International Journal of Surgery 34 (2016) 58–63

Contents lists available at ScienceDirect

International Journal of Surgery

journal homepage: www.journal-surgery.net

Original Research

The effects of platelet apheresis on blood saving and coagulation in bilateral total hip replacement: A prospective study on 60 patients

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HIGHLIGHTS

- We performed a prospective study of platelet apheresis in bilateral total hip replacement.
- Preoperative platelet rich plasma (PRP) harvest was performed.
- The blood transfusion, blood parameters, thrombelastogram and blood-gas parameters were studied.
- PRP is useful in blood coagulation function and blood saving in bilateral total hip replacement.

ARTICLE INFO

Article history:
Received 29 April 2016
Received in revised form
19 August 2016
Accepted 20 August 2016
Available online 24 August 2016

Keywords:
Blood coagulation function
Fibrinogen
Preoperative platelet rich plasma harvest
Thrombelastogram
Total hip arthroplasty

ABSTRACT

Background: Preoperative platelet rich plasma (PRP) harvest has been used in cardiopulmonary surgery for more than 10 years. There is no previous study dealing with PRP in bilateral total hip replacement. This study was to investigate the effects of PRP on blood saving and blood coagulation function in patients with bilateral total hip replacement.

Patients and methods: A prospective, randomized, clinical trial was conducted. Sixty patients were enrolled, including 30 patients undergoing PRP in the PRP group and 30 controls. The surgery time, total transfusion volume, blood loss, allogenic blood transfusion, autologous blood transfusion, urine volume, drainage volume, some blood parameters (including Fibrinogen, D-dimer, Prothrombin time, international normalizedratio, activated partial thromboplastin time, Platelet, Haemoglobin B), thrombelastogram (TEG) and blood-gas parameters were studied in the perioperative stage. The measurement data were analyzed statistically.

Results: There was no statistical difference between the two groups in baseline characteristics, surgery time, total transfusion volume, blood loss, autologous blood transfusion, etc. Allogenic blood transfusion in the PRP group was less than the control group with statistical difference ($p = 0.024$). Fibrinogen in the PRP group was higher than the control group ($p = 0.008$). Among the TEG indicators, activated clotting time and coagulation time K in the PRP group were less than the control group. Clotting rate and maximum amplitude in the PRP group were higher. The blood-gas parameters presented no statistical difference.

Conclusion: The results suggested that PRP probably played a positive role in blood coagulation function as well as blood saving in patients with bilateral total hip replacement.

1. Introduction

Total hip arthroplasty (THA) is developing rapidly in recent years as an orthopedic surgery. The success of THA can effectively relieve the patients' pain and improve body function and the quality of life. The number of procedures per year is estimated to rise in the following years, as even younger patients with hip arthritis are expected to seek surgical treatment [1]. Kurtz et al. recently reported that the projected number of THAs per year will exceed 500,000 by the year 2020 [2]. But bilateral total hip

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http://dx.doi.org/10.1016/j.ijsu.2016.08.233
1743-9191/

replacement is often followed with large trauma and a large amount of blood loss. Thus allogeneic blood transfusion is needed. However, as pointed by several studies, allogeneic blood transfusion is an independent risk factor for THA [3,4]. Coagulopathy is another complication of THA and it has been reported to have a correlation with an increased surgical site infection risk [5].

Preoperative platelet rich plasma (PRP) harvested with autotransfusion devices is regularly used for intraoperative autotransfusion. Now PRP has been used in cardiopulmonary bypass surgery (CPB) for more than ten years with varying results with respect to bleeding and allogeneic blood transfusions [6,7]. PRP harvest has also been shown to reduce postoperative blood loss in CPB and orthopedic surgery [8,9]. In liver and spine surgery, PRP has been used to counteract the intraoperative coagulation defects caused by dilution during intraoperative autotransfusion, hemodilution and the use of other intraoperative plasma substitutes [10]. The effects of plasmapheresis on platelet aggregation in CPB have been studied. The former studies showed PRP harvest in combination with autotransfusion to be as effective in reducing allogeneic blood usage in orthopedic surgery as the combination of autotransfusion and predonation of two units of blood [11].

To our knowledge, there is no previous study dealing with blood saving effects and blood coagulation function using PRP in bilateral THA. Our hypothesis was PRP played a positive role in blood saving effects and blood coagulation function in bilateral THA. The aim of this prospective randomized study was to evaluate the effects of PRP on patients with bilateral THA. The blood loss, allogenic blood transfusion, blood parameters, thrombelastogram (TEG), blood-gas parameters, etc. were studied in the perioperative stage.

2. Materials and methods

2.1. Trial design

We conducted a single-center, prospective, 1:1 randomized and clinical trial in which both participants and examiners were blinded. The study was approved by the local research ethics committee. The study was registered and approved by Chinese Clinical Trial Registry (ChiCTR-IPR-15007051). Informed consent was obtained from each patient.

2.2. Patients

Sixty patients (38 males and 22 females, average age of 47.5 and range of 25–65 years old) were studied, including thirty patients undergoing PRP in bilateral total hip replacement (THR) surgery and thirty patients not undergoing PRP in the control group. The inclusion criteria were patients aged 18–65, ASA level 1–2, normal preoperative platelet count, hemachrome >120 g/L. The exclusion criteria were patients with cardiopulmonary dysfunction, blood coagulation disorders, hematological disease, hepatorenal dycfunction, hypovolemia, taking anticoagulant drugs, and infection.

2.3. Randomization and blinding

Study participants were randomized by a physician who was not involved in the study, using the method of block randomized grouping. The results of the randomized allocation were kept in envelopes, which were attached to the clinical records of the patients. The envelopes were opened before the surgery. The patients and the statistician were blinded as to which group the participants were allocated to.

2.4. Surgical procedure and platelet apheresis

The patients were in lateral position and under general anesthesia. Total intravenous anesthesia was performed with midazolam (0.05–0.1 mg/kg), sufentanil (1.0–2.0 μg/kg), propofol (2–2.5 mg/kg) and rocuronium (0.6–1.2 mg/kg). Remifentanil (0.2–0.25 μg/kg/min) and propofol (4–12 mg/kg/h) were injected for anesthesia maintenance. After anesthesia and before the surgery, blood collection was done through a central venous catheter and was transferred into Cell Saver 5+ (Haemonetics, USA) for collection and storage of platelet. The Haemonetics MCS1 9000 blood cell separator and 994-CFE apheresis set (Haemonetics Corp) were used to prepare PRP. Sodium citrate (10%) was used as an anticoagulant agent. The platelet harvest was stored in shaking state to avoid degeneration.

And then the cementless THR was performed. After inserting the endotracheal tube, respiratory parameters, such as respiratory (RR), tidal volume (TV) were adjusted to maintain the PaCO2 value between 30 and 35 mmHg and the intrathoraxic pressure <25cmH_2O. The arterial blood pressure was routinely measured and controlled hypotension was performed to achieve a 30% reduction of baseline mean arterial pressure with continuous injection of esmolol and intermittent administration of isosorbide dinitrate [12]. The loading dose of esmolol was infused intravenously over 1 min at 1 mg/kg, followed by a maintenance rate of 0.4–0.8 mg/kg/h and 0.5 mg isosorbide dinitrate was administrated if necessary. Intraoperative nasal temperature was monitored and maintained at 36.0–37.0 °C with a heating apparatus. Fluid therapy (6% hydroxyethyl starch and Ringer's solution), heated to 37 °C by electronic heating device, was adjusted with ABP, urinary output (C1 ml/kg/h) and hourly arterial blood gas measurement results, such as pH value, electrolyte, blood glucose and hemoglobin concentration [13]. Once blood glucose reached 150 mg/dl, insulin was given as intravenous bolus equal to the amount of BG/100 units.

The details for the bilateral cementless THR were as the following. The surgery was performed in the lateral position and the more severe side was operated firstly. After sterilized with iodine tinctures and deiodination with alcohol, a skin incision was made and then the damaged femoral head and acetabulum were exposed and carefully sculpted for the fixation of the hip prosthesis. The size of the hip prosthesis was initially evaluated through an experiment using the X-ray film. And then the suitable hip prosthesis was inserted. Finally, the skin incision was closed. Afterwards, the patient was turned on the contra-lateral side for the second procedure. After the surgery, patients were transferred to the recovery room for further resuscitation.

The patient's blood collected from the operation was transferred into Cell Saver 5+. Red blood cells were collected after centrifugation and transfused into the patient's body after the bilateral surgery. The uniform transfusion threshold for allogeneic blood transfusion was 80 g/L after autologous blood infusion. Frozen fresh plasma (FFP) was infused according to British Committee for Standards in Haematology (BCSH) guidelines and the coagulation function check results [14]. FFP was administrated when at least one of the following criteria was met: (a) PT greater than 1.5 times the midpoint of the normal range; (b) APTT greater than 1.5 times the top of the normal range [15]. Large-volume blood transfusion was infused when hemoglobin content was below 70 g/L considering the systemic blood volume, cardiac and cerebral vascular status, pulmonary function and individual conditions, such as temperature, acid-base status, ionised calcium, haemoglobin, platelet count, APTT and fibrinogen level [16]. If the hemoglobin content was between 70 g/L and 80 g/L, small volume red blood cells (≤3 units) was used after assessing the blood-gas situation, bleeding speed and individual conditions. Calcium gluconate was