

# COMPARISON BETWEEN THE EFFECTS OF 5 PERCENT HYPERTONIC SODIUM CHLORIDE SOLUTION AND 0.9 PERCENT SODIUM CHLORIDE SOLUTION ON LEFT VENTRICULAR CONTRACTION

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## ABSTRACT

Hypertonic saline solution can absorb part of the intracellular fluid volume into the extracellular space. The effects of this solution on the cardiovascular system are increased coronary flow and increased left ventricular contraction, without sympathetic system activation. This study was designed to assess the effects of hypertonic saline solution in open heart surgery and to compare it with normal saline solution.

In a case control double-blind study, 46 patients (two groups of 23 patients each) were selected and treated with 2 different methods after open heart surgery. The first group (case) received 5% hypertonic saline solution and the second group (control) received 0.9 percent saline. Physical exam findings, left ventricular pressure and urinary output were measured to compare the two groups.

2, 3, 5, 10 and 30 minutes after the injection of the solution, the indicators of the study were measured. Left ventricular pressure and pulse rate were decreased and mean arterial pressure was increased in the case group. Urinary output in the case group was more than the control.

It therefore seems that hypertonic saline solution can increase cardiac contractility without increasing sympathetic activity, and thus has positive inotropic effects. This solution seems more useful regarding its therapeutic effects in open heart surgery.

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## INTRODUCTION

The effects of hypertonic sodium chloride solution as an effective maintenance fluid on the cardiovascular system has been known for several years, and nowadays this fluid is used in low volumes as a rapid resuscitator and is the primary infusion in hemorrhagic shock (especially in trauma cases). Nevertheless, the mechanisms of such effects on the

cardiovascular system were not clear until very recently, when some authors expressed increased tissue perfusion as the main reason for the effects of the solution.<sup>1</sup>

Hemorrhagic shock develops due to a severe loss of volume from the cardiovascular system, resulting in defective oxygen delivery to the tissues and ending in cellular edema due to severe hypoxia.<sup>2</sup> This cellular edema is present in the endothelial cell lining of the capillaries, causing a decrease

## Effect of 5% NaCl on LV Contraction

**Table I.** Comparison of the effects of 5% hypertonic saline with 0.9% normal saline in open heart surgery patients according to relevant parameters.

	Pulse Rate	Mean Arterial Pressure	Left Vent. Pressure	Urine Output
<b>Hypertonic Solution (1700 mmol/L)</b>				
Before Infusion	120	65	35	375 mL/h
After Infusion				
2 min.	110	80	36	
5 min.	90	90	28	
10 min.	85	95	15	
15 min.	90	85	12	
30 min.	95	60	12	
<b>Normal Saline (308 mmol/L)</b>				
After Infusion				250 mL/h
2 min.	120	65	35	
5 min.	115	60	33	
10 min.	120	65	36	
15 min.	130	60	37	

in vascular caliber; and finally this state in the capillaries accompanied by severe hypoxia creates a vicious cycle, namely the "low flow state" which aggravates cellular damage and causes cellular death. The high osmolarity of hypertonic sodium chloride solution will increase plasma osmolarity after infusion. This phenomenon will transport part of the cellular fluid towards the intravascular compartment. Among those cells which lose their fluid are capillary endothelial cells. Increased intravascular fluid, accompanied by increased capillary caliber, disrupts the afore-mentioned vicious cycle; this event is especially noted in cardiac nutritional vessels.<sup>3</sup>

How does this solution enhance the pulse rate and blood pressure, without causing any increase in sympathetic nervous system activity? It was believed that this solution could exert positive inotropic effects on the cardiac muscle.<sup>3</sup> But according to recent studies performed on animals and humans, it has been demonstrated that hypertonic sodium chloride solution can increase coronary blood flow and enhance cardiac contractility.<sup>4</sup> The above study was performed on the healthy human cardiovascular system, in a non-invasive manner using transesophageal

echocardiography.

Cardiac muscle relaxation and ineffectiveness is essentially due to ischemia. Adrenaline is among those drugs which acts on the cardiac muscle with its positive inotropic effects; this drug is the prototype of the group, and is used as a routine drug in open heart surgery. This group of drugs enhances cardiac contractility, but at the expense of increased sympathetic activity and cardiac workload, so their utilization is associated with some limitations.<sup>5</sup>

This study was designed and executed to assess the cardiovascular effects of 5 percent hypertonic sodium chloride solution in open heart surgery after the termination of cardiopulmonary bypass.

The ultimate goal of the study was to determine if this solution can be used as the drug of choice instead of positive inotropic agents (including Adrenaline) during open heart surgery.

### MATERIALS AND METHODS

This was a case control double-blind study, in which

two groups of patients were selected; each group consisted of 23 patients. In each of these two groups, 10 patients were selected from Shahid Chamran Heart Center, Isfahan University of Medical Sciences and Health Services, and 13 patients were selected from Baghiatallah (a.s.) Hospital, Baghiatallah (a.s.) University of Medical Sciences (the latter hospital is a general hospital). The two groups (i.e., case and control) were assimilated as much as possible regarding age, sex, race, social class and cardiovascular disease entities. The indicators mean arterial pressure, left ventricular end diastolic pressure and hourly urinary output. These indicators were measured 2,3,5,10,15 and 30 minutes after infusion of the solutions. Urinary output was measured hourly. Each of the patients in the two groups received one of the two sodium chloride solutions.

The study group received 5 percent (hypertonic) saline solution and the control group received 0.9 percent saline solution. The measurement process was started 2 minutes after the patients were taken off cardiopulmonary bypass, which seems to be a suitable time for measurement.<sup>6</sup>

2 cc/kg of each solution was infused steadily during a 2 minute period.

## RESULTS

The indicators of the study, namely pulse rate, mean arterial pressure, left ventricular end diastolic pressure and hourly output were decreased in the case group (Table I). Also, the surgeons of the team recorded increased cardiac muscle rigidity. Records of the surgeons have been determined to be valid and reliable in this regard.<sup>6</sup> The mean arterial pressure increased as much as 25 to 30 percent during a 2-3 minute period which was without any increase in heart rate. These results showed that the 5 percent hypertonic sodium chloride solution was capable of increasing coronary blood flow and thus increasing oxygen delivery to the cardiac muscle. This process yielded increased cardiac muscle contractility, so it seems that hypertonic saline solution in appropriate dosage has positive inotropic effects.

Of interest was the fact that serum sodium ion concentration had an acceptable level (about 145 mmol/L) following infusion of the hypertonic solution, while the

normal saline solution could not raise the sodium ion concentration to the desired level.

## DISCUSSION

This study confirms the effects of 5% hypertonic sodium solution in increasing left ventricular contractile force without any signs of sympathetic nervous system activation or increased circulating volume. The effects of this solution, compared with normal saline, seem superior in increasing the indicators of the study. The special feature of hypertonic saline solution is that there is no increased sympathetic activity, which offers a promise in cardiac patients.

The hypertonic solution increases tissue perfusion and oxygen delivery (especially in the cardiac muscle), so there seems to be no need for using Adrenaline in these patients. The dosage recommended by the authors for cardiac patients during open heart surgery is 2 cc per kilogram of body weight which should be infused during a 2 minute period.

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