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Multimodal Nutritional Management in Primary Total Knee Arthroplasty: A Randomized Controlled Trial

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ABSTRACT

Background: This study aims at evaluating the effectiveness of a new multimodal nutritional management (MNM) on albumin (ALB) transfusion, the incidence of electrolyte disorders, blood loss, perioperative levels of ALB and electrolyte, length of hospital stay (LOH), and complications in patients following total knee arthroplasty without tourniquet.
Methods: A total of 162 patients were randomized to receive either the MNM protocol (n = 81, experimental group) or traditional protocol (n = 81, control group). The primary outcomes were the rate and amount of ALB infusion, LOH, total blood loss, maximum hemoglobin drop, allogeneic transfusion rate, and the incidence of electrolyte disorders. The secondary outcomes were levels of ALB and electrolyte at different time points and the incidence of complications.
Results: The rate and amount of ALB transfusion required in MNM group were significantly lower than those in control group ($P = .006$, $P = .021$, respectively). LOH was shorter in MNM group ($P < .001$). Total blood loss and maximum hemoglobin drop were similar. The incidence of kaliopenia and hypocalcemia was lower in MNM group on the first postoperative day ($P = .019$, $P = .028$, respectively). Patients in MNM group had higher levels of ALB, sodium, potassium, and calcium than those in control group on the first postoperative day.
Conclusion: The MNM protocol can effectively low down the amount of ALB transfusion, the number of patients requiring ALB transfusion, the incidence of electrolyte disorders, and LOH following primary total knee arthroplasty without tourniquet. Patients can obtain a smaller decline in ALB, sodium, potassium, and calcium.

Total knee arthroplasty (TKA) is a common orthopedic procedure to relieve pain, improve function, and correct deformity for the patients with end-stage knee joint diseases [1,2]. Along with the accelerated aging of the population, the full number of TKA increases year by year [3]. However, TKA is associated with the high prevalence of postoperative malnutrition and electrolyte disorders. As reported previously, the incidence of postoperative malnutrition was as high as 50% [4], which might increase the risk of postoperative complications, delay wound healing, and increase length of hospital stay (LOH) [5–8]. In addition, substantial evidences had shown the harm of electrolyte disorders, which increased the risk of delirium, in-hospital myocardial infarction, surgical site infections, and surgical readmission after orthopedic surgeries [9–13]. Considering these facts, it has become increasingly crucial to restrain the prevalence of malnutrition and electrolyte disorders by comprehensive nutritional management.

Preoperative fasting in the patients following elective surgery was traditionally considered to be a necessary and agreed practice to reduce the risk of aspiration during anesthesia [14]. Preoperative fasting for 8 h or longer was previously accepted by most surgeons and analgesist. However, the traditional perioperative care seemed to lack scientific basis and cause metabolic stress and insulin resistance [15,16]. A number of studies had demonstrated that preoperative oral carbohydrate treatment, shortening preoperative fasting and postoperative eating time could maintain protein

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balance and body composition [17,18], release the feeling of anxiety and thirst, improve patient comfort [19,20] and decrease LOH [21–23]. Therefore, our center conducted a newly introduced multimodal nutritional management (MNM) with the cooperation of the departments of anesthesiology and nutrition. This study aimed at answering the following 3 questions: (1) Could the MNM reduce the rate and amount of albumin (ALB) infusion and the incidence of electrolyte disorders? (2) Was the regimen effective to promote the perioperative levels of ALB and electrolyte further? (3) Could the MNM reduce the surgical complications without increasing bronchial aspiration?

Methods

Study Design

This was a prospective, randomized, controlled trial registered and approved by the Institutional Review Board of our hospital. Written informed consent and research authorizations were obtained prospectively before surgery from all participants.

Patients' Cohort

Patients undergoing primary unilateral TKA lasting from October 2015 to December 2016 for osteoarthritis or rheumatoid arthritis were considered appropriate for the study. Exclusion criteria included preoperative hemoglobin (Hb) <120 g/L, preoperative ALB <35 g/L, preoperative sodium <135 mmol/L, preoperative potassium <3.5 mmol/L, preoperative calcium <2.10 mmol/L and on the presence of current infection. We also excluded patients with any type of diabetes, cirrhosis, and ischemic heart disease. After meeting the inclusion and exclusion criteria, all the patients were randomized into 2 groups (MNM group and control group) by the method of opaque, sealed envelopes. The new MNM protocols were used as follows: (1) patients received nutrition powder at bedtime on the day before surgery and could intake normally 8 hours before the induction of anesthesia; (2) patients were given protein powder 6 hours before the induction of anesthesia and carbohydrate powder 2 hours before the induction of anesthesia; and (3) patients were given meal nutrition powder eaten together with the first dinner after surgery and nutrition powder at bedtime on the day of surgery. Early feeding started 2-4 hours after surgery. The composition and usage of perioperative nutrition powder were represented in Table 1. Patients in the control group received preexisting perioperative nutritional management. Fasting started 8 hours before surgery and early feeding started 6 hours after surgery. The data were collected by a professional nurse. The dietitian was responsible for distribution of nutrition powder, nutrition education, and informing the usage method of nutrition powder simultaneously.

Anesthesia Protocol

All the patients received general anesthesia. Controlled hypotension was applied and mean arterial pressure was reduced to 70-90 mmHg during surgery. Anesthesia was induced with midazolam 0.05 mg/kg, sufentanil 0.4 mg/kg, cisatracurium 2 mg/kg, and propofol 1.5 mg/kg. Continuous infusion of remifentanil 3-5 mg/kg/h and inhalation of 2.0%-2.5% of sevoflurane were used to maintain reasonable levels of anesthesia and then stopped after finishing suture of deep fascia.

Surgical Procedures and Perioperative Protocols

All operations were performed by a single senior surgeon in our department. The surgical team performed TKA in the standard way, using a midline skin incision, a standard medial parapatellar approach. Tourniquet was not used during surgery. Drainage was used and removed 24 hours postoperatively in every patient. A dosage of 20 mg/kg tranexamic acid was administered intravenously 5-10 minutes before skin incision and 10 mg/kg of tranexamic acid was administered intravenously 3, 6, 12, and 24 hours later. All the patients received physical prophylaxis and chemoprophylaxis for venous thromboembolism according to our previous study [24].

Criteria for Hospital Discharge

Discharge criteria were examined and authorized by the dietitian, resident physician, and surgeon if all the following conditions were met: (1) patients accepted being discharged, which was the prerequisite for discharge; (2) no signs of postoperative infection, no durative leakage and swelling around the wound; (3) visual analogue score ≤3 or pain could be effectively controlled by oral analgesics; (4) accepting normal oral diet; (5) independent mobility (full weight bearing, walking distance ≥200 m/d); and (6) knee function: flexion ≥100°, extension ≥−5°.

Outcome Variables

All data were retrieved from the database. Blood samples were collected and assayed for ALB, Hb, and electrolyte on the first postoperative day (POD1) and third postoperative day (POD3). The primary outcomes were the rate and amount of ALB infusion, total blood loss (TBL), maximum Hb drop, transfusion rate, LOH, and the incidence of electrolyte disorders, including hyponatremia (the serum levels of sodium <135 mmol/L), hypernatronemia (the serum levels of sodium >145 mmol/L), kaliopenia (the serum levels of potassium <3.5 mmol/L), hyperpotassemia (the serum levels of potassium >5.5 mmol/L), hypocalcemia (the serum levels of calcium <2.10 mmol/L), and hypercalcinemia (the serum levels of calcium >2.25 mmol/L). LOH meant postoperative hospital stay in

Table 1
Composition and Usage of Perioperative Nutrition Powder.

Nutrition Powder	Composition	Usage
Protein powder	Energy 300 kcal, protein 12 g, fat 3 g, glucide 56 g, sodium 558 mg, potassium 805 mg, and calcium 90 mg	1 bag, dissolve in 250 mL lukewarm boiled water
Carbohydrate powder	Energy 200 kcal, protein 0 g, fat 0 g, glucide 50 g, sodium 393 mg, potassium 523 mg, and calcium 0 mg	2 bags, dissolve in 200 mL lukewarm boiled water
Meal nutrition powder	Energy 315 kcal, protein 19 g, fat 7 g, glucide 43 g, sodium 216 mg, potassium 352 mg, and calcium 206 mg	1 bag, dissolve in 250 mL lukewarm boiled water
Nutrition powder at bedtime	Energy 315 kcal, protein 19 g, fat 7 g, glucide 43 g, sodium 216 mg, potassium 352 mg, and calcium 206 mg	1 bag, dissolve in 250 mL lukewarm boiled water