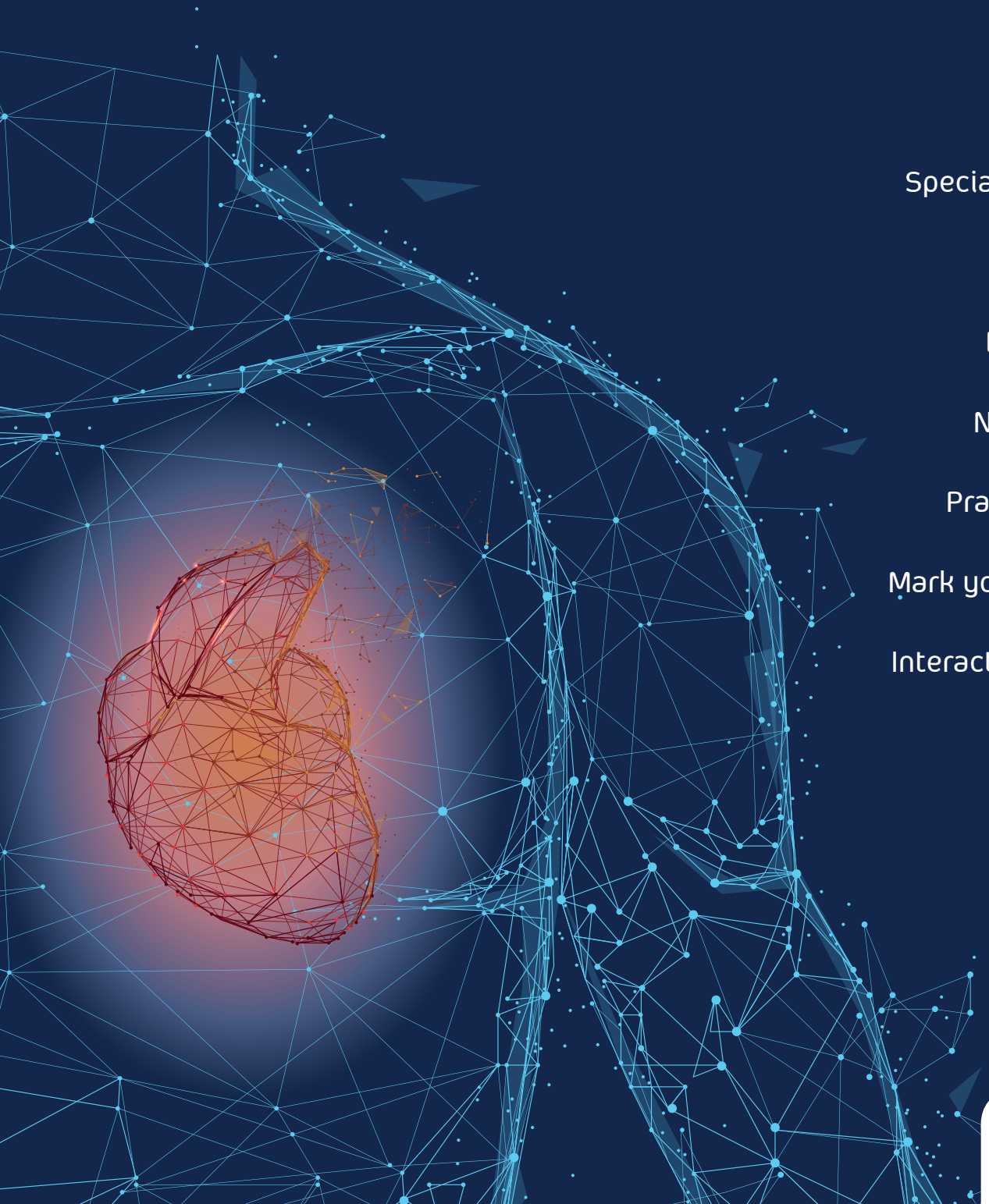
ISSUE 15

PRIME

Perfusion-Related Insights – Management and Evidence



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- Mark your calendar
- Interactive capsule

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Editorial Letter

It is with immense pleasure that we present the 15th issue of PRIME — "Perfusion-Related Insights – Management and Evidence" — a quarterly scientific newsletter that includes review articles, recently published clinical studies, latest guidelines, expert opinion, news, and quizzes on cardiopulmonary bypass (CPB) and perfusion strategies.

The current issue brings to you an interesting article and guidance recommendations under its first section, **'Speciality Insights.'** The first article discusses about the advances and benefits of minimally invasive aortic valve replacement. With the COVID-19 pandemic around, the second article highlights the recommendations of the guidance from an international cardiac surgery consortium for resuming cardiac surgery activity in the SARS-CoV-2 era.

The first article of the second section, **'Journal Talk'** is a summary of a recently published cohort study which summarizes the role of perfusion flow and pressure in acute kidney injury, stroke and death after cardiopulmonary bypass surgery. The second article sheds light on minimally invasive extracorporeal circulation, a cost-effective alternative to conventional extracorporeal circulation for coronary artery bypass grafting.

In the third section, **'Expert Desk,'** a case report is presented which elaborates on left ventricular mass consideration in chronic aortic valve disease for myocardial protection. The fourth section, **'News Corner,'** presents the latest evidence of stress in clinical cardiovascular perfusionists during cardiopulmonary bypass.

Various blood conservation strategies and evidenced based information of its improved outcomes in cardiac surgery is discussed in the fifth section, **'Practice Pearls.'** The final section, **'Interactive capsule,'** will help you test your knowledge regarding the current COVID-19 disease and CPB.

We hope this newsletter enriches your knowledge with the current practices and research updates in the field of cardiopul monary bypass and perfusion. Kindly let us know your comments and suggestions to help us improvise based on your feedback.

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PRIME Newsletter invites new authors for their contribution to the perfusion community. If you are interested in volunteering your time writing an article or a topic of your expertise and willingness to share your knowledge with our readers, we certainly encourage you to do so. We invite everyone interested in joining our team, and you can contact us at the email given below. Any amount of time that you can volunteer in adding to our quality of publication will be greatly appreciated. Thank you for your interest in PRIME Newsletter. What are you waiting for?

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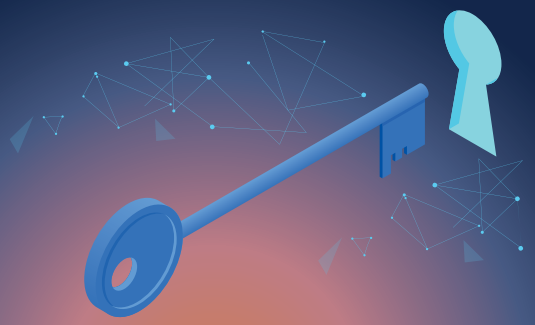

Technically challenging but advantageous outcomes: Minimally invasive aortic valve replacement (mini-AVR)

Introduction

Aortic valve disease is the most common valvular heart disease. Aortic valve replacement (AVR) is the treatment of choice for aortic valve stenosis (AS).[1] AVR surgeries has stood the test of time but is no longer an operation that is exclusively approached through a standard aortic valve replacement (SAVR) by median sternotomy using only sutured prostheses.[2] The increased adoption of **minimally invasive aortic valve replacement (mini-AVR)** techniques, despite being technically challenging, is reflected in its advantageous outcomes.[1] **SAVR is deemed to be the gold standard operation** for aortic valve disease and represents the benchmark against which new therapies are compared. However, certain subgroups of patients with significant comorbidities (lung disease, renal insufficiency, etc) and deemed at an elevated risk might not be considered suitable candidates for SAVR. [2]

These shortfalls in SAVR have stimulated the development of alternative interventions in the form of **sutureless aortic valve replacement (SuAVR), minimally invasive aortic valve replacement, and more recently, transcatheter aortic valve implantation/transcatheter aortic valve replacement (TAVI/TAVR).**[2]

Standard aortic valve replacement (SAVR)

This approach is used for aortic valve surgery performed through a median sternotomy with cardiopulmonary bypass and has excellent outcomes.[2]

Advantages[2]	Disadvantages[2]
Gold standard operation in conditions:	**Not suitable for:**
• Endocarditis	• Patients with significant comorbidities and deemed at an elevated risk
• Anomalies of coronary origin	• Patients presenting anatomical features that determine particular intra-operative challenges
• Bicuspidy	
• Congenital population: Redo surgery after homograft implantation	

Sutureless aortic valve replacement: Technique and results

It is a less invasive approach for AVR and progressively gaining agreement. It has effective results and a reduced interventional burden on the patient. Sutureless valves are bioprostheses that can be surgically implanted without or not more than four annular anchoring sutures. It has preserved the benefits of conventional in the form of allowing complete excision of the diseased native valve and cleaning of aortic annulus of calcified debris or infected material.[2]

Two main types of sutureless aortic prostheses categorised by implantation mechanism are:[2]

- **Self-expandable Perceval S**
- **Balloon-expandable Intuity sutureless valve**

Approaches[2]	Benefits of minimally invasive accesses[2]	Indications[2]
a. Traditional Median sternotomy b. Minimally invasive accesses: Ministernotomy (MIS) and Right anterior thoracotomy (RAT)	Reduce bleeding and blood transfusions, atrial fibrillation, wound infection, ventilation times, and time to return to normal activities.	Multiple comorbidities or those in need of multiple procedures.

Main drawback of sutureless valves includes concerns for paravalvular leaks and the need for pacemaker implantation.[2]

Minimally invasive aortic valve replacement

It is an AVR procedure that, as opposed to conventional full sternotomy, is performed through a small chest wall incision.[2]

Two techniques available: MIS and RAT[2]

Minimally invasive surgery

Benefits[2]

- **Lower incidence of postoperative:**
  - Atrial fibrillation
  - Blood transfusion
- **Shorter ventilation time and length of stay in hospital**

Right anterior thoracotomy (RAT)

It has lower incidence of postoperative complications and shorter length of stay in hospital compared to MIS.[2]

Disadvantages[2]

- Increased operative times
- Technical difficulty and steep learning curves

Transcatheter aortic valve replacement (TAVR): Results and comparison with surgery

There is progressive expansion in indications and a rapid technological development in initially targeted:[2]

- Patients with severe AS
- Unfit for conventional surgery
- Intermediate-risk categories

Conclusion

- The introduction of sutureless valve technologies, which reduces the need for anchoring sutures, has been shown to reduce operative time and duration of the cardiopulmonary bypass, being amenable to be applied to the combined cardiac surgery procedures.[2]
- The use of these devices also simplifies minimally invasive approaches and is a valid adjunct in patients with small aortic annulus, fragile aortic wall or requiring redo operations.[2]
- Increased use of these valves in current surgical practice should be considered by the heart team and encouraged.[2]
- However, there is a paucity of long-term durability data, SAVR remains a cornerstone in "nonconventional" conditions, such as redo surgery after homograft implantation.[2]

References

1. Lamelas J, Alnajar A. Recent advances in devices for minimally invasive aortic valve replacement. Expert Rev Med Devices. 2020;17(3):201-208.
2. Spadaccio C, Alkhamees K, Al-Attar N. Recent advances in aortic valve replacement. F1000Res. 2019;8:F1000 Faculty Rev-1159.

Guidance from an international cardiac surgery consortium: Resuming cardiac surgery activity in the SARS-CoV-2 era

Objectives

- To provide the guidance around safely resuming cardiac surgery, research and education during the SARS-CoV-2.
- To provide a framework for restarting cardiac surgery in the outpatient and inpatient settings, in accordance with the current understanding of SARS-CoV-2.

Developed by

Cardiovascular research consortium from 19 countries representing a wide spectrum of experience with COVID-19.

Survey

- Conducted in 60 cardiac surgery centers in North and South America, Europe, Asia and Australia
- **Duration:** Undertaken on March 23rd, 2020
- **Period:** Peak of the COVID pandemic
- **Population:** Over 600 cardiac surgeons

Observations

- Median reduction in cardiac surgery case volume was 50-75%
- No cardiac surgery in 5% of centers
- >50% reductions in intensive care capacity: every third of centers
- Massive and unexpected spike in the demand for critical care beds
- Inadequate supply of therapeutic and personal protective equipment

Recommendations for resuming cardiac surgery in the SARS-CoV-2 era

Recommendations	Class	Level of evidence
Resuming Cardiac Surgery		
The cardiovascular service line and cardiac surgery should be among the first clinical services to resume care as soon as critical care capacity becomes available.	I	C
Government regulations, hospital capacity, and disease burden should be agreed. Flexible institutional plans for cardiac service line should be widely communicated with clinicians.	I	C
Effective triage of elective cardiac surgery patients and triage should be led by specialists in cardiac surgery.	I	C
Referring physicians, patients and the community should be updated with clear, accurate and timely information on the availability of cardiovascular services and how to access them.	I	C

Recommendations	Class	Level of evidence
Cardiac Surgery Care Provision		
All cardiac surgery patients should be screened pre-operatively for COVID-19. Consideration given to deferring care or other care modalities for patients that test positive.	I	C
Cardiac Surgery Intensive Care should be structured so that cardiac surgical patients with SARS-CoV-2 may be kept within the unit, thereby infection risk to other patients and healthcare workers minimized.	I	C
Surgical procedures on patients with SARS-CoV-2 should be minimized. Strict adherence to protocols designed to reduce the risk of health-care workers.	I	C
It has been observed that discharging post-operative cardiac surgery patients to nursing facilities is not beneficial and may be harmful where there is increase prevalence of SARS-CoV-2 infection and mortality.	III	C
Cardiac Surgery Research and Education Management		
Remote working and telemedicine may be used for close and convenient patient follow-up.	I	C
It is reasonable to revise resident rotations for reduced operative experience and support research programs halted or suspended during the pandemic response.	IIa	C

Reference
Chikwe J, Gaudino M, Hameed I, Robinson NB, Bakaeen FG, Menicanti L, et al. Committee Recommendations for Resuming Cardiac Surgery Activity in the SARS-CoV-2 Era: Guidance from an International Cardiac Surgery Consortium [published online ahead of print, 2020 May 15]. Ann Thorac Surg. 2020;S0003-4975(20)30722-0.

Journal talk

The role of perfusion flow and pressure in acute kidney injury, stroke and death after cardiopulmonary bypass surgery

Introduction

Cardiac surgery employing the use of cardiopulmonary bypass (CPB) is common in Australia. There is variability in the reporting of incidence of acute kidney injury (AKI) associated with cardiac surgery; but documented as high as 30%. It is well established in the literature that AKI following cardiac surgery is associated with increased morbidity and mortality. AKI is associated with longer ICU stay, longer hospital stay, increased risk of myocardial infarction, and increased mortality at 30 days.

There are many factors that may contribute to AKI following cardiac surgery; perfusion flow and pressure during CPB represent some of the less well understood intraoperative variables in terms of their impact on renal perfusion. Thus, there is 'limited evidence to make strong recommendations regarding how to conduct CPB in regard to perfusion flow and pressure.' Present study aimed to evaluate the role of perfusion pressure and flow in the development of CPB-associated AKI.

Materials and Methods

Study design:

A retrospective cohort study

- Patients were included from the Australian and New Zealand Collaborative Perfusion Registry who underwent coronary artery bypass grafting and/or valvular surgery between 2008 and 2018. Patients flowchart is summarised in the Figure.

Primary predictor variables:

- Length of time the perfusion flow was <1.6 L/minute/m^2
- Length of time perfusion pressure was <50 mmHg
- Primary outcome: New postoperative acute kidney injury defined by the risk-injury-failure-loss-end stage criteria

Secondary outcomes: Stroke and in-hospital death

- The influence of perfusion flow and pressure during cardiopulmonary bypass on the primary and secondary outcomes was estimated using separate multivariate models.

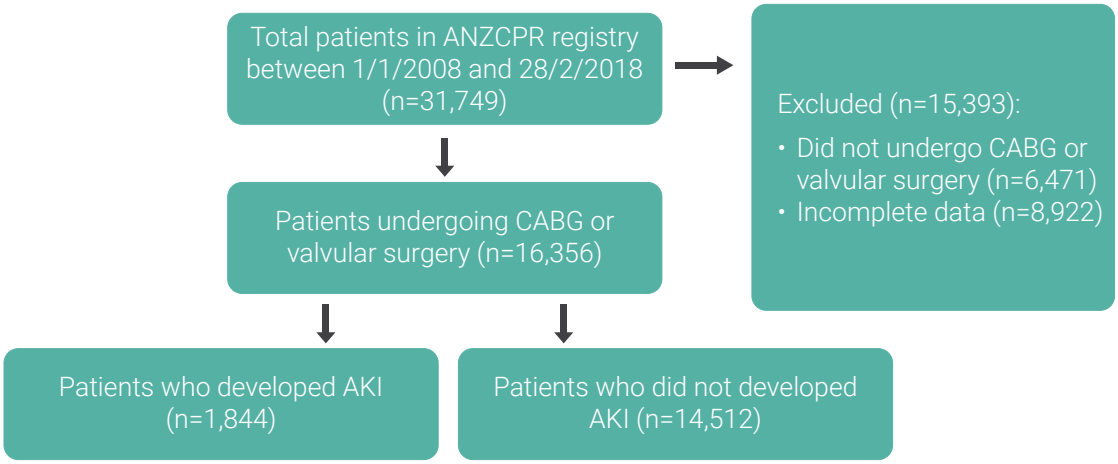

Figure: Patients flowchart

ANZCPR: Australian and New Zealand Collaborative Perfusion Registry; CABG: Coronary artery bypass grafting; AKI: Acute kidney injury

Results

The incidence of outcomes and the univariate and multivariate linear regression analysis with AKI are represented in Table 1 and 2.

Table 1: Incidence of AKI, stoke and death in the analysis sample

Outcomes	No AKI (n=14,512)	AKI (n=1,844)
Acute kidney injury (AKI)		11%
Risk (>50% increase in sCr)		7.8%
Injury (>100% increase in sCr)		2.7%
Failure (>200% increase in sCr)		0.8%
Stroke	1%	3.1%
Death	1%	7.6%

Table 2: Statistical analysis of AKI with univariate and multivariate linear regression

	Univariate linear regression		Multivariate linear Regression	
	95% CI	p value	95% CI	p value
Time (minutes) spent for perfusion flow <1.6 L/minute/m^2 (log)	0.009, 0.027	0.002	-0.007, 0.007	0.944
Time (minutes) spent for perfusion pressure <50 mmHg (log)	−0.003, 0.018	0.142	−0.011, 0.012	0.925

AKI: Acute kidney injury; CI: Confidence interval

Conclusion

This binational retrospective cohort study suggests that neither the time spent for perfusion flow (<1.6 L/minute/m^2) nor the time spent for perfusion pressure (<50 mmHg) during CPB was predictive of postoperative AKI, stroke or death.

Reference

Turner L, Hardikar A, Jose MD, et al. Acute kidney injury, stroke and death after cardiopulmonary bypass surgery: the role of perfusion flow and pressure [published online ahead of print, 2020 Jun 9]. Perfusion. 2020;267659120924919.

A cost-effective alternative to conventional extracorporeal circulation for coronary artery bypass grafting: Minimally invasive extracorporeal circulation

Introduction

Contemporary advances in cardiac surgery including, surgical techniques, anaesthesia and intensive care management markedly improved clinical outcomes. However, cardiac surgery is still hampered by considerable morbidity and subsequent mortality, especially in complex and high-risk procedures. Significant operative mortality and major morbidity (approaching the rate of 30%) is still observed not only in high-risk cases, but also in the most common scenario of an isolated mitral valve replacement (MVR) or an elective combined procedure like aortic valve replacement (AVR)+coronary artery bypass grafting (CABG) and MVR+CABG. This literally means that in real world, one out of three patients may experience a serious postoperative complication in this setting.[1] Minimally invasive extracorporeal circulation was developed with the aim of **reducing the impact of the adverse effects associated with conventional extracorporeal circulation.** The aim of this study was to compare outcomes for patients undergoing coronary artery bypass grafting using minimally invasive extracorporeal circulation with those performed using conventional extracorporeal circulation.[2]

Favourable postoperative result[1]

- Optimal intraoperative perfusion
- Advanced cardiopulmonary bypass (CPB) technology

Role of minimal invasive extracorporeal circulation (MiECC)[1]

Comprises of certain components:

- Closed circuit with biologically inert blood contact surfaces
- Reduced priming volume
- Centrifugal pump
- Membrane oxygenator
- Heat exchanger
- Venous bubble trap
- Venous air removing device
- Cardioplegia system
- Shed blood management device

Rationale for MiECC use1

- Allows optimal perfusion with higher mean arterial pressure
- Systemic vascular resistance close to normal values
- Reduced requirement for vasoactive drugs
- Integrity of microcirculation
- Improved end-organ protection (Figure)

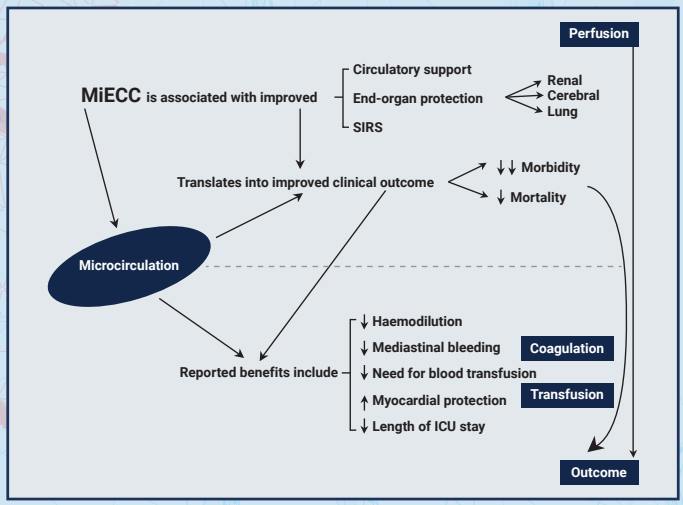

Figure: Schematic representation of the pathophysiologic pathway that leads from preserved microcirculation to improved clinical outcome with MiECC use[1]

MiECC: Minimal invasive extracorporeal circulation; ICU: Intensive care unit; SIRS: Systemic inflammatory response syndrome

Methods

A retrospective analysis was performed of patients undergoing minimally invasive extracorporeal circulation coronary artery bypass grafting at a single centre. Outcomes were compared using univariate analysis.[2]

Results

- Total patients included in the study:[2] 354
- Patients undergoing minimally invasive extracorporeal circulation for coronary artery bypass grafting:[2] 118
- Postoperative outcomes and analysis are summarized in Table.

Table: Outcomes and analysis[2]

Study variables	Minimally invasive extracorporeal circulation group	Level of evidence	p Value
Operative times (mean ± SD, hours)	3.31 ± 1.52	3.56 ± 0.73	0.03
12-hour blood loss (mean ± SD, mL)	322.3 ± 13.2	380.8 ± 15.2	<0.01
Blood transfusion	25.8%	36%	0.04
Mean number of red blood cells transfused (mean ± SD)	0.45 ± 0.95	0.97 ± 2.13	0.01
Number of coagulation products administered (mean ± SD)	0.161 ± 0.05	0.40 ± 0.09	0.05
Incidence of acute kidney injury	11.0%	19.9%	0.03
Cost saving per patient	679.50 £		

SD: Standard deviation

Conclusion

- MiECC for CABG is associated with a reduced requirement for blood transfusion, reduced incidence of AKI and a significant cost saving.
- Hence, MiECC should be considered as an adjunct for all patients undergoing coronary artery bypass grafting.

References

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Expert Desk

Myocardial protection by left ventricular mass consideration in chronic aortic valve disease

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Objective:
To present a case report of Left Ventricular Mass (LV Mass) calculation and use of custodial cardioplegia by consideration of LV Mass for myocardial protection in chronic aortic valve disease.

Case Study:
A 56-year-old, non-smoker, male without any apparent history of DM, HT, presented to cardiology OPD with exertional dyspnoea NYHA CL III, and few episodes of exertional syncope. His clinical examinations revealed normal hemodynamic parameters, however on aortic area auscultation, there was harsh Gr IV/VI ejection systolic murmur noted. ECG was unremarkable except the presence of left ventricular hypertrophy (LVH). CXR suggestive of mild cardiomegaly. 2D-Echo and colour doppler study showed degenerative calcified aortic valve with severe Aortic Stenosis (AS), with peak gradients of 99 mmhg and mean gradient of 60 mmhg across the aortic valve with mild Aortic Regurgitation (AR). Additionally, there was a global hypokinesia with Left Ventricular (LV) dysfunction, ejection fraction (EF) 30%. Suggesting long standing obstructive aortic valve disease. The patient was planned for early aortic valve replacement (AVR).

Discussion:
Custodial cardioplegia solution in this patient with severe aortic valve disease was calculated on the basis of LV Mass. We got the same results with the single dose custodial cardioplegia where dose was calculated by 2D-echo Linear method, as we conventionally observe in the cardioplegia solution on the basis of body weight and if we premise a heart weight of about 400 g, expected dose comes 0.25 ml/min/100 g and that's exactly the value, we have measured in this case study as proven in many animal experiments.

Conclusion:
Determination of the dose and type of crystalloid cardioplegic solution by LV mass, appears to be useful to ensure myocardial protection during cardioplegic arrest in the hypertrophied left ventricle in chronic aortic valve diseases.

Keywords
LV Mass determination, crystalloid cardioplegia/HTK Solution, A Single-Dose Hyperpolarisation, 2D- Echocardiography Linear Method, Hyperkaliaemic Cold Blood Cardioplegia, Chronic Aortic Valve disease, LV Hypertrophy.

Introduction

Patients with chronic aortic valve disease and left ventricular hypertrophy (LVH) who underwent aortic valve replacement (AVR) were always the part of challenging pathophysiology and skilful surgical correction. Selection of method for myocardial protection represents a great challenge to the perfusionist and surgical team in hypertrophied heart in such kind of cardiac surgeries. Several strategies have been described to protect the hypertrophied myocardium during cardiopulmonary bypass (CPB) and avoid the ischemia-reperfusion injury, yet the ideal strategy has not been identified. This case study inspects the use of cold custodial cardioplegia by LV Mass consideration to protect hypertrophied myocardium in patients undergoing aortic valve replacement (AVR). LV Mass has been calculated by Linear Method of 2D-Echocardiography. Calculated LV Mass was 498 gm by obtaining LV dimensions which ranged in severe hypertrophy of the heart.

Single dose hyperpolarised cardioplegia dose was calculated as 2 ml/gm of LV mass (In 1985 – 1986 As per the guideline given by the First Department of Surgery, Osaka University Medical School, Osaka, Japan for the repetitive cardioplegia which mentioned the ranges from 2.0 to 3.6 ml/gm).

A Case Report

A 56-year-old gentleman obtained fitness for aortic valve replacement (AVR) by pre-anaesthesia check-up (P-A-C) before a day. His measured height 165 cm, weight 81 kg and calculated BSA 1.8 m^2. He was diagnosed with severe Aortic Stenosis (AS), and peak gradients of 99 mmhg and mean gradient of 60 mmhg across aortic valve with mild Aortic Regurgitation (AR). Additionally, there was global hyperkinesia with Left Ventricular (LV) dysfunction, mild mitral stenosis (MS), moderate mitral regurgitation (MR), mild tricuspid regurgitation (TR), moderate pulmonary artery hypertension (PAH) ejection fraction (LVEF) 30%.

Coronary angiogram was normal, Haematological investigations within normal limits. He underwent an uneventful AVR by median sternotomy and conventional cardiopulmonary bypass (CPB) submission, ascending aortic cannulation obtained by 24fr right angled metal tip arterial cannula and bi-caval cannulation done with the selection of 24fr right angled venous cannula for SVC and 28fr right angled venous cannula for IVC, 14fr "Y" cardioplegia needle used for the delivery of custodial cardioplegia in the aortic root. With the help of given LV dimensions by applying 2D-Echocardiography linear method intended LV Mass calculated was 498 gm(500 gm approx.) and the calculated custodial cardioplegia dose was 996 ml (1000 ml) for this severe LV hypertrophied patient.

Immediately after applied cross clamp myocardial protection instituted with 1000 ml (996 ml) dose of custodial cardioplegia, it was delivered antegrade way by using roller pump and kole's chamber at the bath temp 4°C with the flow of 180-200 ml/min with the pressure of 100-110 mmhg for the duration of 5-6 minutes. ABG obtained on CPB with adequate readings. AVR done with a 21 mm Dafodil pericardial bioprosthetic using interrupted horizontal non-pledgetted mattress technique with 2/0 ethibond surgical suture. Achieved the heart rhythm without any arrhythmic events and came off CPB with the minimal inotropic support and sinus rhythm. CPB time was 118 minutes and the cross-clamp time was 80 minutes. Patient extubated immediately on OT table without any inotropic support and the uneventful post-op progression till the discharge from the hospital. He is regular on follow-up and doing well. Regression of LV mass found to be 245 gm, peak gradient fell to 42 mmhg and mean gradient 28mmhg across aortic valve with improved LVEF 55% within 3 months follow-up.

Discussion

In this case study LV Mass was determined by preoperative 2D-Echocardiography Linear Method. This non-invasive method is safe and easy to apply for estimation of required LV mass and has been proposed that the good correlation with Cardiovascular Magnetic Resonance (CMR) and the angiography method. This would facilitate dose determination of cardioplegic solution for all chronic aortic valve disease patients. From the First Department of Surgery, Osaka University Medical School, Osaka, were studied long trial series with the hyperkaliaemic cold blood cardioplegia. Here initial dose was used as higher from 1.0 to 3.6 ml/gm (average 2.7 ml/gm). First infusion of cardioplegic solution was delivered through the aortic root when possible, and the subsequent infusions were performed through coronary orifices;two-thirds of the dose went to the left coronary system and the remaining third, to the right coronary system. A dose that was half the initial dose was reinfused every after 30 minutes.

The Brettschneider HTK (histidine, tryptophan, alpha-ketoglutarate) solution (low Ca, low Na, procaine and histidine buffer) has been clinically studied and proven for the longer duration of myocardial protection in case of minimally invasive or complex cardiac surgeries or in the heart transplant cardiac surgeries. There was no much data available regarding a use of custodial cardioplegia for the conventional cardiac surgeries. And if we premise a heart weight of about 400 g, it means .25 mL/min/100 g. And that is exactly the value we have measured in this case of AVR surgery. It is necessary to reduce the O_2 consumption as much as possible because of the biological fact: the lower the O_2 consumption, the higher is the creatine phosphate content, that means also only speculate, since no clinical data do exist. By the extended cardioplegic perfusion the energetical content of the myocardium increases, that may be beneficial for patients

with low ejection fraction. The creatine phosphate and O_2 consumption are the equilibration processes are volume related but, mainly, time related because these diffusion processes require time. The mode of administration of cardioplegia by HTK solution means only singular antegrade cardioplegia perfusion. Using HTK solution means no re-plegia up to 3-4 hours of cardiac arrest is necessary. Many researches first switch from blood to crystalloid and then furthermore switch from re-plegia to no-replegia, and dose calculation considered on LV Mass calculation rather than body weight of the patient.

2D Echocardiography, Cardiovascular Magnetic Resonance (CMR) and Angiography are the Methods for Left Ventricular Mass Measurements:

2D:LV mass – male

- Normal: 96 – 200 gm
- Mild: 201 – 227 gm
- Moderate: 228 – 254 gm
- Severe: >255 gm

2D:LV mass – female

- Normal: 66 -150 gm
- Mild: 151 – 171 gm
- Moderate: 172 – 192 gm
- Severe: >193 gm

Key factors affecting LVM:

- LVM is strongly influenced by body size.
- Males have larger LVM than females.
- Athletes have increased LVM compared to nonathletes.
- Black men and women have larger LVM than their white or Asian Counterparts.
- Obesity is associated with increased LVM.

The above-mentioned body size, ethnic, and exercise-related factors are associated with increased LVM, as well as proportional increases in left ventricular (LV) volume, which initially maintains normal LV wall stress. Accordingly, LV relative wall thickness (RWT), defined as the ratio of twice the LV inferolateral wall thickness to the LV internal diameter measured at end-diastole, initially remains unchanged. Other factors to be considered are age and blood pressure.

Conclusion

Due to major advantages in anaesthesiology, intensive care medicine, and cardiac surgery, today patient's safety and surgeon's convenience have advanced into primary evaluative criteria for cardioplegia selection and intra-operatively myocardial protection, which ensured by clinical perfusionist on CPB. That is the update of the present situation. Any cardioplegic method impacts both of these parameters.

Scientifically, the need of cardioplegic reperfusions reflects, inadequate potency of any applied method, thereby reaching the limit of myocardial resuscibility early. In this case selection of single dose cardioplegia and accurate calculation of dose without re-plegia means time saving and dose calculation was scientific on the basis of LV Mass consideration.

Determination of the dose of cardioplegia solution by LV Mass, appears to be useful to ensure myocardial protection during cardioplegic arrest in hypertrophied left ventricle. Approximately 3.0 ml per gram of LV Mass seems to be optimum initial dose for patient with chronic aortic valve disease in case of repetitive type of hyperkaliaemic cold blood cardioplegia. And its slightly less as 2 ml per gram of LV Mass in selection of hyperpolarised single dose custodial cardioplegia. At this point ambitious modern cardiac surgery is feasible by selection and quantity of single dose hyperpolarised solution without cardioplegic reinfusion.

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NEWS CORNER

Clinical cardiovascular perfusionists are subjected to stress during cardiopulmonary bypass

Cardiac perfusionists are allied health professionals who are trained to operate, maintain, and record the output of a cardiopulmonary bypass (CPB) machine, also known as a heart-lung machine. They are an important part of a cardiac surgical team, which include a cardiothoracic surgeon, anaesthesiologist, cardiac care nurses, and operating room technicians.

The key responsibilities of the perfusionist are:

- Maintaining and regularly testing CPB equipment
- Selecting patient-specific equipment
- Regulating the blood flow and blood temperature during surgery
- Analysing the blood chemistry throughout surgery and making adjustments as needed
- Administering anaesthetics and medications through the heart-lung circuit under the direction of the anaesthesiologist or surgeon
- Employing an intra-aortic balloon pump, when needed, to enhance cardiac perfusion and heart function

Performing cardiopulmonary bypass is a complex task which involves evaluating visual input from patient monitors and technical parameters displayed at the heart-lung machine console as well as reacting to other sensory input. It is important to have competent clinical cardiovascular perfusionists, with attention, perception, and coping with mental stress. This study aims at evaluating attention, perception, and stress levels of clinical cardiovascular perfusionists during cardiopulmonary bypass.

Materials and Methods

Study participants:

Nine clinical cardiovascular perfusionists

Procedure:

Participants were asked to wear Tobii 2 eye-tracking glasses throughout the procedure.

Specific time points analysed were:

- Cardiopulmonary bypass start
- Initial cardioplegia delivery
- Steady state
- Cross-clamp off
- Weaning from cardiopulmonary bypass

It was supplemented by participants' self-evaluation regarding their stress levels and by National Aeronautics and Space Administration Task Load Index (NASA TLX) questionnaires.

Results

- Professional experience ranged from 0.5 to 24 years.
- Large variations in areas of interest hits, fixation, and dwell times.
- Across all phases, the venous reservoir, mean arterial pressure, arterial pump display, cardioplegia control, and data management system received the highest levels of attention.
- Pupil diameter measurements increased at the start of cardiopulmonary bypass, cardioplegia delivery, and weaning off, but returned to base level during steady state.
- Self-evaluation showed that subjective stress level was highest at the start and the end of the procedure.
- NASA TLX questionnaires revealed medium-to-high mental and temporal workloads, but low physical workloads.
- Performance, effort, and frustration indices showed medium workloads.

Conclusion

During cardiopulmonary bypass, perfusionists are subjected to stress. Peak stress levels were highest during the start and end of cardiopulmonary bypass. Furthermore, visual attention and perception varied between the operative phases. Further studies are indicated to evaluate the design of heart-lung machines and stress-coping strategies during cardiopulmonary bypass.

Reference

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Practice Pearls

Update on blood conservation for cardiac surgery

Perioperative bleeding requiring blood transfusion is common during cardiac operations, especially those procedures that require cardiopulmonary bypass (CPB). Cardiac operations consume as much as 10% to 15% of the nation's blood supply, and evidence suggests that this fraction is increasing largely because of increasing complexity of cardiac surgical procedures. Complex cardiac operations like redo procedures, aortic operations, and implantation of ventricular assist devices require blood transfusion with much greater frequency.[1]

In contrast, there is a growing body of evidence demonstrating that blood product transfusion is associated with an increased risk of morbidity and mortality. **A broad approach to blood conservation is one way to minimize the risk.** Limiting the use of blood and blood products in cardiac surgery is a multimodal strategy that involves a combined effort among all disciplines involved in patient care.[2]

Blood conservation methods are numerous but not mutually exclusive, and they have been applied to all aspects of a patient's medical care during the perioperative period.[2]

Various blood conservation strategies[2]

- Increasing preoperative red blood cell (RBC) mass
- Use of autologous blood
- Decreasing perioperative bleeding
- Optimising transfusion practices

Evidence based information

Avgerinos DV ***et al*** conducted a study to see the impact of their implementation of a more aggressive strategy for intraoperative blood conservation in cardiac surgery.[3]

Materials and Methods

Comparison of database retrospectively and outcomes from two different time periods after implementation of a more effective two-way blood conservation strategy: More aggressive intraoperative autologous donation (IAD) based on a newly constructed nomogram, and the use of a shorter length circuit of the cardiopulmonary bypass (CPB) which allowed for lower fluid volume as a prime.[3]

Results

- A total of 1126 patients (Group 1) were studied after the implementation of the new strategy and compared with 3758 patients (Group 2) of the previous strategy.[3]
- There was a significant reduction in the percent change of the intraoperative haematocrit between Groups 1 and 2 (14 vs 28%, p=0.01), with an increase in the mean IAD volume (655 vs 390 ml, p=0.02) and a reduction in the CPB priming volume (1000 vs 1600 ml, p=0.03).[3]
- Group 1 required significantly less blood transfusions in the perioperative period (29 vs 49%, p=0.02) and had significantly reduced postoperative rates of respiratory failure (3 vs 7%, p=0.03), pneumonia (1 vs 3.1%, p=0.01), chest tube output (350 vs 730 ml, p=0.01), reoperation for bleeding (1.2 vs 2.5%, p=0.04) and length of stay (6.1 vs 8.2 days, p=0.05).[3]

Conclusion

Blood conservation is safe and effective in reducing transfusions in cardiac surgery, minimising perioperative morbidity and mortality. Aggressive IAD and low CPB prime, along with effective retrograde autologous priming, is the three-way blood conservation strategy that leads to improved outcomes in cardiac surgery.

References

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2. Nalla BP, Freedman J, Hare GM, Mazer CD. Update on blood conservation for cardiac surgery. J Cardiothorac Vasc Anesth. 2012;26(1):117-133.
3. Avgerinos DV, DeBois W, Salemi A. Blood conservation strategies in cardiac surgery: more is better. Eur J Cardiothorac Surg. 2014;46(5):865-870.

Interactive Capsule

Multiple-choice questions

1. What is COVID-19?

a. Name of virus
b. Name of disease
c. Name of drug
d. A place in China

2. How can we maintain hand hygiene?

a. Wash with soap and water
b. Wash with plain water
c. Wipe hands with tissue paper or cloth
d. Wash with soap and water and, scrub for at least 20 secs

3. What are the methods to prevent COVID-19?

a. Physical distancing- 1 meter
b. Physical distancing- 2 meter
c. Physical distancing- 6 feet
d. Both b and c

4. How does Coronavirus transmit?

a. Droplets spread - When a person sneezes or cough
b. Constant touching of face, eyes or mouth in public place
c. Close contact with a COVID-19 infected person
d. All of the above

5. Select the incorrect statement from below regarding, "Recommendations for resuming cardiac surgery in the SARS-CoV-2 era."

a. Remote working and telemedicine may be used for close and convenient patient follow-up
b. Discharging post-operative cardiac surgery patients to nursing facilities is beneficial where there is high prevalence of SARS-CoV-2 infection
c. All cardiac surgery patients should be screened pre-operatively for COVID-19
d. Postpone care for patients that test positive for COVID-19

6. Retrograde autologous priming (RAP) of the cardiopulmonary bypass (CPB) circuit is considered as a blood conservation strategy?

a. Yes
b. No

7. Which are the intra-operative techniques of blood conservation?

a. Intraoperative phlebotomy before cardiopulmonary bypass (CPB)
b. Use of crystalloid oxygenator prime to achieve normovolemic haemodilution
c. Intraoperative retransfusion of all blood removed by cardiotomy suction
d. Reinfusion of all blood remaining in venous tubing and the oxygenator after CPB
e. All of the above

8. Which anticoagulant is delivered through double-lumen tubing to the suction catheter and mixed with aspirated blood en route to a standard cardiotomy reservoir containing a 120-pm filter?

a. Heparin
b. Citrate
c. Any of the above
d. None

9. Maximum blood conservation requires routine drainage of all venous blood into the oxygenator with reinfusion of oxygenator contents after decannulation.

a. True
b. False

10. Select the incorrect statement from below: Minimally invasive extracorporeal circulation,

a. Allows optimal perfusion with higher mean arterial pressure
b. Reduced requirement for vasoactive drugs
c. Improved end-organ protection
d. Systemic vascular resistance is less than normal values

Answers: 1 - b, 2 - d, 3 - d, 4 - d, 5 - b, 6 - a, 7 - e, 8 - c, 9 - a, 10 - d

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