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Review

Choice of fluids in the perioperative period of kidney transplantation☆

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ABSTRACT

Normal saline has traditionally been the resuscitation fluid of choice in the perioperative period of kidney transplantation over balanced potassium solutions. However, the problems arising from hyperchloraemia triggered by the infusion of normal saline have led to studies being conducted that compare this solution with balanced solutions. From this narrative review it can be concluded that the use of balanced crystalloids containing potassium in the perioperative period of kidney transplantation can be considered safe. These solutions do not affect serum potassium levels any more than normal saline, whilst maintaining a better acid–base balance in these patients.

Elección de fluidos en el periodo perioperatorio del trasplante renal

Palabras clave:
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RESUMEN

El suero salino normal (SSN) ha sido clásicamente el fluido de resucitación elegido en el periodo perioperatorio del trasplante renal frente a aquellas soluciones balanceadas con potasio. Sin embargo, los problemas derivados de la hipercloremia desencadenada por la infusión de SSN han llevado a la realización de estudios que comparaban esta solución con los fluidos equilibrados. Mediante la presente revisión narrativa se deduce que el uso de cristaloides balanceados con contenido de potasio en su formulación, en el perioperatorio de trasplante renal, puede considerarse seguro. Estas soluciones no provocan una alteración del potasio sérico mayor que la provocada por el SSN y mantienen mejor el equilibrio ácido-base en estos enfermos.

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Introduction

Fluid and electrolyte replacement during the post-transplant period aims to maintain an adequate intravascular volume to ensure renal perfusion so immediate graft function is optimized. To achieve this goal, an adequate understanding and management of fluid therapy is essential; a major surgery is commonly associated to renal insufficiency and electrolytic disorders such as hyperkalemia that should be prevented and the function of the graft needs to be warranted.[1]

Delayed graft function is a term used to describe acute renal failure after transplantation and may be defined by the need for dialysis during the first postoperative week. Delayed graft function is important predictor of the subsequent clinical course of the graft.[1,2] There are several factors that are related to a delayed graft function: age of donor, quality of the tissues, cold storage, reperfusion injury, prerenal causes, immunosuppressive drugs, etc.[3,4] Likewise, the presence of hyperkalemia may contribute to graft dysfunction.[5] Classically, normal saline (NS) has been chosen during the perioperative period of renal transplantation. This choice has been based on the belief that the use of potassium containing replacement fluids could produce hyperkalemia.[6]

However, there are views that attribute to NS an increase of serum chlorine that predispose to the development of metabolic acidosis and the generation of hyperkalemia through a transcellular movement of ions. This concept has been that basis for the elaboration of several studies during the last decade comparing the use of NS and balanced crystalloid solutions (including potassium in their formulation) during the perioperative period of renal transplantation.[7–11]

The present short reviews is brief pathophysiological assessment of this concept as well as a description of the publications in the current medical literature.

Type of fluids

Intravenous fluids are separated into 2 types: crystalloids and colloids. Crystalloids are made of sterile water and electrolytes and sometimes contain glucose as a source of calories. Colloids are solutions containing high molecular weight particles that increase oncotic pressure and are added to a crystalloid. This group includes albumin, gelatins, dextrans and starches (derived from corn and potato).[12]

The increase in oncotic pressure increases intravascular fluid retention capacity as compared to crystalloids. This theory is based on the theoretical premise that larger particles are trapped in the intravascular space by an intact endothelial barrier for longer period of time.[13]

However, it is necessary to consider that a colloid only behaves as a colloid (that is, increasing oncotic pressure) when the glycocalyx is intact.[14] In fact, in the perioperative period (in situations such as preoperative fasting) bleeding and insensible losses can reduce the extracellular volume and activate the inflammatory cascade, with consequent damage of the glycocalyx, which increases capillary permeability and looses of intravascular fluids.[15,16] This fact explains why large clinical trials observed that the advantage in volume expansion is generally only about 30–40% in favor of colloids, far from theoretical potency in situations of intact glycocalyx.[17–19]

Furthermore, the use of colloids increases the cost, have limited availability (the case of albumin, which is a blood product) and are associated with clotting disorders that may cause persistent renal damage, mainly observed with the use of hydroxy-ethyl starches.[20–23]

These details may have led clinicians to choose crystalloids as the first option in the postoperative period of renal transplantation.

Crystalloids are classified into 2 large groups. Unbalanced and balanced crystalloids; the NS is considered unbalanced fluid.

The NS contains 154 mEq/L of sodium and 154 mEq/L of chloride; therefore it has no buffer capacity.

From the standpoint of renal hemodynamics, it tends to reduce the volume of diuresis, prolonging it over time. The activity of natriuretic factors, the inhibition of antinatriuretic system and the effect on cardiac output is similar to that of balanced solutions,[24] but the water management is different from unbalanced crystalloid solution. With very large volumes of infusion and in the absence of spurious stimuli of ADH, it tends to produce hypernatremia. By contrast, the infusion of discreetly hypotonic solutions in large quantities favors hyponatremia more than hypernatremia.[25,26] The relative hypotonicity of certain balanced crystalloids solutions causes inhibition of ADH and the water diuresis occurs earlier and more satisfactory than with NS.[26] However, at this point it is important to remember that the inhibition of ADH release induced by resuscitation together with administration of hypoosmotic balanced solutions will promote the entry of water into the interstitial space, with the consequent deleterious effect that may occur in certain clinical circumstances.[27]

With regard to glomerular filtration, the infusion of NS, by distending the right cardiac cavities, increases the secretion of atrial natriuretic peptide, which dilates the afferent artery and inhibits the sodium channels of the collecting tubule. Therefore, the delay in the initiation of diuresis is a tubular effect, secondary to the activation of ADH due to a relative hypertonicity, so it requires a considerable volume of infusion.[28]

Hypovolemia due to situations as surgical interventions, forced diuresis, development of a third space or drainage, produce activation of the renin-angiotensin-aldosterone axis and increase in thirst.[29] It should be remembered that the patient will develop hyponatremia if they are allowed to drink without salt, if we resuscitate with hypotonic solutions or glucose containing fluids without salt. Such salt depletion may increase the dependence of glomerular filtration on an intact renin-angiotensin system and sensitize the patient to the development of acute renal failure.[30]

Hyperchloremia, hyperchloremic metabolic acidosis and hyperkalemia

According to the Stewart model, the physical–chemical approach to the analysis of acid-base balance confers a predominant role to chloride, and hyperchloremia.[31] The