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Reposição Volêmica Intraoperatória: Cristaloides *versus* Coloides em Revascularização Cirúrgica do Miocárdio sem Circulação Extracorpórea *

Intraoperative Volume Replacement: Crystalloids versus *Colloids in Surgical Myocardial Revascularization without Cardiopulmonary Bypass*

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RESUMO

Soares RR, Ferber L, Lorentz MN, Soldati MT - Reposição Volêmica Intraoperatória: Cristaloides *versus* Coloides em Revascularização Cirúrgica do Miocárdio sem Circulação Extracorpórea.

JUSTIFICATIVA E OBJETIVOS*: O uso de cristaloides ou coloides na reposição volêmica de intervenções cirúrgicas de grande porte é assunto controverso. O objetivo deste trabalho foi comparar os efeitos do cristaloide (solução fisiológica a 0,9% SF) com coloide (gelatina fluida modificada) quando administrados no intraoperatório de revascularização cirúrgica do miocárdio (RVCM) sem circulação extracorpórea (CEC).*

MÉTODO*: Quarenta pacientes submetidos à RVCM sem CEC foram divididos aleatoriamente em dois grupos similares. O primeiro grupo recebeu gelatina fluida modificada e SF e o segundo grupo recebeu somente SF. Registrou-se a diurese, nível da hemoglobina, sangramentos intra e pós-operatórios, valores de glicemia e lactato do intraoperatório em quatro medidas distintas. Foram avaliados a morbimortalidade pós-operatória, o tempo de internação na unidade de terapia intensiva (UTI) e o tempo de internação hospitalar.*

RESULTADOS*: O tempo de extubação do grupo da gelatina foi de 6,6 horas contra 7,3 horas do grupo do SF. O tempo de internação no CTI foi de 2,4 dias no grupo da gelatina contra 3,3 dias no grupo do SF. O tempo de internação hospitalar no grupo da gelatina foi de 10,3 dias contra 6,8 dias no grupo do uso exclusivo de SF. A ocorrência de complicações renais, respiratórias, disritmias cardíacas, infartos, infecções, reintubações, transfusões sanguíneas e reoperações foi a mesma.*

CONCLUSÕES*: O uso de coloides, representados pela gelatina fluida modificada associada a cristaloides ou o uso de cristaloides exclusivamente não alterou o prognóstico pós-operatório de pacientes submetidos à RVCM sem CEC nos pacientes estudados. Talvez mais importante que o tipo de líquido administrado ao paciente cirúrgico seja a manutenção de estabilidade hemodinâmica adequada durante o procedimento.*

Unitermos: CIRURGIA, Cardíaca: revascularização do miocárdio; circulação extracorpórea; VOLEMIA: cristaloide, coloide.

SUMMARY

Soares RR, Ferber L, Lorentz MN, Soldati MT – Intraoperative Volume Replacement: Crystalloids *versus* Colloids in Surgical Myocardial Revascularization without Cardiopulmonary Bypass.

BACKGROUND AND OBJECTIVES: *The use of crystalloids or colloids for volume replacement in large size surgeries is controversial. The objective of this study was to compare the effects of the intraoperative administration of crystalloids (normal saline – NS) with those of colloids (modified fluid gelatin) for surgical myocardial revascularization (SMR) without cardiopulmonary bypass (CPB).*

METHODS: *Forty patients undergoing SMR without CPB were randomly divided in two similar groups. The first group received modified fluid gelatin and NS and the second group received only NS. Urine output, hemoglobin level, intra- and postoperative bleeding, blood glucose levels, and intraoperative lactate in four distinct measurements were recorded. Postoperative morbidity and mortality, length of stay in the intensive care unit (ICU), and length of hospitalization were analyzed.*

RESULTS: *Time to extubation in the gelatin group was 6.6 hours versus 7.3 hours in the NS group. The length of stay in the ICU was 2.4 days in the gelatin group versus 3.3 days in the NS group. The length of hospitalization was 10.3 days in the gelatin group versus 6.8 days in the NS group. The incidence of renal and respiratory complications, cardiac arrhythmias, myocardial infarctions, infections, reintubations, blood transfusions, and reoperation was the same in both groups.*

CONCLUSIONS: *The use of colloids represented here by modified fluid gelatin associated with crystalloids or the use of crystalloids alone did not change the postoperative prognosis of patients undergoing SMR without CPB. Perhaps maintenance of the hemodynamic balance during the surgery is more important than the type of fluid administered.*

Keywords: SURGERY, Cardiac: myocardial revascularization, cardiopulmonary bypass; VOLEMIA: crystalloid, colloid.

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Intraoperative Volume Replacement: Crystalloids versus *Colloids in Surgical Myocardial Revascularization without Cardiopulmonary Bypass*

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INTRODUCTION

Surgical myocardial revascularization (SMR) without cardiopulmonary bypass (CPB) has already conquered its place in contemporaneous medicine. It reduces the transfusion of blood products, the incidence of myocardial damage reflected in the release of troponin-I, and some studies have reported a reduction in the length of stay in the intensive care unit (ICU) and hospitalization [1,2].

Proper volume replacement is essential in patients undergoing SMR without CPB. Hypovolemia leads to inadequate tissue perfusion, renal failure, cardiac arrhythmias, and reduction in oxygen delivery to tissues. On the other hand, hypervolemia leads to an increase in the cardiac work load, reduction in myocardial contractility, respiratory failure, reduction in gastrointestinal mobility, and reduction in oxygen delivery to tissues. The ideal would be to maintain hemodynamic stability and improve tissue perfusion without promoting great losses into the insterstitial tissue. The choice between colloids and crystalloids is controversial [3,4]. It has already been demonstrated that if hypervolemia is avoided the type of fluid used for hydration does not affect pulmonary permeability or the development of pulmonary edema [5]. However, the choice of fluid and volume to be administered influences the prognosis of severely ill patients [6].

Volume replacement of intraoperative losses (fasting and insensible losses), commonly with crystalloids (NS or Ringer's lactate) favor a reduction in plasma osmotic pressure, leading to loss of fluids into the third space [7]. Crystalloids cross freely the capillary membrane and a small volume remains in the intravascular space [8]. Colloids stay longer in the blood stream, but its volume expansion effect is transitory. The benefits of colloids as volume expander is secondary to its osmotic strength combined with its depuration from the blood stream, which depends on the percentage of extravasation, degradation, and renal and gastrointestinal losses [9].

Modified fluid gelatin and medium size starch are the synthetic colloids used more often in our country. Gelatin results from the hydrolysis of bovine collagen. Modified fluid gelatin is a synthetic colloid used for volume replacement, it is isooncotic in relation to plasma and it has a half-life of four hours. Different from first-generation gelatins, succinylation of modified gelatin reduces the incidence of anaphylactic reactions [10]. Succinylation causes a conformational change that increases the size of the gelatin molecule. Evidence that this conformational change affects renal function does not exist [11,12], and its effect on coagulation seems to be small [13,14].

The objective of the present study was to compare the effects of the intraoperative administration of crystalloids (NS) to those of colloids (modified fluid gelatin) in surgical myocardial revascularization (SMR) without cardiopulmonary bypass (CPB).

METHODS

After approval by the Ethics Commission and signing of the informed consent, a prospective, randomized study of patients scheduled for SMR without CPB was undertaken. Patients with bleeding disorders, myocardial infarction in the past three weeks, hemoglobin below 10 $g.dL^{-1}$, renal (creatinine > 1.3 $mg.dL^{-1}$) or liver failure (aspartate aminotransferase > 40 $U.L^{-1}$ and alanine aminotransferase > 40 $U.L^{-1}$), on anticoagulants, and those admitted for urgent procedures were excluded from the study. All medications were maintained until the day of the surgery except oral anticoagulants and acetyl salicylic acid, which were discontinued two and seven days before the surgery, respectively.

Patients undergoing surgical myocardial revascularization without cardiopulmonary bypass (CPB) between January and June of 2007 were included in the study. They were randomly divided in two groups by a closed envelope system. In all patients, monitoring consisted of cannulation of the radial artery and subclavian vein, electrocardiogram (ECG), esophageal temperature, pulse oximetry, capnography, endotracheal pressure, urine output, activated coagulation time (ACT), and serial blood tests.

All patients observed an 8-hour fasting, and they did not receive venous infusion on the day of the surgery. Pre-anesthetic medication consisted of oral bromazepam 3 mg, the night before the surgery and one hour before arriving at the operating room. Midazolam (0.05 to 0.1 $mg.kg^{-1}$) and fentanyl at a total dose of up to 25 $\mu g.kg^{-1}$ were used for anesthetic induction and repeated as needed to maintain anesthetic balance and good anesthetic-surgical plane. Isoflurane was the inhalation agent used, maintaining a minimal alveolar concentration between 0.25% and 1%. The lungs were ventilated with a tidal volume of 7 to 8 $mL.kg^{-1}$ and inspired oxygen fraction of 60% in a mixture with room air. The final expiratory pressure was maintained at 5 cm of water.

Volume replacement was aimed at maintaining the central venous pressure (CVP) above 10 mmHg. Patients in the first group (GEL) received modified fluid gelatin and NS; the second group received only NS. In all patients, NS was administered to replace insensible losses and infusion of drugs during surgery. Fluids infused were warmed to maintain normothermia. Mean arterial pressure was maintained between 70 and 85 mmHg, and sodium nitroprusside (to control hypertension) or phenylephrine (to treat hypotension)

were used whenever necessary. Packed red blood cells were used when hemoglobin (Hb) reached 9 $mg.mL^{-1}$.

Hemodynamic parameters monitored included the heart rate, mean arterial pressure, and central venous pressure. Laboratorial data included arterial blood gases, blood glucose levels, hemoglobin, hematocrit, potassium, and lactate. All were documented at the time of anesthetic induction, sternotomy, anastomosis, insertion of cannulas, closing of the incision, and on the first postoperative day (24 hours after the surgery).

The amount of fluids administered, urine output, and blood loss were measured in the intraoperative period and up to 24 hours after the surgery.

Regarding postoperative complications, respiratory failure was defined as the difficulty to reduce ventilatory parameters and progression to extubation; the elevation of creatinine above 1.5 $mg.dL^{-1}$ was considered renal failure; arrhythmia was defined as the presence of a cardiac rhythm other than sinus rhythm; and in the ICU patients were evaluated for the presence of electrocardiographic changes that indicated the need for a new hemodynamic study, and elevation of the marker for myocardial necrosis (CK-MB above 24 $mg.dL^{-1}$) for the diagnosis of acute myocardial infarction. Signs of infection (body temperature above 38° C, and leukocytosis with left shift) were also investigated. The need for postoperative blood transfusions was evaluated until hospital discharge, tolerating hemoglobin levels as low as 9 $mg.dL^{-1}$.

The Chi-square test was used to analyze the frequency distribution as well as the Fisher's Exact test whenever necessary (expected value below 5 in one square). The Student *t* test was used to compare means. For continuous parameters that did not present a Gaussian distribution, the Kruskal-Wallis test was used to compare means. The limit of statistical significance used in this study was 5% ($p < 0.05$).

RESULTS

Forty patients undergoing SMR without CPB from December 2006 to December 2007 participated in this study. Patients who did not fulfill the criteria established were excluded. Patients were divided in two groups according to the sealed-envelope system.

Both groups were similar regarding demographic and intraoperative parameters, as well as the preoperative use of beta-blockers and angiotensin converting enzyme inhibitors (ACEI) (Table I).

As for the parameters collected during the surgery, statistical analysis showed that both groups were similar regarding the parameters listed below:

Fluid balance: intraoperative urine output, total urine output, intraoperative bleeding, total bleeding, preoperative hemoglobin, postoperative hemoglobin, and transfusion of blood products (Table II).

Laboratorial data: blood glucose (four measurements per patient) and lactate (four measurements per patient) (Table III).

Hemodynamic evaluation (all items evaluated in nine moments): heart rate (bpm); mean arterial pressure (MAP, mmHg); CVP (mmHg); peripheral oxygen saturation (SpO_2); and expired CO_2 ($P_{ET}CO_2$) (Table IV).

The use of vasoactive or inotropic drugs did not show statistically significant differences between both groups (Table V).

Postoperative complications, such as renal and pulmonary complications, postoperative transfusion, arrhythmia, need of a new hemodynamic study, reintubation, reoperation, or postoperative infection did not show statistically significant differences (Table VI),

As for the postoperative follow-up, time to extubation in the ICU (h), number of days in the ICU, and length of hospitalization, comparison of the median was similar in both groups (Table VII).

Table I – Demographic Data and Other Patient Characteristics

Parameter	Gelatin group	NS group	Statistical test	p
Age (years)	66 ± 10	67 ± 11	0.32 *	0.75
Weight (kg)	73 ± 10	71 ± 12	0.62 *	0.54
Euroscope	7.8 ± 11.1	5.1 ± 3.8	0.10 **	0.76
Gender (M/F)	13/7	15/5	0.06 #	0.73
Number of grafts	2.3 ± 0.7	2.4 ± 0.7	0.21 *	0.80
Use of beta-blockers	14	12	0.11 #	0.74
Use of ACEI	10	9	0.00 #	1.00
Diabetes mellitus	6	7	0.05 #	1.00
COPD	2	4	##	0.66

ACEI – angiotensin converting enzyme inhibitor; COPD – chronic obstructive pulmonary disease.
Statistical tests: * Student *t* test; ** Kruskal-Wallis; # Chi-square; ## Fisher's Exact test

Table II – Fluid and Blood Balance

Parameters	Gelatin group	NS group	Statistical test	p
Intraoperative				
Crystalloids (mL.kg^{-1})	23 ± 11	50 ± 10	7.93 *	< 0.0001
Colloids (mL.kg^{-1})	12 ± 4	0 ± 0	12.1 *	< 0.0001
Urine output (mL.kg^{-1}.min^{-1})				
Intraoperative	1.6 ± 0.5	2.2 ± 1.6	0.60 **	0.44
Postoperative	1.4 ± 0.5	1.6 ± 0.8	0.36 **	0.55
Bleeding (mL.kg^{-1})				
Intraoperative	4.8 ± 3.5	5.2 ± 2.3	0.34 *	0.73
Total	13.7 ± 6.7	14.9 ± 7.3	0.55 *	0.58
Hemoglobin (g.dL^{-1})				
Preoperative	13.5 ± 1.4	13.3 ± 1.5	0.44 *	0.66
Postoperative	10.6 ± 1.5	10.7 ± 1.7	0.13 *	0.89
Transfusion of packed red blood cells (nº. units)	0.4 ± 0.8	1.0 ± 1.8	0.54 **	0.46

Statistical tests: * Student *t* test; ** Kruskal-Wallis

Table III – Intraoperative Laboratorial Data, Mean of Four Measurements

Parameter	Gelatin group	NS group	Statistical test	p
Blood glucose (mg.dL^{-1})	134 ± 37	128 ± 30	0.59 *	0.54
Lactate (mg.dL^{-1})	13.6 ± 6.4	10.6 ± 5.9	1.54 *	0.13

Statistical test: * Student *t* test

Table IV – Hemodynamic and Ventilation/Oxygenation Data, Mean of Nine Measurements

Parameter	Gelatin group	NS group	Statistical test	p
HR (BPM)	76 ± 10	74 ± 7	0.86 *	0.39
MAP (mmHg)	96 ± 19	104 ± 18	1.33 *	0.19
CVP (mmHg)	11.0 ± 3.8	12.4 ± 3.3	1.20 *	0.23
$P_{ET}CO_2$	26.4 ± 3.4	27.5 ± 2.3	1.18 *	0.24
PaO_2	98.7 ± 1.4	98.6 ± 1.2	0.23 *	0.81

Statistical test: * Student *t* test
CVP – central venous pressure; MAP – mean arterial pressure; PaO_2 – arterial oxygen saturation; $P_{ET}CO_2$ – expired fraction of carbon dioxide

Table V – Intra- and Postoperative Drugs

Parameter	Gelatin group	NS group	p *
Vasodilator	18	19	1.00
Noradrenaline	1	3	0.60
Dobutamine	0	1	1.00

Statistical test: * Student *t* test

Table VI – Assessment of Postoperative Complications

Parameter	Gelatin group	NS group	p *
Renal complication	1	0	1.00
Blood transfusion	2	2	1.00
Respiratory complication	2	4	0.66
Acute myocardial infarction	0	0	-
Reoperation	0	1	1.00
Catheterism	1	1	1.00

* Fisher's Exact test

Table VII – Postoperative Follow-up

Parameter	Gelatin group	NS group	Statistical test	p
Length of hospitalization (days)	10.3 ± 13.3	6.8 ± 0.8	0.02 **	0.89
Ventilation (hours)	6.6 ± 4.5	7.3 ± 4.7	0.54 *	0.59
Length of stay in the ICU(days)	2.4 ± 0.9	3.3 ± 3.4	1.25 **	0.26
Reoperation	0	1	##	1.00
Mortality	0	1	##	1.00

Statistical tests: * Student *t* test; ** Kruskal-Wallis; ## Fisher's Exact test

The length of anesthesia and surgery was similar in both groups. One patient died in the ICU from multiple organ failure 30 days after the surgery.

DISCUSSION

Surgical myocardial revascularization (SMR) without cardiopulmonary bypass (CPB) was first used in 1964 [15], but it was later abandoned due to the development of cardiopulmonary bypass and cardioplegic solutions. The interest on the technique increased in a few cardiovascular surgery centers around 1980 and, during the last decade with the development of modern stabilizers that allow good surgical exposure besides improving graft permeability the use of the procedure has been increasing in several centers around the world. Several metanalysis reported a reduction in the incidence of atrial fibrillation (AF) in SMR without CPB. Although AF is one of the factors that contribute for the development of intra- and postoperative strokes, its reduction did not show a linear translation in the reduction in the incidence of strokes in SMR without CPB [16-19]. Probable advantages of this surgery without CPB are seen especially in high risk patients with significant comorbidities [20], elderly, and, probably, emergency surgeries. In a retrospective study, Puskas et al. demonstrated significant benefits of SMR without CPB in women [21]. Contraindications of this procedure include the presence of intracavitary thrombus, malignant ventricular arrhythmias, deep intramyocardial vessels, and combined procedures with valvular change and left ventricular aneurismectomy.

Hemodynamic changes secondary to positioning of the heart, the use of a stabilizer, and distortion of the rings of the cardiac valves to obtain adequate surgical exposure have been described in SMR without CPB [22]. One should minimize ischemia during anastomosis. Ischemic and pharmacological preconditioning and optimization of oxygen delivery to the myocardium through hemodynamic stability is used to reduce the effects of ischemia [23,24].

Several studies have demonstrated the advantages of myocardial revascularization without CPB. The challenges faced by the anesthesiologist and surgeon during the procedure are associated mainly with the surgical exposure for the anastomosis and myocardial protection during the interruption of coronary blood flow. The anesthesiologist should be prepared for hemodynamic changes, deterioration of the cardiac function, and intraoperative ischemia [24]. In those patients, ventricular function curves demonstrate an abnormal response, such as blunting of the curve when the final diastolic volume surpasses 70 $mL.m^{-2}$ [25]. Thus, the ejection fraction decreases with an increase in preload and, therefore, volume replacement should be carefully done.

Controversies on the ideal type of fluid for intraoperative volume replacement persist. Concerns about the effects on the microcirculation and tissue oxygenation restrict studies on crystalloids and colloids to intraoperative period [26].

In the population of the present study, modified fluid gelatin associated with NS or only NS was used for intraoperative volume replacement, and it did not interfere with the postoperative prognosis, it did not change postoperative morbidity and mortality, length of stay in the ICU, and length of hospitalization. Although mortality is not a good parameter to evaluate the results when studying volume replacement, organ dysfunction is a sensitive indicator to evaluate its benefits [27].

When large volumes are administered, the use of a balanced solution of colloids diluted in normal saline was less deleterious for homeostasis and fluid and electrolyte balance, and it also improved gastric perfusion and renal function [28,29]. Both hypovolemia and transference of fluid into the third space have a negative effect on the microcirculation and tissue oxygenation. Modified fluid gelatin was used in this study to improve intraoperative hemodynamics and optimize the results of the surgery. It is possible that the number of patients (20 in each group) as well as the volume of gelatin used (15 $mL.kg^{-1}$) was small and it indicates a limitation of the study by favoring similar results.

Volume replacement was based on hemodynamic parameters, avoiding hypo- and hypervolemia. The central venous pressure was used to guide volemic replacement. Although it does not exclude or confirm the presence of hypovolemia, since both groups showed similar filling pressures, differences in volemic conditions seem unlikely.

The reduction in tissue edema and capillary permeability expected when using colloids did not show a clinical equivalent in the present study and differences in the rate of complications between both groups were not detected. The times to tracheal intubation, staying in the ICU, and hospitalization were similar in both groups ($p > 0.06$). The use of gelatin was not related with the risks reported in the literature, i.e., adverse effects on renal function and coagulation, and allergic reaction.

Surgical trauma causes an inflammatory response usually proportional to the magnitude of the trauma. The inflammatory response leads to a reduction in the plasma osmotic pressure and increases capillary permeability resulting in the transference of fluids from the intravascular to the interstitial space. Accumulation of colloid molecules (endogenous or exogenous) in the extravascular space increases interstitial osmotic pressure with further increases in the transcapillary flow into the interstitial space favoring the development of interstitial edema [30].

Adequate approach to intraoperative volume replacement goes beyond simple hemodynamic effects. Optimization of intraoperative volume replacement is one of the resources used to limit the incidence and severity of the systemic inflammatory response and organ dysfunction after cardiac surgery [31]. Surgical trauma leads to an increase in capillary permeability with loss of plasma and proteins into the interstitial space [32]; it is expected that the development of volume expansion with the consequent increase in blood pressure and hydrostatic pressure would be followed by greater loss of volume into the interstitial space, i.e., hypovolemia secondary to trauma is difficult to treat with a poor response to an increase in plasma volume especially when the hydrostatic pressure of the blood is increased. Under those circumstances, even the use of colloids may be useless since the permeability of the capillary membrane is changed. Prior studies have demonstrated that the intraoperative use of colloids can improve perfusion in the microcirculation but without relating this event with postoperative morbidity or mortality [33]. Van de Linden et al. compared HES and gelatin in the management of the intravascular volume of patients undergoing myocardial vascularization in a randomized, prospective study; however, this study was not able to determine which drug would be better in this type of surgery [26]. In resuscitation of critically ill patients (non-cardiac surgery), albumin and normal saline were showed as equally safe without differences in mortality as long as one avoided the development of hypervolemia. As for the preoperative period, Parker et al. concluded that the inclusion of 500 mL of colloids before surgeries to repair fractures of the shoulder did not improve the results [34]. Feng et al. did not demonstrate an anti-inflammatory response with modified fluid gelatins [35], but HES seemed to attenuate capillary permeability by exerting some modulation of the inflammatory response. Vargas et al. investigated the effects of colloids on reperfusion ischemia, as well as the inflammatory reactions of Dextran, gelatin, and HES and concluded that compared to gelatin and Dextran, HES might show some advantage by inhibiting post-ischemic microvascular dysfunction [36].

Despite the large number of studies on this subject, further studies are necessary to define the best volemic replacement in large size surgeries. Evidence of the benefits of the perioperative use of colloids or crystalloids in surgical myocardial revascularization was not observed in the population of the present study. Maintaining hemodynamic stability, and not the type of fluid administered, is probably what determines the best clinical result.

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RESUMEN

Soares RR, Ferber L, Lorentz MN, Soldati MT - Reposición Volémica Intraoperatoria: Cristaloides *versus* Coloides en Revascularización Quirúrgica del Miocardio sin Circulación Extracorpórea.

***JUSTIFICATIVA Y OBJETIVOS**: El uso de cristaloides o coloides en la reposición volémica de intervenciones quirúrgicas de gran envergadura es un asunto controvertido. El objeto de este trabajo fue comparar los efectos del cristaloide (solución fisiológica al 0,9% SF), con coloide (gelatina fluida modificada), cuando se administran en el intraoperatorio de revascularización quirúrgica del miocardio (RVCM) sin circulación extracorpórea (CEC).*

***MÉTODO**: Cuarenta pacientes sometidos a la RVCM sin CEC fueron divididos aleatoriamente en dos grupos similares. El primer grupo recibió gelatina fluida modificada y SF, el segundo grupo recibió solo SF. Se registró la diuresis, el nivel de la hemoglobina, el sangramiento intra y postoperatorio, y los valores de glicemia y*

lactato del intraoperatorio en cuatro medidas distintas. Se evaluaron la morbimortalidad postoperatoria, el tiempo de internación en la Unidad de Cuidados Intensivos (UCI) y el tiempo de internación hospitalaria.

***RESULTADOS**: El tiempo de extubación del grupo de la gelatina fue de 6,6 horas contra 7,3 horas del grupo del SF, el tiempo de internación en UCI fue de 2,4 días en el grupo de la gelatina contra 3,3 días en el grupo del SF. El tiempo de internación hospitalaria en el grupo de la gelatina fue de 10,3 días contra 6,8 días en el grupo del uso exclusivo de SF. El aparecimiento de complicaciones renales, respiratorias, arritmias cardíacas, infartos, infecciones, reintubaciones, transfusiones sanguíneas y reoperaciones, fue la misma.*

***CONCLUSIONES**: El uso de coloides, representados por la gelatina fluida modificada, asociada a cristaloides o el uso de cristaloides exclusivamente, no alteró el pronóstico postoperatorio de pacientes sometidos a la RVCM sin CEC en los pacientes estudiados. Tal vez, más importante que el tipo de líquido administrado al paciente quirúrgico, sea el mantener la estabilidad hemodinámica adecuada durante el procedimiento.*