loss, length of stay and showed accelerated recovery. It has greatly improved cosmetic result.

Key Words
Minimally invasive cardiac surgery, femoral cannulation, Chitwood clamp, better cosmeses.

Introduction
The invasiveness of most surgical and interventional procedures relies heavily on the physician’s access to the operative field. The invasiveness is based on incision and the presence of cardiopulmonary bypass machine in cardiac surgery. Though the median sternotomy affords unlimited exposure to all surfaces of the heart as well as internal chambers, it has its own potential side effects, poor cosmeses and carries social stigma.

Minimally invasive cardiac surgeries can include procedures that eliminate or minimize complications associated with regular conventional surgeries. There are numerous techniques for minimally invasive cardiac surgeries. We device effective and logical circuit choice and they can be tailored to individual procedures which includes the use of smallest circuit possible but aiding with maintenance of adequate perfusion.

Materials And Methods
Surgical Incision And Approaches:
Minimally invasive techniques have different methods to access the heart depending upon the type of surgery.
- In AVR, incision was made in the right anterior second or third intercostal space.
- For MVR, the approach is through a small right anterior thoracotomy in either third or fourth
intercostal space. In women, incision in the fourth intercostal space (infra mammary incision) was mostly preferred.

- In the cases of ASD, small right mini thoracotomy through the fourth intercostal space was done.

Circuit Selection

The reduction of perfusion surface area is considered essential for minimally invasive perfusion.

- So we used smaller cannulae which helped in the reduction of surface area.
- The smaller circuits require less prime which cause less hemodilution.

In most cases, we used 3/8” tube in the venous line so that there is less prime and decreased hemodilution. Thus it helped in the reduction of homologous blood transfusion. Though we used 3/8” tube in the venous line, venous drainage was extremely good.

Arterial Cannulation

As per standard guidelines, percutaneous cannulation was considered a safe option for minimally invasive cardiopulmonary bypass. We used femoral arterial cannulation in all cases and the arterial flow and pressure was maintained very well. Seldinger’s technique was used as a standard method in all surgeries. We used Medtronic cannulas of size 15-19 Fr which are made of pliable materials that allow for ease of insertion. Adequate flows are achieved with these cannulas. The cannulas were secured, deaired and connected to the bypass circuit after insertion. Right Subclavian artery cannulation can also be done in some cases. But we haven’t used it, as we are doing well with femoral cannulation itself.

Venous Cannulation And Venous Return

Femoral Venous cannulation was done in almost all cases and right atrium cannulation was done in some cases. Thin-walled cannulas made of polyurethane was used to prevent kinking and these small cannulas are useful in venous drainage where exposure is limited in most procedures. Medtronic femoral venous cannulas of size 17-23 Fr were used. Internal Jugular Vein (IJV) Cannulation was also done in all cases which helped in the enhancement of venous drainage. For IJV cannulation, we used Medtronic femoral arterial cannula.
of size 15Fr for all cases. The position of venous cannulas were checked with the help of Transesophageal Echocardiography (TEE).

Assisted venous drainage (AVD) can be used for the augmentation of venous return. Vacuum assisted (VAVD) and kinetic assisted (KAVD) can be used. But it may cause harmful effects like micro air embolism and the high negative pressure may have damaging effects to the blood cells by the turbulence generated through the cannulae tip. Since we were getting adequate venous return by the simple cannulation techniques, we did not use any of these assisted venous drainage techniques.

Cardioplegia Delivery

Cardioplegia was given by antegrade method in all cases. Chitwood clamp was used for aortic cross clamping through right third or fourth intercostal space. Antegrade root cardioplegia was given at the pressure of around 100-150 mmHg. Both Blood (St. Thomas II) and Crystalloid (Delnido) cardioplegia have been used and myocardial protection was good.

Even though we have advanced techniques like endoaortic balloon and heart port system, our preferred cannulation technique is direct arterial cannulation, aortic cross clamping using Chitwood clamp through right 3rd or 4th intercostal space and direct cardioplegia delivery.

Discussion

We have followed conventional perfusion protocols for pump blood flow, anticoagulation, temperature management, myocardial protection, and acid-base regulation except for cannulation strategies which required additional instrumentation. In MICS, the CPB was initiated likewise for conventional CPB. For aortic cross clamping, the pump flow is reduced while full venous decompression is maintained to decrease the systemic pressure and keep the heart empty. Then the cardioplegia was given by antegrade method after cross clamping. Mean arterial pressure of around 60-70mmHg was maintained in almost all cases. Urine output was also good in the average range of 1-3ml/kg/hr. The average

Table-1 : Comparative Study for blood transfusion between conventional and minimally invasive group

<table>
<thead>
<tr>
<th>Blood &amp; its Components</th>
<th>Conventional Surgery</th>
<th>Minimally Invasive Cardiac Surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Procedure</td>
<td>No. of units transfused</td>
</tr>
<tr>
<td>PRBCs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASD</td>
<td>2</td>
<td>ASD</td>
</tr>
<tr>
<td>MVR</td>
<td>4</td>
<td>MVR</td>
</tr>
<tr>
<td>AVR</td>
<td>3</td>
<td>AVR</td>
</tr>
</tbody>
</table>

| Platelets|           |                      |           |                       |
| ASD      | 3         | ASD                  | 3         | -                     |
| MVR      | 4         | MVR                  | -         | -                     |
| AVR      | 3         | AVR                  | -         | -                     |

| Fresh Frozen Plasma|           |                      |           |                       |
| ASD      | 1         | ASD                  | -         | -                     |
| MVR      | 3         | MVR                  | -         | -                     |
| AVR      | 2         | AVR                  | -         | -                     |

This is not strictly followed protocol. It will change according to the surgeon's convenience. (- indicates 'not used')

Table-2 : Minimally Invasive Cardiac Surgeries done in our institution in the year 2016

<table>
<thead>
<tr>
<th>S. No</th>
<th>Diagnosis</th>
<th>Procedure</th>
<th>No of patients</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RHD/MS/MR</td>
<td>MVR</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>AS/AR</td>
<td>AVR</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>ASD</td>
<td>PPC</td>
<td>8</td>
<td>8</td>
</tr>
</tbody>
</table>

All the 25 patients survived with more gratifying results and with no postoperative morbidity and mortality.
cross clamp time was around 80 minutes. After the procedure has been completed, deairing is achieved by aortic root venting, mechanical ventilation (CPAP) and by filling of the heart. Transesophageal echocardiography was used to monitor the deairing of intra cardiac chambers. Then the patient was weaned off CPB gradually after all the parameters were stable. Average bypass time was around 130 minutes. Protamine was given to neutralize heparin. Then the cannulas were removed. Femoral arterial cannula was removed and the site of cannulation was repaired. To ensure the safety and adequacy of perfusion, we monitored venous drainage, arterial inflow, myocardial decompression, cardioplegia and cardiac venting rates. The patients were extubated (within 6-8 hours) earlier while comparing to the patients with conventional surgeries. They received less or no blood transfusion and the post-operative results were good. ICU stay was also reduced and they recovered faster than other patients. We have done 25 cases in the one year which included the procedures of Atrial Septal defects, Mitral and Aortic valve replacements.

Results

On comparing the patients who underwent conventional cardiac surgery with the Minimally invasive cardiac surgery we have observed that the patients with minimally invasive procedure had more accelerated recovery with lesser pain. Blood loss is also lesser in minimally invasive patient group. Haematocrit was also maintained well throughout the surgery. Chances of postoperative wound infection is lower in minimally invasive procedure due to limited incisions. Length of ICU stay and hospital stay is also reduced in minimally invasive group. ICU stay was around 2-3 days in minimally invasive group whereas in conventional surgery group it was around 4-5 days. Likewise, the minimally invasive group patients were discharged in 5-7 days and conventional group patients in 8-10 days. The patients found the cosmetic results with Minimally Invasive Cardiac Surgery more gratifying, unlike the patients with conventional surgery. This was observed on a short term clinical follow up and they also received less or no blood transfusion comparing to the patients with conventional surgery.

Conclusion

MICS is easier and provides better cosmetic results. So we recommend MICS for the patients with no contraindications. We wish to do more surgeries by MICS so that we could provide better results, less blood transfusion and accelerated recovery.

References

The *Indian Journal of Extra-Corporeal Technology* (IJECT) is the official journal of the Indian Society of Extra-Corporeal Technology (ISECT). We welcome the original articles and papers on topics interest to perfusionists, pertaining to clinical perfusion and extracorporeal-circulation.

**Types of Papers**

- **Original article**: word limit 5000 (excluding references), 40 references maximum, not more than 10 tables/figures
- **Mini review article**: word limit 2500 (excluding references), 20 references maximum, not more than 5 tables/figures
- **Review article**: word limit 6000 words (excluding references), 60 references maximum, not more than 10 tables/figures
- **Case report**: word limit 2000 words (excluding references), 10 references maximum, not more than 3 tables/figures
- **Innovations**: word limit 2000 words, 3 figures, 10 references (these articles describe new techniques or instrumentation)
- **Technical Challenges**: word limit 2000 words, 3 figures, 10 references
- **Invited commentary**: word limit 1500 words, 0 references (this is an invited discussion on an original article that is of significance and will accompany the article when published)
- **Book review**: word limit 1000, no references or figures.
- **Editorial**: word limit 1500 words (excluding references), 10 references maximum.

**Abstract**

The abstract is an essential and the most read part of the paper. It should be factual and free of abbreviations except for SI units of measurement. All original articles must have a structured abstract with **Background, Methods, Results and Conclusions**, written on a separate page. A short abstract (not exceeding 100 words) must accompany all case reports and how to do it articles.

**Keywords**

Following the abstract, 3–6 key words should be given for subject indexing. They should be taken from Index Medicus or composed on similar lines.

**Text**

- **Introduction**: should state the purpose of the investigation and give a short review of pertinent literature.
- **Materials and methods**: must indicate clearly the steps taken to acquire the information. It should be detailed and may be separated into subsections. Generic names of drugs and equipment should be used throughout the manuscript, with brand names (proprietary name).
**Results:** should be reported concisely and regarded as an important part of the manuscript. Should be presented either in tables and figures and briefly commented on in the text or in the text alone. For statistical analysis, numbers of patients or subjects should be given, with percentages in brackets. Results of statistical tests should be reported as well as the p values.

**Discussion:** is an interpretation of the results and their significance with reference to pertinent work by other authors. It should be clear and concise. The importance of the study and its limitations should be discussed.

**Acknowledgements:** of personal assistance should, if appropriate, be placed at the end of the text.

**References:** should always be relevant; more is not necessarily better. They should be numbered in the order in which they appear in the text, and should be given in the ‘Vancouver style’. Journals should be indexed and their abbreviations confirm to, Index Medicus.

**References format should be as follows:**

Journal author(s), title of the article, name of the journal, volume number, page numbers (inclusive).

Book – author(s) title of the book, place of publication, publisher, year, page number used.
ISECT was constituted by ten founder members in 1983 and was registered under society act in Tamil Nadu in 1985. And every year the ISECT is getting renewed its registration regularly.

The ISECT logo was designed by founder members Mr. Kuppuswamy, Mr. Anandhan, Mr. K.M. Rao under the guidance of Dr. Solomon Victor (Chennai), Dr. G.B. Parulkar (Mumbai) and Dr. I.K. Gujral (Chandigarh).

Dr. Nimish A. Shah (Mumbai), Solomon Victor (Chennai), Dr. G.B. Parulkar (Mumbai), Dr. Gujral (Chandigarh), Dr. Gopinath (New Delhi), Dr. Stanley John were founder patrons and advisors of ISECT in 1983.

Initially the office got located in the residence of one of our founder member from Chennai Mr. Kuppuswamy, due to financial constraints, later in the year 2013, we took a place on lease and our office has been shifted to the new premises.

Mr. V.M. Joshi and Mr. Kuppuswamy were our founder president and secretary respectively.

In 1989, GB resolved and appealed to IACTS to get certification by it, by constituting a body to certify the existing perfusionists by awarding PG diploma in perfusion technology as on that date in the interest of professionalism.

In 1991 most of the perfusionists underwent certification as laid down by IACTS.

In 1991 regular course in perfusion was started by Medtronic India with help of IACTS under its sponsorship.

Dr. Murlidharan, Chief Anaesthetist was the first coordinator for perfusion course and he was felicitated by ISECT in 1994.

The first two year post graduate diploma in Clinical Perfusion course was introduced at Nizam’s Institute of Medical Sciences (NIMS), Hyderabad in 1992, which was designed by our senior members Mr. N. Chandrasekhar and Mr. K. Madhusudan Rao and both of them were given position in the institute as tutors in the rank of assistant professors at that institute. Later it was followed by many institutions in the country.

At present few institutes like AIIMS New Delhi and Narayana Hrudayalaya and some other institutes in our country are offering graduate and post graduate courses in Clinical Perfusion.

ISECT has been making efforts to control the mushrooming unwanted admissions in perfusion technology courses around the country at various hospitals / institutions with motive for financial gains. In one case such practice was observed with fifty seats for admission into course, with persuasion, the intake was reduced to four seats only. The ISECT is making efforts to streamline the training programs in Clinical Perfusion by fixing proper criteria for selection, infrastructure, number of operation theaters, and faculty members in the ratio of 1:1 with the government of India.

Life membership subscription has been fixed at INR 2000/-

In 1989, Dr. Solomon Victor paved way for ISECT members for participation in IACTS conferences.

ISECT has come out with its own journal in 1990 with the help of IACTS.

ISECT underwent democratic changes in its structure and now elections for office bearers are conducting in more democratic way through secret ballot and by appointing a returning officer.

The ISECT is now in a bit financially sound position and is able to meet its routine requirements, e-filing tax returns and the effort to get the income tax exemption and 80G certification is in progress through our chartered accountant.

As to encourage the young perfusionists for their participation in scientific sessions, the ISECT has initiated several awards and the following are few of them:

1. Gold medal award initiated in 2001 Kolkata conference for the best paper presentation every year in the name of Dr. Gopinath. This was made possible from the interest accrued on corpus fund of INR 30,000/- contributed by Emeritus Prof. Dr. Gopinath, an eminent cardiac surgeon from AIIMS New Delhi.
2. Best paper gold medal is sponsored by Shri. Mahajan of J. Mitra and bro New Delhi every year for the past one decade.

3. Senior members has also sponsored cash awards for young perfusionists with exemplary papers.

- After gaining independence the ISECT started its own scientific conferences and chairpersons were honored with mementos from 2003 onwards.
- ISECT website has been first designed and started in the year 2003.
- In 2003 Hyderabad conference, it was resolved to start the work on recognition of perfusion as a profession at Govt. of India level and since then the efforts are in progress at various level.
- In ISECTCON 2004 life time achievement award has been started to senior perfusionists for their eminent services in the field of Clinical Perfusion.
- Directory of life members with their details was published in 2003 and in 2005.
- Retired perfusionists are exempted from registration fee for ISECT conferences.
- Since 2001, ISECT is independently conducting conferences, with good scientific paper presentations. Strength of life members has increased to 800 approximately.
- ISECT is working on ‘nationalization of ISECT’. And give financial support to life members in distress.
- Advanced Clinical Perfusion course for life members has been started successfully.
- On invitation, five senior members gave presentation on the profession of perfusion, his /her role in cardiac surgery, in the premises of parliament secretariat before the dept. Related parliamentary standing committee headed by Shri Amar Singh in 2008 to peruse the government of India in recognizing the profession and to regulate through a statutory provision by constituting a council / board to protect the professional interests both professional and academic.
- Based on the above representation perfusionists profession was included in the para medical council bill on 11th July, 2008, which is still under consideration before parliament. This was first step towards the professional recognition by the government of India.
- Representatives of ISECT personally submitted a memorandum to Hon’ble health minister, Dr. Harsh Wardhan, Government of India in 2014 to designate perfusionists either Clinical Perfusionists or Cardiovascular Perfusionists in government services, with a positive response from him.

- Representatives of ISECT met honorable health minister Shri J.P.Nadda, Government of India, on 1st February, 2016 representing him for proper designation of perfusionists, constitution and creation of a regulatory body on the lines of a statutory council by Govt. of India by adopting at least four members from ISECT till a regulatory body on the lines of a council is constituted.
- ISECT have submitted suggestions on the allied and healthcare professional's central council bill 2015 in honorable health minister’s office.
- “Central govt. has to recognize ISECT as a governing and advisory body to govt. of India in all aspects of clinical perfusion profession and education till a regulatory body on the lines of a statutory council/board or commission is constituted. Requested to designate perfusionists as Clinical Perfusionists. And fixed qualification in all centers conducting perfusion courses.
- Constituition and creation of a regulatory body on the lines of a statutory council by govt. Of India. Honorable health minister promised ISECT representatives to do his best from his side for perfusionists.
- For betterment of ISECT and to uplift our society at international level by achieving the following goals:

1. Steps for formation of a statutory body on the lines of various councils to stream line the professional standards, clinical perfusion education, and registration of perfusionists under statutory provision.
2. Initiative steps for providing appropriate group insurance to all life members from the 2% extra fund generated from annual conferences.
3. Nationalization of ISECT
4. Efforts to get accreditation to our society from NABH.
5. Efforts to get exemption from income tax for our society funds.
6. Efforts to get 80G certificate from income tax authorities for receiving donations from philanthropists.

Dr Kamla Rana
President - ISECT
On behalf of the Organizing Committee of the 18th Annual Conference of the Indian Society of Extra-Corporeal Technology, we wish to invite you to the ISECTCON-2018 to be held in VISAKHAPATNAM (Waltair) City of Destiny, during 2nd & 3rd February, 2018.

Visakhapatnam (nicknamed Vizag) is the largest city, both in terms of area and population in the Indian state of Andhra Pradesh. It is located on the coast of Bay of Bengal in the north eastern region of the state. It is the Financial Capital of Andhra Pradesh. visakhapatnam is the principal commercial hub of the state, and contributes to its economy in many sectors such as heavy industries, tourism, industrial minerals, fishing, and information technology. Visakhapatnam Port is the fifth busiest port in India in terms of cargo handled. Visakhapatnam is home to the oldest shipyard and the only natural harbour on the east coast of India. Visakhapatnam developed into one of the country’s chief ports and became the headquarters of the Eastern Naval Command of the Indian Navy. The city is nestled between the Eastern Ghats mountain range and the Bay of Bengal, and is often known as The Jewel of the East Coast, The City of Destiny and the Goa of the East Coast. Visakhapatnam’s beaches (such as Ramakrishna Mission Beach and Rushikonda), parks (such as Kailasagiri and VUDA Park), museums (such as the Kursura Submarine Museum and Visakha Museum), and proximity to areas of natural beauty (such as the Kambalakonda Wildlife Sanctuary, Araku Valley, and Borra Caves).

Once again we welcome you in large numbers to participate in the scientific sessions & make this event a grand success.

Organizing committee ISECTCON-2018

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Greetings to all,

It is our pleasure to announce the 19th Annual Conference of ISECT on February 22-23rd, 2019, to be held in Chennai, Tamilnadu, India.

Chennai holds the colonial past and is an important city of South India. It was previously known as Madras.

Chennai, the capital city of Tamil Nadu is sited on the Coromandel Coast of the Bay of Bengal. It has played a very crucial role in the traditional, historical and academic growth of the country, representing the different elements of the highest variety of the Dravidian civilization. Today, Chennai, the capital city is the 4th largest city of India and is also the leading commercial centre of South India. The credit of the booming economy of the city goes to the leading industries including automobile, software services, petrochemicals, financial services, textiles and hardware manufacturing. Chennai, being an important metropolitan city is very well-connected to all the major cities of India as well as with the countries overseas. And, it is also considered as the cultural hub of South India which is famous for its affluent heritage in classical dance, music, architecture, sculpture, crafts, etc.

Over the past 19 years, the Annual Conference has become the premier gathering for Perfusionist to showcase their success stories, network with peers, develop organizational partnerships and hear from speakers willing to share their tips, techniques, and experiences for the benefit of our profession.

Through the Annual Conference we aim to provide attendees with practical, hands-on experiences so they can return home with relevant, actionable plans to improve their clinical efforts. Speakers will present topics which have real-world application for Perfusionists and which will help all of us address the challenges and shape the future of Perfusion Technology in India.

The Annual Conference on Perfusion Technology also provides an exciting opportunity for sponsoring organizations to showcase their products and services to perfusionists from across the country.

It is a matter of great pride that this would be enriching everyone with adequate knowledge. Moreover, this turns out into an experience both meaningful & memorable for all involved.
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