Postoperative hemoglobin and recovery of hip muscle strength after total hip arthroplasty

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ABSTRACT

Background: The presence/absence of postoperative anemia are presumed to have an impact on early recovery after surgery. This study was performed to compare hip muscle strength and hemoglobin during the perioperative period in 82 patients undergoing THA.

Methods: Evaluation of presence/absence of anemia was performed by calculating the 10-day postoperative/preoperative Hb ratio. Muscle strength was investigated before and 2 months after surgery.

Results: Postoperative SLR strength showed a significant difference between the patients whose 10-day postoperative/preoperative Hb ratio was < 85% and ≥ 85%.

Conclusion: We need to consider perioperative strategies to minimize anemia in order to improve patient outcomes.

1. Introduction

Total hip arthroplasty (THA) is an effective treatment for end-stage osteoarthritis of the hip and osteonecrosis of the femoral head. Studies have shown that most patients report improvement of hip pain and physical function after THA compared with their preoperative state. However, the time required for recovery of hip joint function after surgery varies among patients. A number of factors seem to influence early recovery after surgery, among which the presence/absence of postoperative anemia and its severity are presumed to have an impact on rehabilitation. Lower limb muscle strength has a marked influence on daily activities, so the recovery of lower limb muscle strength is also closely related to postoperative improvement in performing activities of daily living (ADL). Accordingly, this study was performed to compare postoperative hip muscle strength and hemoglobin (Hb) during the perioperative period in patients undergoing THA.

1.1. Patients and methods

The subjects were 82 women who underwent primary THA at our hospital from 1 March 2015 to 28 December 2016. Their mean age was 66.5 years (range: 36–91 years). The underlying disease was osteoarthritis of the hip in all 82 patients and intraoperative blood salvage was

done with an Extra (LivaNova, Tokyo, Japan) in all subjects.

Evaluation of Hb was performed by calculating the ratio of the preoperative Hb to that on postoperative day 10. Muscle strength on the operated side was investigated before and 2 months after surgery. Maximum voluntary bilateral hip flexion and abduction strength were measured by using a hand-held dynamometer (Isoforce GT-300, OG Giken Co. Ltd., Okayama, Japan) during isometric contraction for 3 s against manual resistance, as reported previously.¹ First, the subject rested in the supine position with the hip and knee in the neutral position for flexion/extension and for abduction/adduction. The dynamometer sensor was placed at the proximal border of the patella when assessing hip flexion, with the “lever arm” for calculation of hip flexion torque being the distance from this border of the patella to the anterior superior iliac spine. Similarly, the sensor was placed 5 cm proximal to the proximal border of the lateral malleolus when assessing hip abduction, and the lever arm for calculating hip abduction torque was the distance from this point to the anterior superior iliac. Torque was calculated as force multiplied by the lever arm and was expressed as a percentage of body weight (Nm/kg). For comparison of muscle strength, the postoperative/preoperative ratio (%) was determined in each patient.

The significance of differences in mean muscle strength between the patients with and without low Hb was evaluated by using the unpaired

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t-test for normally distributed data. Statistical analysis was performed with StatView Ver. 5.0 software for Macintosh (SAS Institute Inc., North Carolina) and $p < 0.05$ was considered to indicate statistical significance. This study was approved by the Institutional Review Board.

2. Results

The mean blood loss during THA was 353 mL (range: 151–750 mL), while the mean volume of transfusion delivered by intraoperative salvaged blood was 174 mL (range: 78–327 mL). The mean preoperative Hb and 10-day postoperative Hb was 12.7 g/dL, and 11.6 g/dL, respectively. The mean 10-day postoperative/preoperative Hb ratio was 91.5%. Among the 82 subjects, the 10-day postoperative/preoperative Hb ratio was less than 85% in 16 patients (19.5%, 10-day < 85% group) and was $\geq 85\%$ in 66 patients (80.5%, 10-day $\geq 85\%$ group). The mean age of the 10-day < 85% group was 68.7 years and that of the 10-day $\geq 85\%$ group was 66.1 years.

For patients in the 10-day < 85% group, the mean preoperative and postoperative straight leg raising (SLR) strength was 0.51 Nm/kg and 0.66 Nm/kg, respectively. On the other hand, patients in the 10-day $\geq 85\%$ group had a mean preoperative and postoperative SLR strength of 0.54 Nm/kg and 0.78 Nm/kg, respectively. In addition, the 10-day < 85% group showed a mean preoperative and postoperative abduction strength of 0.94 Nm/kg and 1.26 Nm/kg, respectively, while the mean preoperative and postoperative abduction strength of the 10-day $\geq 85\%$ group was 1.05 Nm/kg and 1.34 Nm/kg respectively. There was no significant difference in preoperative SLR or abduction strength between the 10-day < 85% group and the 10-day $\geq 85\%$ group ($P = 0.53$ and $P = 0.27$, respectively). However, postoperative SLR strength showed a significant difference between the two groups ($P < 0.05$) (Fig. 1). On the other hand, there was no significant difference in postoperative abduction strength between the 10-day < 85% group and 10-day $\geq 85\%$ group ($P = 0.43$).

In the 10-day < 85% group, the mean postoperative/preoperative ratio of SLR strength on the operated side was 149% and that of abduction strength was 145%. In the 10-day $\geq 85\%$ group, the mean postoperative/preoperative ratios of SLR strength and abduction strength on the operated side were 166% and 140%, respectively. The postoperative/preoperative ratio of SLR strength or abduction strength

showed no significant differences between the 10-day < 85% group and the 10-day $\geq 85\%$ group.

3. Discussion

Major orthopedic arthroplasty procedures are predominantly performed in elderly patients with multiple and decreased overall physical function. Anemia has an increased prevalence among the elderly.² In prospective and retrospective cohort studies, preoperative anemia was detected in approximately 24% of patients undergoing elective THA or total knee arthroplasty.³ It was also reported that the Hb level decreased by an average of 3.0 g/dL after total hip or total knee arthroplasty and the prevalence of anemia increased to 51% postoperatively.³ Preoperative and/or postoperative anemia is associated with significant adverse clinical outcomes, such as an increased frequency of allogeneic transfusion,⁴ decreased physical function,^{5–7} higher infection rate,³ longer hospital stay,^{4,7–9} and increased mortality.^{7–10} Accordingly, strategies to minimize anemia such as improvement of the serum iron level, preoperative autologous blood donation,^{11–14} intraoperative and/or postoperative blood salvage,^{15–17} and allogeneic blood transfusion should be considered for patients undergoing elective surgery. However, some studies^{18–20} have shown that allogeneic blood transfusion is a significant risk factor for surgical-site infections after orthopedic surgery. Kim et al.¹⁸ conducted a systemic meta-analysis of data on 21,770 patients undergoing THA or total knee arthroplasty and reported that the prevalence of surgical-site infections was 2.88% and 1.74% in the transfusion and non-transfusion group, respectively. Woods et al.²⁰ reported that the transfusion volume was significantly associated with surgical site infection (odds ratio: 4.00) in patients undergoing lumbar spine surgery after adjusting for both preoperative Hb and intraoperative blood loss. In consideration of these issues, our institution has the policy of preventing postoperative anemia by transfusion of preoperatively donated autologous blood and by intraoperative blood salvage.

There have been several previous reports about the relationship between anemia and postoperative recovery. Lawrence et al.⁵ examined the correlation between postoperative Hb and walking ability in 5793 patients at least 60 years old undergoing hip fracture repair, and reported that a higher postoperative Hb level was independently associated with a longer walking distance at discharge. Foss et al.⁷ found that anemia was significantly associated with impaired walking ability on each of the first 3 days after surgery and was an independent risk factor for not being able to walk on the third postoperative day according to adjusted multiple regression analysis (odds ratio: 0.41, $p = 0.002$).

On the other hand, studies comparing the relationship between anemia and the quality of life (QOL) score after orthopedic surgery have come to varying conclusions about whether the influence of Hb is relevant or not. Conlon et al.⁵ investigated the association between Hb levels and QOL in patients over 65 years old undergoing primary hip arthroplasty and reported a positive correlation between the discharge Hb level and the change of the SF-36 score from before surgery to 2 months postoperatively. Conversely, other studies comparing Hb values and various QOL scores (SF-36, FSI, VAS-fatigue, FACT-Anemia, etc.) have found no correlation between the postoperative Hb and these scores in patients undergoing hip or knee arthroplasty.^{21–23}

Concerning quadriceps strength, some authors reported that adults with end-stage hip osteoarthritis have reduced strength of the knee extensor muscles, knee flexor muscles, and hip muscles.^{24–26} Quadriceps strength has a significant influence on daily function in patients with end-stage hip osteoarthritis,²⁷ and some authors have reported impairment of functional performance after THA in patients with quadriceps weakness.^{28–31} In addition, some studies have demonstrated that quadriceps weakness persists for several months to 1 year after surgery despite improvement of hip pain, functional improvement, and participation in rehabilitation.^{32,33} Therefore, quadriceps strength is

Fig. 1. SLR and abduction strength for patients classified into 85% > 10th day group and 85% $\leq$ 10th day group Postoperative.

SLR strength showed a significant difference between the two groups (*: $P < 0.05$).

one factor that affects daily activities in patients with hip osteoarthritis or patients who have undergone THA, and it thought that quadriceps strength also influences the progress of postoperative rehabilitation.

Regarding the relationship between the postoperative Hb level and muscle strength in the present study, recovery of postoperative Hb was related to postoperative hip flexion (SLR) strength (to which quadriceps also contributes), and a significant difference was noted between patients in the 10-day < 85% group and those in the 10-day ≥ 85% group. As quadriceps strength has a significant influence on performance of daily activities, our findings suggested that a higher postoperative Hb level was associated with better postoperative rehabilitation and improvement in daily activities.

In conclusion, postoperative recovery of Hb was related to postoperative hip flexion (SLR) strength. Because perioperative anemia is common in orthopedic patients and is associated with adverse clinical outcomes, we need to consider perioperative strategies to minimize anemia and interventions for blood management when planning elective THA or total knee arthroplasty in order to improve patient outcomes.

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