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Ventricular Mass Index as a Reliable Method to Calculate Cardioplegia Volume

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ABSTRACT

Introduction: In cardiac surgery is essential protect myocardial tissue during cardiac arrest to perform the surgical procedure. The Cardioplegic solution has showed significant efficacy for myocardial protection by providing buffer mediators. The volume needed to achieve cardiac arrest is usually calculated using patient's weight or body surface area as a reference. However, the increase in ventricular mass secondary to cardiac pathology frequently does not coincide with the patient's weight and body surface area, requiring different cardioplegic solution volume to achieve myocardial arrest and protection. In this study we explored the true volume of cardioplegia administered to achieve myocardial arrest and protection adjusted to myocardial mass index.

Method: We selected patients undergoing open heart surgery with cardiac arrest and administration of cardioplegia solution as myocardial protector and were registered following variables: Age, sex, body weight, body surface, Mass Ventricular Index, cardiovascular factor risk, cardiac pathology and surgical complications.

Results: Were analyzed 112 patients of 60±10 years old, 76% (n = 85) were male and 24% (n = 27) female. The cardioplegic solution calculated at 30, 40 and 50 ml using as reference Body Weight (BW) and Body Surface (BS) showed significant differences with real volume administrated to approach electromechanical cardiac arrest, as well as between BW and BS (p = 0.001), indicated that adjust 14 ml for each gram indexed myocardial mass probably could provide better performance to achieve myocardial arrest and protection.

Conclusion: The real cardioplegic solution volume administrated in open heart surgery is significantly different with volume calculated with BW and BS as reference and calculated with VMI very probably is a better way to calculate the cardioplegia solution volume.

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Introduction

The valvular heart disease usually requires open cardiac surgery with cardiac arrest to substitution of diseased valve, using cardioplegic solution to provide myocardial arrest and protection during cool ischemia, intracardiac procedure and extracorporeal circulation (1-7).

The cardioplegic solution is applied in open heart surgery to produce electromechanical cardiac arrest, which gives cardiac surgeons the opportunity to perform surgical procedure in a bloodless field and provide buffer mediators (Histidine–tryptophan–ketoglutarate) to protect myocardial cells

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through reducing energetic cell metabolism (8-10).

To calculate the cardioplegic solution volume to produce cardiac arrest, usually is used the body weight or body surface, however, in the surgical practice frequently do not match the cardioplegic volume calculated with real volume required to reach cardiac arrest, probably because exist ventricular mass increased by valvular cardiac pathology. (11) In this study we explored the true volume of cardioplegia administered to achieve myocardial arrest and protection adjusted to myocardial mass index.

Methods

Was performed a cross-sectional retrospective study authorized by institutional committees. Were include patients underwent to open heart surgery to resolve valvular cardiac disease with Bretschneider cardioplegic solution (Custodiol) to cardiac arrest and were registered the following variables: Age, sex, body weight, body surface, cardiovascular factor risk, cardiac pathology and surgical complications. The Ventricular Mass Index (VMI) was calculated by echocardiography evaluation using Devereux's formula.

Statistical analysis

The univariate analysis was performed with mean, standard deviation and percentages. The inferential analysis with t student and ANOVA test. A p value < 0.05 was considered significant and the IBM-SPSS v29.0 statistical program was used.

Results

Were analyzed 112 patients of 60±10 years old, 76% (n = 85) were male and 24% (n = 27) female, with body weight of 97± 10 kg, Body Surface of 18±2 m2 and Ventricular Mass Index (VMI) of 107±35. The patients were undergone to aortic valve (n = 62) and mitral valve substitution (n = 49). All patients were portables of at less two cardiovascular factor risk, highlighting Hypertension (75%) and Mellitus Diabetes (53%). The principal trans surgical complications were ventricular fibrillation (n = 9) and atrioventricular block (n = 3). (Table 1)

The cardioplegic solution calculated at 30, 40 and 50 ml using as reference Body Weight (BW) and Body Surface (BS) showed significant differences with real volume administrated to approach electromechanical cardiac arrest, as well as between BW and BS (p = 0.001), indicated that adjust 14 ml for each gram indexed myocardial mass probably could provide better performance to achieve myocardial arrest and protection.

Table 1. Cardiac pathology, cardiovascular factor risks and trans surgical complications.

	n	%
Cardiac Pathology		
Aortic stenosis	62	56
Mitral stenosis	49	44
Cardiovascular Factor Risk		
Hypertension	75	68
Mellitus Diabetes	53	48
Smoking	41	37
Dyslipidemia	34	31
Trans surgical complications		
Ventricular fibrillation	9	8
Atrioventricular Block	3	2

Table 2. Cardioplegia solution volume compared with Body Weight, Body Surface and Real Cardioplegia Volume administrated to cardiac arrest.

	Cardioplegia solution volume			Real Cardioplegia Volume (ml)	P**
	Body Weight (kg)	Body Surface (m2)	P*		
30 ml	2200±45	540±60	0.001	1500±40	0.001
40 ml	3800±75	720±80	0.001		
50 ml	4800±86	900±100	0.001		
p value was calculated with t student * and ANOVA test **					

Discussion

The cardiac valvular disease requires underwent to open heart surgery for valvular substitution with cardiac arrest with cardioplegic solution infusion to gives cardiac surgeons the opportunity to perform surgical procedure in a bloodless field and provide myocardial protection too, although the volume of this solution calculated using BW and BS as reference usually is not sufficient to reach the desired effect. (19-21) In this study we observed that the real cardioplegic solution volume administrated showed significant differences with the volume calculated with BW and BS as reference, suggesting use the VMI probably has a better approach to reach efficient electromechanical cardiac arrest and myocardial protection into cool ischemia during intracardiac surgical procedure.

In a search scenario for a better way to calculate cardioplegia volume because the ventricular myocardial mass usually is very different to BW and BS by changes produced for valvular pathology, probably use the VMI as reference to calculate the real cardioplegic volume could be the better way to reach myocardial protection through provide substrates with energetic potential that permit normal mitochondrial activity into the myocardial cell (19-21).

In this sense, calculate the cardioplegia solution volume to 14 ml by gram myocardial mass index could provide sufficient protection activity during cool ischemia and myocardial arrest, although this hypothesis must be proven in specific investigations, because this measure was obtained until later the real cardioplegia volume was administrated due to observational retrospective cross-sectional characteristics of present investigation.

Conclusion

The real cardioplegic solution volume administrated in open heart surgery is significantly different with volume calculated with BW and BS as reference and calculated with VMI very probably is a better way to calculate the cardioplegia solution volume.

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