

HYPERTONIC SALINE 5% VS. LACTATED RINGER FOR RESUSCITATING PATIENTS IN HEMORRHAGIC SHOCK

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Abstract

Background: Though hypertonic and isotonic crystalloids are used nowadays in resuscitating patients in hemorrhagic shock, yet there is no sufficient data in support of either. The aim of this study was to compare the hemodynamic effects of hypertonic saline 5% and lactated ringer solutions when used for the resuscitation of patients in hemorrhagic shock.

Methods: In a double-blinded randomized clinical trial, sixty adult patients in hemorrhagic shock admitted to the Emergency Department of a teaching hospital between September 2005 and September 2006, were enrolled in this study. Patients were divided into two groups. The first group received lactated ringer 20 ml/kg, and the second group received 4 ml/kg of 5% hypertonic saline infused intravenously within 10 to 15 minutes followed by lactated ringer 10 ml/kg/hr. Hemodynamic parameters were measured at hospital admission as well as every 15 minutes for an hour; and the results were compared between the two groups.

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Results: Gastrointestinal bleeding was the most common cause of shock. There was a significant difference between the baseline and final hemodynamic parameters (MAP, HR, CVP) in each group; however, data of the two groups did not differ significantly. The PaO₂ was higher in the lactated ringer group and there was no difference in PaCO₂, neither in each group, nor between the two groups.

Conclusion: Both hyper and isotonic crystalloid solutions can improve hemodynamic status and the blood gas measurements, similarly; however, lactated ringer is a more potent solution in improving tissue oxygenation.

Keywords: hemodynamic, 5% hypertonic saline, lactated ringer, resuscitation, hypovolemic shock, hemorrhagic.

Introduction

Volume resuscitation and early surgical interventions are the two most important measures to save patients in hemorrhagic shock. Crystalloids, such as normal saline and lactated ringer, and colloids, such as albumin and dextran, can effectively treat hypovolemic shocks, regardless of whether they are used solely or simultaneously¹.

Several studies have asserted that in hypovolemic shock, hypertonic crystalloid solutions, such as 5% hypertonic saline, increase the extra-cellular volume more than the frequently used isotonic crystalloid. In addition, the positive inotropic effect as well as the shorter time required for fluid resuscitation are other benefits reported for this group of solutions²⁻⁴. Other studies¹, however, claim that lactated ringer or normal saline are solutions of choice in this group of patients.

It seems that there is not sufficient data to clearly define whether hypertonic or isotonic solutions is the most efficient solution for resuscitating patients in hemorrhagic shock⁵. The present study, therefore, was designed to evaluate the hemodynamic effects of hyper-and isotonic solutions in resuscitating patients in hemorrhagic shock.

Materials and Methods

The study was approved by the Ethical Committee of Research Department of Tehran University of Medical Sciences. Following obtaining informed written consents from the patients' immediate family members, sixty consecutive adult patients with hemorrhagic shock admitted to the Emergency Department (ER) of a teaching hospital between September 2005 and September 2006, were enrolled in a double-blinded randomized clinical study.

Patients ages ranged between 22-62 years, with a mean of 43.95 ± 12.18 years (35% of them being in the 41-50 age-group). Forty-two (70%) were males and eighteen (30%) were females. Gastrointestinal bleeding (80%) and trauma (20%) were the two main causes of hemorrhage. Patients with a positive history of renal or cardiac diseases, concurrent septic and cardiologic shock, pregnant women, those under mechanical ventilation as well as patients who had received intravenous infusions previously, were excluded from the study.

Hemorrhagic shock as defined as the loss of about 1500 to 2000 ml of blood and characterized by a heart rate (HR) higher than 120/min, mean arterial pressure lower than 80 mmHg, respiratory rate between 30-40/min, reduced pulse pressure, and confusion.

Patients were divided into two equal groups based on a computerized randomization program. The first group ($n = 30$) received lactated ringer 20 ml/kg and the second group ($n = 30$) received 4 ml/kg of 5% hypertonic saline infused intravenously within 10 to 15 minutes and followed by the infusion of lactated ringer 10 ml/kg/hr. The hemodynamic parameters, such as, mean intraarterial pressure (MAP), heart rate, central venous pressure (CVP), and arterial blood gas (ABG), were measured and recorded at entrance to OR as well as every 15 minutes until an hour later.

According to previous studies indicating a CVP of 10.3 ± 5.8 cm/water vs. 14.0 ± 1.6 cm/water in the 60th minute, the required sample size ($\alpha = 0.05$) was calculated to be 30 patients in each group.

Data was analyzed in SPSS Ver. 12 and $P < 0.05$ was considered as a significant value. Mann-Whitney statistical test was used to compare the mean difference of the parameters at each time interval; Fisher's Exact Test was used for comparing the ratios. Kolmogrov-Smirnov Z test was used to examine the normal distribution of MAP, HR, CVP, SO_2 , pH, HCO_3 and PaO_2 . *Repeated measure analysis of variance* was used for comparing the changes in MAP, HR, CVP, SO_2 , pH, HCO_3 and PaO_2 during the study period in each group and between the two groups.

Results

There was no significant difference in the demographic data including age, gender and cause of hemorrhagic shock in the two groups (Table 1).

Table 1
Comparison of the mean age, gender frequency and cause of hemorrhagic shock in the lactated ringer and saline hypertonic groups.

Variable		Lactated ringer	Hypertonic Saline	P
Age		43.90 ± 13.04	44.00 ± 11.96	0.85
Sex	Male	21 (70%)	21 (70%)	0.99
	Female	9(30%)	9(30%)	0.99
Cause of hemorrhagic shock (Gastrointestinal bleeding)		21(70%)	18(60%)	0.63

There was a significant difference between the baseline and final mean arterial pressure (Fig. 1), heart rate (Fig. 2), CVP (Fig. 3), and HCO_3 , pH and $PaCO_2$ (Table 2) in arterial samples in each group. However, the trend of changes did not differ considerably between the two groups.

Fig. 1

The mean arterial pressure (MAP) trend of changes in the lactated ringer and hypertonic saline groups.

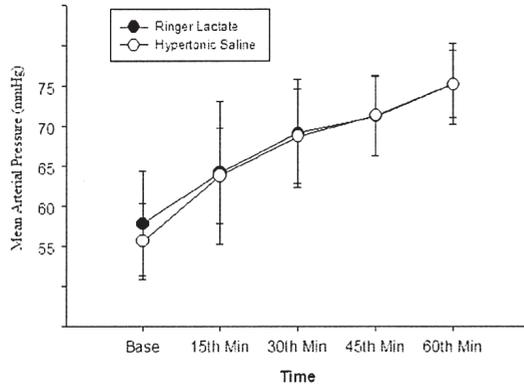


Fig. 2

The HR trend of changes in the lactated ringer and hypertonic saline groups

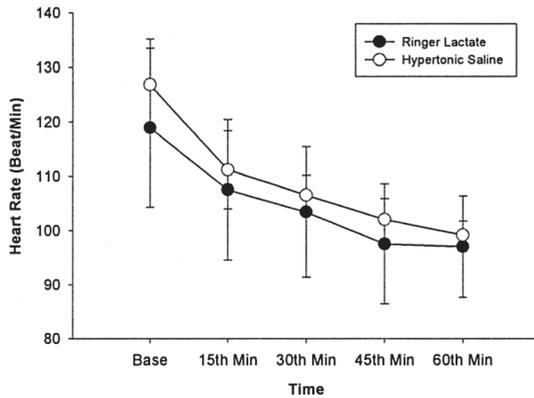


Fig. 3

The CVP trend of changes in the lactated ringer and hypertonic saline groups

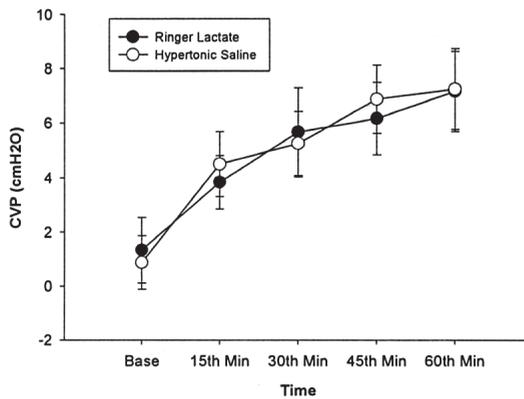


Table 2
The HCO₃, pH and PaCO₂ trend of changes with time in the lactated ringer and saline hypertonic groups.

	HCO ₃		pH		PaCO ₂	
	RL	H/S 5%	RL	H/S 5%	RL	H/S 5%
Base	16.6±3.1	13.9±6.7	7.3±0.01	7.2±0.1	34.6±6.7	33.2±6.1
15 min	18.9±2.6	17.5±5.1	7.3±0.10	7.3±0.12	35.7±6.3	33.4±2.3
30 min	19.5±2.8	19.4±2.8	7.3±0.1	7.3±0.7	34.9±3.8	34.2±2.2
45 min	20.7±3.4	20.5±2	7.4±0.05	7.3±0.04	35.6±3.3	33.7±2
60 min	22.2±1.8	21.9±1.6	7.4±0.06	7.4±0.04	36.6±3.1	34.8±1.1

The PaO₂ was significantly higher in the group who received lactated ringer solution (in the 45th minute: 100.09 ± 29.73 vs. 79.61 ± 7.06 mmHg and in the 60th minute: 97.50 ± 24.51 vs. 80.51 ± 6.30 mmHg).

The baseline and final PaCO₂ did not show a significant difference in either group. The variable was not shown to be different between the two groups (Table 2).

Discussion

The infusion of hypertonic saline increases plasma osmolality and causes a shift from the intracellular to the extracellular compartment; thus, increasing intravascular and inter-tissue volumes^{6,7}. The resulting plasma volume improves the hemodynamic state^{2,8}. In addition, sodium causes vasodilatation in systemic and pulmonary vessels in association with slight inotropic effects³.

Several studies have reported the infusion of hypertonic saline solution to be associated with rapid increase in the body volume, an increase in cardiac contractility, improved cardiac output and consequently a more stable hemodynamic state^{11,12}. Conversely, the present study showed a significant difference between the baseline and final amount of hemodynamic variables (mean arterial pressure and heart rate) in each

group while such a difference was not noted between the two groups.

In studies conducted by Veroli et al, no significant difference was noted in the hemodynamic variables following the infusion of hypertonic saline and normal saline in patients undergoing general anesthesia⁸. This data is supportive of our results. It should be noted, however, that Veroli's study showed a decreased requirement for fluid, a shorter infusion time and no accompanying side effects, following the prescription of 7.5% hypertonic saline. Likewise, Prough et al. showed that following the infusion of the two solutions, a similar increase in the cardiac output and mean arterial pressure of dogs in toxic shock¹³.

Wan et al. also showed that both normal and hypertonic saline increased the heart rate, cardiac output, CVP, mesenteric and coronary blood flow within the first hour following infusion. They concluded that both solutions have similar systemic and local impacts¹⁴. In another study, Pinto et al. studied the effects of 3% hypertonic saline and lactated ringer in the acute phase of hemorrhagic shock; they showed a significant improvement in the hemodynamic state of both groups compared with the control group. A significantly lower intracranial pressure and higher serum osmolarity was reported in the hypertonic saline group; however, cerebral perfusion pressure was reported to be higher in the two groups when compared to the controls. They concluded similar hemodynamic effects for both regimens¹⁵.

The improvement of tissue oxygenation is the main objective of treatment and many studies believe lactated ringer to be a more potent solution in achieving this goal¹. Findings of the present study support this hypothesis by reporting a significant difference between the baseline and final results of SO_2 , pH, HCO_3 and PaO_2 in the arterial samples of the two groups. Moreover, PaO_2 was demonstrated to be significantly higher in the lactated ringer group; however, other variables did not show a significant difference between the two groups. Braz et al have obtained similar results. Although, they reported similar improvements in the systemic and gastrointestinal oxygenation following hemorrhagic shocks in dogs following the infusion of both regimens, they found significant higher pH

and arterial oxygen pressure, following the use of lactated ringer solution. They claimed that hypertonic saline solution was not as favorable as the lactated ringer in improving systemic and gastrointestinal oxygenation; it could not even increase the local oxygenation to the obtained amount in the controls¹⁶.

While Us et al have reported a reduced oxygen level in the two groups following the resuscitation; others have indicated an improved tissue oxygenation and perfusion in association with a reduced systemic resistance and pulmonary inflammatory response following the administration of hypertonic saline in rats compared with the isotonic saline^{17,18}. The present study also revealed that PaCO₂ volumes did not differed significantly in each group or between the two groups.

Several studies have revealed an improvement in the patients' survival rate following hypertonic saline infusion^{19,20}. Further studies are therefore recommended to explore this issue.

Conclusion

It is concluded that both the lactated ringer and hypertonic saline solutions, improve the hemodynamic status and blood gas parameters in a similar fashion; however, the lactated ringer is a more potent solution in improving tissue oxygenation.

Limitations

The small sample size of the present study due to the limited referrals of individuals in hemorrhagic shock, constitutes limitation to the present study.

Summary

1 – Why is the topic important?

Though both hypertonic and isotonic crystalloids are nowadays used in resuscitating patients in hemorrhagic shock, as yet there is no sufficient data in support of either.

2 – What does this study attempt to show?

Several studies have asserted that during hypovolemic shock, hypertonic crystalloid solutions, such as 5% hypertonic saline, increases extra-cellular volume more frequently than with isotonic crystalloid. In addition, crystalloids decreased positive inotropic effects as well as the shorter time needed for fluid resuscitation, are other benefits reported for this group of solution. The subject, however, remains controversial.

3 – What are the key findings?

There was a significant difference between the baseline and final hemodynamic variables in each group; however, the data of the two groups did not differed significantly. The arterial O₂ pressure was reported to be higher in the lactated ringer group. The PaCO₂ did not differed significantly neither in each group, nor between the two groups.

4 – How is the patient care impacted?

Both solutions can similarly improve the hemodynamic status and blood gas parameters, however, the lactated ringer is a more potent solution in improving tissue oxygenation.

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