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Oral Hydration Before and After Hip Replacement: The Notion Behind Every Action

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Abstract

Introduction: Even though nearly 20 patients undergo hip replacement every hour just in Italy and the United Kingdom, it is unclear what are the most appropriate oral hydration practices that patients should follow before and after surgery. Improper administration can cause postoperative fluid disturbances or exacerbate pre-existing conditions, which are not an uncommon find in older subjects. **Significance:** Considering that the number of hip operations is expected to increase in the next years as well as the age of patients, it is important to recall the notions behind water balance, especially in light of modern surgical and anesthetic practices. This technical perspective discusses the perioperative changes in the hydration status that occur during hip replacement and provides the concepts that help clinicians to better manage how much water the patient can drink. **Results:** The points of view of the surgeon, the anesthetist, and the nurse are offered together with the description of mineral waters intended for human consumption. Before surgery, water should be always preferred over caffeinated, sugar-sweetened, and alcoholic beverages. The drinking requirements on the day of surgery should consider the water output from urine, feces, respiration, exudation, and bleeding along with the water input from metabolic production and intravenous administration of fluids and medications. Healthy eating habits provide water and should be promoted before and after surgery. **Conclusions:** The judgment on which is the most appropriate approach to oral hydration practices must be the responsibility of the multidisciplinary perioperative team. Nevertheless, it is reasonable to argue that, in the presence of a patient with no relevant illness and who follows a healthy diet, it is more appropriate to stay closer to dehydration than liberalizing water intake both prior to surgery and in the early postoperative hours until the resumption of normal physiological functions.

Keywords

perioperative care, water-electrolyte balance, anesthesia, prosthesis implantation, hip, orthopedic surgery

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Introduction

The maintenance of a good hydration status requires that the physiological losses from urine, feces, respiration, and exudation are regularly compensated by equal amounts of fluids. The volume and composition of fluid lost every day depends on ambient temperature, physical activity, and energy consumption. All these variables and no competence make individuals dull drinkers. Most people, in fact, do not care if they drink too much or too little as long as the

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kidneys do the work. This negligence is risky in surgical patients, especially in the presence of cardiovascular diseases, kidney malfunction, or prolonged infusion of intravenous solutions. Anatomical cavities like the peritoneum and bowel lumen are easily subjected to liquid accumulations, and a long history of fluid balance research thus focuses on abdominal surgery. However, we argue that centering studies on these operations has deprived other surgical fields of fluid balance notions. Hip replacement is one of these, with the current recommendations stating that liquids whether oral or intravenous should be given essentially not too much nor too little.[1] The undesirable high rates of fluid disturbances in hip surgery mirror this hesitation.[2-4] We know that the extent of pre-existing conditions[5] or their chronicity[6] is an important forecaster for a fraction of postoperative events like hyponatremia. However, in the current era of perioperative medicine where everything should be enclosed by recommendations, each blind spot undermines the efficiency of the system, and it is thus time to recall the concept behind fluid administration. As a perioperative team dealing with hip operations, we debate in the paper the different aspects of fluid balance in patients undergoing hip replacement from a surgical, anesthetic, and nursing point of view. We believe that giving an outline of the hydration status could encourage awareness among colleagues and stimulate more research to increase healthcare quality.

The Surgical Perspective

Fluid balance disturbances can be classified into changes in volume (hypervolemia, euvolemia, hypovolemia), concentration (mainly hyponatremia), composition (variations of ions other than sodium), and distribution (fluid shifts). It is not uncommon to find one of them during the preoperative assessment of older subjects with uncompensated cardiovascular diseases, reduced renal function, liver disease, polydipsia, hypertriglyceridemia, excessive water consumption, or on a low-salt diet. These patients are the ones more likely to have electrolyte imbalances also after surgery. Other causes of fluid disturbances can be long-term medications, which should be considered whether to stop or replace before surgery.[7] For instance, vigorous therapy with thiazide diuretics or loop diuretics can cause blood sodium to plummet, angiotensin-converting enzyme inhibitors and angiotensin II receptor antagonists might expose to hypotension after the induction of anesthesia, potassium-sparing diuretics can lead to hyperkalemia in case of prolonged reduction of renal perfusion during surgery. Patients must have a good hydration status once positioned on the operating table. The inevitable tissue damage causes changes in fluid concentration and distribution, with inflammation and neuroendocrine activation causing sodium-containing fluids to be sequestered into the interstitial space. Being no more part of the circulatory dynamics, the isotonic fluid translocations deplete the volume of blood that, in turn, triggers the secretion of aldosterone causing oliguria. Bleeding is a relevant extrarenal loss to be considered in surgery but, during modern total hip replacement, it does not usually exceed 10% of the circulating volume because of practices that avoid undesirable hypothermia and the hemostatic effect of tranexamic acid. In theatre, the patient's wound remains open for about 60 minutes, a time that is likely not to contribute significantly to water losses from body tissues exposed to air. Despite the intraoperative bolus of glucocorticoids or the use of cryotherapy with intermittent compression after surgery, it is expected that traumas of muscles and other soft tissues would cause a certain degree of glycocalyx impairment, endothelial dysfunction, and fluid leakage, disturbing the maintenance of euvolemia and creating a certain degree of lower limb edema. The hip procedure does not directly affect the abdominal area and, therefore, it is reasonable to exclude splanchnic bed extravasation or bowel edema. Over time, the edematous muscles and tissues adjacent to the implant heal and return to 75% and 10% of normal hydration, respectively, thus supporting the movement in the correct lever arm.

The Anesthetic Perspective

On the day of surgery, the total volume administered depends on blood losses, estimated fluid shifts, and operative time. Based on what we mentioned above, there is no need to administer litres of intravenous fluids. It is suitable for most patients a single bag of Hartmann's or Ringer's solution (1000 mL of sodium lactate 60%) started at the induction of anesthesia up to its exhaustion in the recovery room. This judicious use of an isotonic solution is sufficient to maintain euvolemia, avoid concentration or compositional changes, and reduce the stimulus for aldosterone secretion during surgery. For those patients undergoing central neuraxial spinal anesthesia, the total volume from both continuous infusion of propofol and injections (midazolam, ketamine, magnesium, metaraminol, others) does not usually exceed 150 mL, but it must be considered when estimating oral water inputs after surgery. Also, liquids lost daily through the bladder and wound tubes have a use for the calculation of the fluid status. However, these drains are not recommended in hip replacement, and the urinary catheter when used has to be removed as soon as possible and within 24 hours.[1] Also, we should consider that there is a persistence of fluid retention after surgery that depends on the total volume and composition of the solution administered. Although we tend to give less intravenous fluids than other major surgeries, it is generally assumed that fluid retention could persist for a few days.[8] Given this consideration, we argue that the urine output in the first postoperative days does not mirror the water intake and that it is preferable for the patient to introduce water by mouth gradually. Also, even the smallest depletion of functional extra-cellular fluid volume keeps the release of aldosterone active after surgery. Therefore, we must pay particular attention to the resumption and dosage of regular antihypertensive drugs and diuretics, which can exacerbate salt losses in the first postoperative days. Failure to correct any volume depletion during surgery would manifest circulatory instability and orthostatic hypotension, dizziness, and weakness, thus affecting early rehabilitation. Fluid restriction (500-750 mL/day) is recommended in patients with postoperative hypervolemic or euvolemic hyponatremia, while hypovolemia is managed with the infusion of sodium chloride in metabolic alkalosis or sodium lactate in acidosis. Should any postoperative complications arise that require the administration of intravenous solutions, the balance chart should also consider any gravitational contribution from the new endoprosthesis as well as from the removal of bone materials. If we have been attentive to all the precautions, there will be no need for any of these actions nor for the evaluation of body weight changes.

The Nursing Perspective

The volume status evaluation consists of a clinical assessment (e.g., thirst, tongue, edema, tissue turgor, urine gravity test), cardiovascular evaluation (e.g., postural changes in blood pressure, pulse rate, capillary refill test, jugular venous pressure), body monitoring (e.g., weight changes, bioimpedance analysis), and blood tests. This evaluation must take place during the preoperative assessment and in time for surgery, especially for fragile individuals who may require drug or lifestyle changes. For instance, hyponatremia (serum sodium concentration ≤135 mmol/L) can take up to 2 weeks to be corrected.[9] Upon admission, we do not support the nothing-by-mouth schedule from midnight, with the appropriate hydric preparation allowing the consumption of water until 2 hours before the induction of anesthesia.[1] On the day of surgery, the need for oral water depends on the intraoperative fluid management and on the hydric content of foods consumed. In the general population, daily consumption of 2.5 L for males and older adults and 2 L for females are considered adequate liquid intakes according to EFSA[10] (European Food Safety Authority). Similar intakes are advised by SINU (Italian Society of Human Nutrition).[11] Presuming that 20% of these amounts would come from non-liquid foods, then older adults would daily require 1.6-2 L of drinks as stated by the ESPEN[12] (European Society for Clinical Nutrition and Metabolism) and the BDA[13] (British Dietetic Association). We argue that these reference values are also relevant to patients undergoing hip replacement and that it is not advisable to encourage drinking except in cases of great losses (e.g., pyrexia, vomiting, diarrhea). The postoperative pain, nausea, stress, inflammation, and certain drugs used in the surgical wards (e.g., opioids, NSAIDs, PPIs)[14] are known to trigger vasopressin release. If exacerbating factors were not opportunely controlled, this hormone would be excessively secreted and cause an inappropriate and transient fluid retention along with clinically relevant hyponatremia. Fundamentally, water inputs calculation should incorporate the sips to swallow oral tablets, the quantity contained in foods, the estimated production of metabolic water (100 kcalories produce 12.3 g of metabolic water),[15] and the total volume administered intravenously. Another aspect worthy of awareness is that a nothing-by-mouth schedule from midnight coupled with a delay in postoperative feeding is known to cause a catabolic breakdown of fats and proteins, an increased production of non-volatile solutes that burden the kidney, and a hepatic glycogen depression that makes the liver sensitive to toxins.[7] Cut calorie fasting before and after hip replacement is, therefore, beneficial to ensure a continuous flow of nutrients that support the function of all body systems.

Not All Waters Are The Same

It has never been discussed, to our knowledge, which is the most appropriate water to drink before and after surgery. It is not common information, but there are different types of water for human consumption: the direct mains water from aqueducts (tap water or table water), natural mineral water, and spring water. All types meet legislative limits for chemical, microbial and radioactive substances, with the natural mineral and spring waters coming from an underground source and being tapped at a natural or drilled exit. One of the main characteristics that differentiate natural mineral water from others is that its composition must remain consistent over a lengthy period, and it is, therefore, reasonable to choose in case of targeted purpose. Natural mineral waters can be grouped according to different properties.[16] They can be categorized by fixed or dry residue, which is the weight of all minerals after complete evaporation of 1 L of water (very low: <50 mg/L; low: 50-500 mg/L; medium: 500-1500 mg/L; high: >1500 mg/L), by hardness, which is the content of calcium and magnesium salts (15-50 °F; 1 French degree is equivalent to 10 mg/L of calcium carbonate), by pH (acid if pH<7; alkaline if pH>7), by the temperature at the source (cold if < 20°C; hypothermal if 20-30°C; mesothermal if 30-40°C; hyperthermal if > 40°C), and by effervescence (natural if free carbon dioxide at the source vs CO2 added at tapping). However, the most attractive categorization is by mineral content, which encompasses bicarbonate (bicarbonate>600 mg/L), sulphate (sulphate>200 mg/L), chloride (chloride>200 mg/L), calcic (calcium>150 mg/L),

Table 1. Daily water balance for patients undergoing hip replacement.

	Day before		Day of Surgery		Day after	
Section 1.1	*M*	*F*	*M*	*F*	*M*	*F*
Water output	—					
Urine[a,b]	1520 mL	1350 mL	1300 mL	1150 mL	1520 mL	1350 mL
Feces[c]	150 mL	110 mL	150 mL	110 mL	150 mL	110 mL
Respiration, exudation[d,e]	980 mL	880 mL	950 mL	850 mL	980 mL	880 mL
Bleeding	N/A	N/A	400 mL	400 mL	N/A	N/A
Total output	2650 mL	2340 mL	2800 mL	2510 mL	2650 mL	2340 mL
Section 1.2	—					
Metabolic water input						
Metabolic water[f,g]	270 mL	220 mL	130 mL	110 mL	270 mL	220 mL
IV Water input	—					
IV Fluids	N/A	N/A	1000 mL	1000 mL	0 mL	0 mL
IV Medications	N/A	N/A	150 mL	150 mL	0 mL	0 mL
Total input	270 mL	220 mL	1280 mL	1260 mL	270 mL	220 mL
Oral fluid balance (needs)	**≈2380 mL**	**≈2120 mL**	**≈1520 mL**	**≈1250 mL**	**≈2380 mL**	**≈2120 mL**
Section 1.3	—					
Oral input						
Beverages						
Milk[h]	0 mL	0 mL	130 mL	110 mL	130 mL	110 mL
Tea[i]	140 mL	140 mL	0 mL	0 mL	0 mL	0 mL
Non-liquid foods	—					
Fruits[j,g]	265 mL	215 mL	180 mL	115 mL	265 mL	215 mL
Vegetables[k,g]	260 mL	220 mL	130 mL	110 mL	260 mL	220 mL
Starchy foods[l,g]	145 mL	115 mL	75 mL	60 mL	145 mL	115 mL
Pulses, fish, eggs, meat, dairy[m,g]	190 mL	150 mL	95 mL	75 mL	190 mL	150 mL
Total input	860 mL	700 mL	480 mL	360 mL	860 mL	700 mL
Drinking water needed	1520 **mL**	1420 **mL**	**1040 mL**	**890 mL**	**1520 mL**	**1420 mL**

[a]Day before and after: 1 mL/kg/hour during 16 hours of arousal; 0,6 mL during sleep (73 kg male, 65 kg female).
[b]Day of surgery: 0,5 mL/kg/hour for 6 perioperative hours; 1 mL for 10 hours; 0,6 mL during sleep (73 kg male, 65 kg female).
[c]200 g of feces (150 mL of water) in males and 150 g of feces in females (110 mL of water).
[d]Day before and after: 25 mL/square meter of body surface/hour per 16 hours of arousal; 15 mL during sleep (Moesteller method: male 1.9 and female 1.7).
[e]Day of surgery: 25 mL/square meter of body surface/hour per 14 hours of arousal; 15 mL during sleep (Moesteller method: male 1.9 and female 1.7).
[f]Day before and after: 12.3 mL/100 kcal, with about 2190 kcal required in males (60-74 years old, height 180 cm, weight 73 kg, LAF 1,4) and about 1800 kcal required in female (60-74 years old, height 170 cm, weight 65 kg, LAF 1,4).
[g]Day of surgery: considering a caloric breakdown of 20% at breakfast, 10% at mid-morning snack, 30% at lunch, 10% at mid-afternoon snack, and 30% at dinner, it was assumed that on the day of surgery the patient might skip 2 snacks and the lunch.
[h]125-150 g (110-130 mL of water).
[i]140 g (140 mL of water).
[j]Day before and after: fresh apple 125-150 g (105-130 mL of water), fresh pear 125-150 g (110-135 mL of water).
[k]Day before and after: fresh carrots 180-200 g (160-185 mL of water), fresh lettuce 70-80 g (65-75 mL of water).
[l]Day before and after: bread 100-120 g (40-45 mL of water), cooked pasta 60-80 g (75-100 mL of water after boiling).
[m]Day before and after: grilled meat 100-120 g (65-80 mL of water), baked fish 120-150 g (85-110 mL of water).

magnesiac (magnesium>50 mg/L), fluorurate (fluoride >1 mg/L), ferrous (iron>1 mg/L), and low-sodium waters (<20 mg/L). It would be interesting to initiate prospective trials to investigate their role in the maintenance of perioperative water and electrolyte balance. It is reasonable to think that calcic and bicarbonate waters could have a virtuous use in hip replacement. The infusion of isotonic solutions is known to decrease proximal tubular reabsorption of calcium.[8] Moreover, periprosthetic bone losses occur after hip replacement because of adaptive bone remodeling, stress shielding secondary to implants, and many other factors.[17] High-calcium water could help stabilize daily needs in older patients (1200 mg), and bicarbonate waters can act as adjuvants against bone resorption.[18] Regardless of any benefit, water must be the preferred source of hydration before and after surgery compared to beverages like coffee, tea, or juices. In fact, nerve drinks contain pharmacologically active substances, such as caffeine and theophylline that increase diuresis and natriuresis,[19] while juices provide sugars.

Conclusion

Historically, the appropriateness of intraoperative fluid balance has gone through phases promoting liberalization, goal-directed fluid therapy, or a zero-balance approach, with hip replacement never really attracting the attention of researchers. At present, over 500 patients every day undergo hip replacement just in Italy[20] and United Kingdom.[21] We believe that a true understanding of the physiology of fluids and electrolytes is necessary also in this major orthopedic surgery. Effectively, the fluid management must be projected in time, remodeling pharmacotherapy or lifestyle habits affecting the balance before surgery. Patients should be recommended to follow a healthy diet that provides up to 500 mL of water from non-liquid food. If this dietary requirement is satisfied, then men must be instructed to daily drink 10 glasses of water (glass ≈200 mL) and women up to 8 glasses, which should be evenly distributed over the 16 waking hours (1 glass every 1.5-2 hours). On the day of surgery, water is allowed until 2 hours before the induction of anesthesia, being always the reference choice over caffeinated or sugar-sweetened beverages. Other clear fluids can be pulp-free extracts from a small quantity of fresh fruit or vegetables. In determining the correct fluid management, the perioperative staff must consider the reduced water output from urine, respiration, and exudation, the extent of the bleeding, the intravenous volumes administered in theatre, the endogenous water production, and the exogenous water introduced with food (Table 1).

The core of fluid management is mastering the undesirable changes in volume, tonicity, composition, and distribution of body fluids that undermine the appropriate central euvolemia. The practices of oral hydration are usually addressed according to local experiences and procedures. However, we reasoned that it is suitable for most patients on the day of surgery to drink no more than 1 L to be evenly distributed in 12 hours (apart from the 8 hours of sleep, the 2 hours of preoperative fasting, and the 2 hours of anesthetic and surgical times). In consideration of the different points of view that we reported, we conclude that staying closer to dehydration is more acceptable than liberalizing water intake until resumption of normal physiological functions. Great value is placed on patient experience, and we believe that the patient's journey and outcome would be highly enhanced if both patients and health professionals are instructed on the quantity, quality, and timing of drinking water (Supplementary 1).

Author Contributions

MB, TWW and RGM conceived and discussed the concept of this viewpoint. MB designed the work and wrote the first draft of the manuscript. The surgeons (LM and RGM) revised the surgeon's perspective. The anesthetists (TC and JC) revised the anesthetist's perspective. The specialized nurse (KS) revised the nursing perspective. The indications on oral water consumption were written in the following article by the first author, with all authors revising, reading, and approving the final manuscript. All authors have agreed to be personally accountable for the author's own contributions and to ensure that questions related to the accuracy or integrity of any part of the work, even ones in which the author was not personally involved, are appropriately investigated, resolved, and the resolution documented in the literature.

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Supplemental Material

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