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ORIGINAL STUDY

Comparison of unilateral and rapidly staged bilateral hip resurfacing arthroplasty

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The purpose of this study was to compare the clinical results and complication rates after unilateral vs. staged bilateral metal-on-metal hip resurfacing arthroplasty (HRA) when using a comprehensive blood management program, to determine if there was increased risk for staged HRAs.

The study group included 25 consecutive bilateral patients with osteoarthritis (OA) (50 hips). The control group consisted of the first 100 consecutive patients with OA (100 hips) who had unilateral resurfacing during the same period of time by the same surgeon. All patients were enrolled in the same comprehensive blood management program.

No transfusion was required in either group. No patients experienced symptomatic anaemia. There was no difference in blood loss per hip between the two groups.

This study suggests that transfusion can virtually be eliminated in both unilateral and staged HRA's using an appropriate blood management strategy without collection of autologous blood preoperatively.

Keywords : hip resurfacing ; unilateral versus bilateral ; blood loss ; blood management.

INTRODUCTION

A blood transfusion in total hip arthroplasty (THA) adds risks and cost to this procedure (*3,5,19*). Known risks of allogenic transfusion include the risk of HIV and hepatitis transmission, transfusion reaction, a higher rate of periprosthetic infection, and side effects related to the blood storage lesion (*11*). Autologous blood does not carry the risk of disease transmission, but it still carries the risk of bacterial overgrowth, transfusion reaction due to clerical error, side effects due to the storage lesion, and the risk of adverse response during blood donation (*21*). Over half of the units collected are wasted and the red blood cell increase after autologous blood transfusion is only modest. In addition, many patients are not candidates for autologous donation.

Metal-on-metal total hip resurfacing arthroplasty (HRA) has recently been shown to be a successful alternative to standard stemmed THA in young and active patients. Many patients are requesting one-stage bilateral HRA in order to limit their recovery time and to return to normal function as soon as possible ; it is therefore critical for surgeons to understand whether it is safe to offer a rapidly two-stage bilateral HRA instead in order to avoid the increased blood transfusion and complication rates

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of one-stage bilateral HRA, but also fit the patient's requirements. The rate of blood transfusion required for HRA has not yet been widely reported (*15,16*), nor has a comparison of the clinical outcome between rapidly two-stage bilateral and unilateral HRA been performed. The purpose of this study was to compare the clinical outcomes and complication rates between patients undergoing either rapidly two-stage bilateral (within the same week) or unilateral metal-on-metal HRA when using our comprehensive blood management program which was designed to minimize the need for blood transfusion for metal-on-metal HRA procedure.

MATERIAL AND METHODS

The study group included 25 consecutive patients (50 hips) with a diagnosis of osteoarthritis (OA) who had rapidly two-stage bilateral HRA between Feb 2006 and April 2008. Our protocol involved operating on the first hip on Monday, return to the operating room for the opposite hip on Wednesday and discharge from the hospital on Friday. The control group consisted of the first 100 consecutive patients (100 hips) with OA who had a unilateral HRA during the same period of time by the same surgeon employing the same comprehensive blood management program. The minimally invasive (MIS) posterior approach was used for all the cases. The demographic and perioperative data were prospectively collected and reviewed for each patient. There were no statistical differences of patient demographic characteristics seen between the two groups (Table I). The clinical outcomes as well as medical and surgical complications that occurred before 6 weeks follow-up were compared between the two groups.

Blood Management Program

This blood management program involved measurement of preoperative haemoglobin (Hgb), discontinuation of all medication known to increase bleeding preoperatively, correction of anaemia, blood conservation in surgery, and a low transfusion trigger (Fig. 1). No tranexamic acid or autologous blood donation was utilized in this program.

Preoperative

All patients had their Hgb checked 1-2 months preoperatively. Patients with an Hgb below 15 g/dl were given prescription iron for one month. If the Hgb was below 13 g/dl, it was rechecked after one month of treatment with iron. If the Hgb was still below 13 g/dl, erythropoietin (Epo) was administered preoperatively and a cell saver was used intraoperatively. If a patient was a Jehovah's Witness or was a rapidly two-stage bilateral case, a Hgb cut off of 15 g/dl was used to trigger the use of Epo. One of two established Epo protocols was used depending on the remaining time before surgery. Either a series of three weekly Epo injections (40,000 units SQ each) preoperatively and one in the recovery room, or a series of 10 (20,000 units each) daily injections preoperatively was administered. All patients were counseled to stop taking aspirin and all non-steroidal anti-inflammatory drugs (NSAIDS) except Celebrex, and to stop taking clopidogrel and all over-the-counter supplements one week prior to surgery. Coumadin was discontinued five days preoperatively. Injectable anticoagulants were

Table I. — Demographics comparison between two groups

	Group 1 - Unilateral	Group 2 - Bilateral	P-Value
Number of Hips	100	50	
Number of Patients	100	25	
Age (years)	53 ± 8	51 ± 7	0.12
Weight (lbs)	193 ± 39	197 ± 35	0.47
Body Mass Index (BMI)	28 ± 4	28 ± 4	0.88
Acetabular Component (mm)	57 ± 4	58 ± 3	0.59
Femoral Component (mm)	52 ± 4	53 ± 3	0.11
Gender			0.3
Males	76 (76%)	21 (84%)	
Females	24 (24%)	4 (16%)	

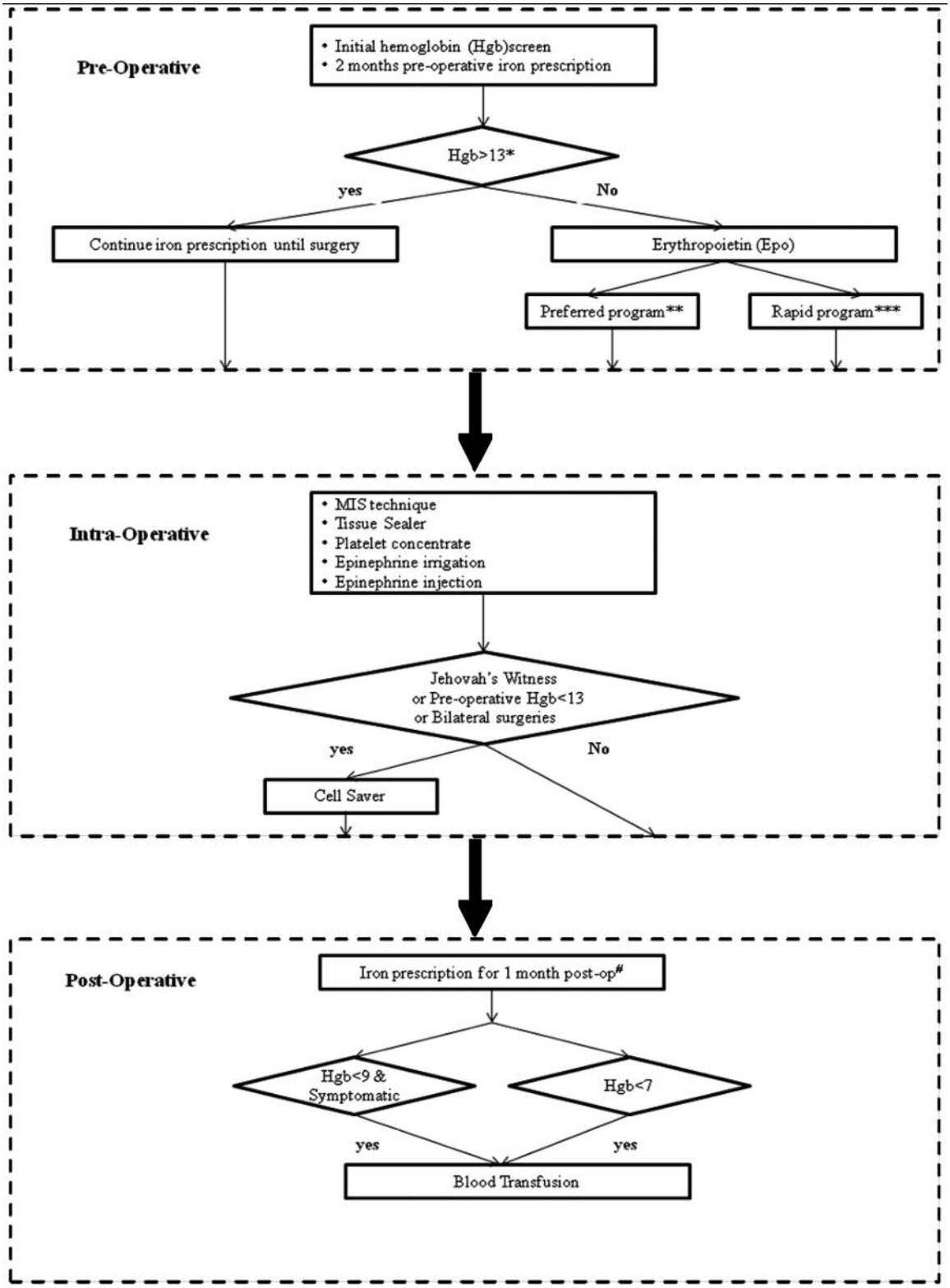

Fig. 1. — Flow chart of comprehensive blood management program

discontinued 24 hours prior to surgery. No pre-donation of autologous blood was utilized for any patient.

Intraoperative

The incision was four inches in length and a posterior minimal invasive surgical (MIS) approach was used in all cases. A Magnum uncemented acetabular component (Biomet, Warsaw, Indiana, USA) was used in combination with either a Recap cemented or uncemented femoral component (Biomet, Warsaw, Indiana, USA) to perform the metal-on-metal HRA procedure. Intra-operative dissection was carried out with a standard electrocautery using the coagulation setting of 60. The Aquamantys™ System (Salient Surgical Technologies, Dover, NH, USA) was used intermittently throughout the operation to further prevent blood loss by shrinking the collagen walls of blood vessels. A cell saver was used in unilateral cases when indicated by the criteria described above. The intra-operative cell saver was used in all Jehovah's Witness and in all rapidly two-stage bilateral cases. Adequate blood for processing and reinfusion was not always collected. The wound was irrigated with approximately three liters of saline solution containing epinephrine at a concentration of 5 mg /liter. Platelet concentrate (prepared from the patient's own blood) was routinely utilized. Finally, the subcutaneous tissue was injected with a local anaesthetic solution containing epinephrine. All Jehovah's Witnesses in this study consented to use of cell saver and platelet concentrate.

Postoperative

The hospital stay was counted as postoperative days (or nights spent in hospital) in this study : the day of operation did not count as a hospital day, but the day of discharge counted as a hospital day. An ice machine was used for several days. The Hgb was checked on postoperative days one and two. Patients were only considered for transfusion if their Hgb was below 7.0 or if they had symptomatic anemia. A ten-day course of daily Arixtra (GlaxoSmithKline, Research Triangle Park, NC, USA) injections was begun 23 hours postoperatively. This was followed by daily aspirin 81 mg for one month. If a patient was on Coumadin preoperatively, a loading dose was given on the day of surgery and then the patient's preoperative schedule was resumed (no aspirin or Arixtra was used in this situation). Clopidogrel was resumed after the Arixtra was completed in patients who were on clopidogrel preoperatively. All patients were given a one-month prescription of iron to take postoperatively.

Statistical methods

The significance level was set up as 0.05. The comparisons of numerical variables between the two groups were evaluated by using standard *t*-tests. The categorical variables included gender, whether Epo was received, whether cell saver was used, whether there was a surgical complication or medical complication prior to the 6 weeks postoperative visit. Their statistical significances were evaluated based on Chi-square tests.

RESULTS

Clinical outcomes are summarized and compared in Table II. No transfusions were required. No autologous blood was employed. No tranexamic acid was used. No drains were used. The average intraoperative blood loss was 230 cc per hip ; there was no significant difference between both groups. Significantly more patients in the study group were given Epo injections to increase their Hgb level (20% vs. 6%). Only 7% of patients in the control group received blood from intra-operative salvage (cell saver) compared to 84% of patients in the study group ($p < 0.001$). However, the average amount of cell saver blood received per hip was similar in both groups. The Hgb level on postoperative day two after surgery was significantly higher for the control group than for either the first (14. vs 11, $p < 0.001$) or the second (14 vs. 10 ; $p < 0.001$) surgery of the study group. The lowest Hgb recorded was in a patient in the unilateral group who had an Hgb of 7.2 g/dl on postoperative day two and was asymptomatic.

The average length of the hospital stay per hip was significantly longer for the study group than the control group (2 *vs.* 1.8 days ; $p = 0.003$). The preoperative and postoperative average Harris Hip Score (HHS) scores were not statistically different between the two groups. The postoperative average HHS score was significantly improved compared to the preoperative average HHS score in both groups ($p < 0.001$).

There was no failure, when revision or reoperation for any cause was used as the endpoint. The incidence of perioperative complications within six weeks was similar between the two groups. In the study group, there were two medical complications

Table II. — Comparison of clinical outcomes between the study and control groups

	Study Group-Rapidly two-stage bilateral (50 hips in 25 patients)	Control Group- Unilateral (100 hips in 100 patients)	P Value
Intra-operative blood loss per hip (ml)	229 ± 119	233 ± 103	0.83
Preoperative Hgb (g/dL)	14 ± 2	15 ± 1	0.15
Hgb on post-op day 2 (mg/dL)	11 ± 1*	14 ± 9	< 0.001
	10 ± 2**		< 0.001
Patients that received Epo (#)	5 (20%)	6 (6%)	0.04
Length of hospital stay per hip (days)	2 ± 0.3	1.8 ± 0.5	0.003
Cell Saver			
Patients that received (#)	21 (84%)	7 (7%)	< 0.001
Amount per patient (ml)	120 ± 77	126 ± 27	0.96
Intra-Op Transfusion			
Number Received	0	0	NA
Amount	0	0	NA
Blood Transfusion in 6 weeks			
Number	0	0	NA
Amount	0	0	NA
Surgical Complication			
Number	0 (0%)	1 (1%)	0.48
Description	NA	nerve palsy	
Medical Complication			
Number	2 (4%)	3 (3%)	0.22
Description	arrhythmia (1) myoclonic reaction (1)	spinal headache(2) fall with concussion (1)	
Pre-Op HHS	54 ± 10	57 ± 14	0.06
HHS at the final follow-up	95 ± 9	92 ± 10	0.99

*after first hip ; **after the second hip.

(4%) (one arrhythmia and one myoclonic reaction) and no surgical complications (0%). In the control group, there were three medical complications (3%) (two spinal headaches and one concussion) and one surgical complication (1%) (nerve palsy).

DISCUSSION

Avoiding blood transfusion is critical to improve the outcome of hip arthroplasty surgery. Patients who undergo bilateral surgery normally have higher blood transfusion and complication rates than unilateral patients in traditional stemmed THA procedures (*2,18*). Hip resurfacing is often considered to be a more complicated surgical procedure that requires more surgical time and a more extensive surgical exposure compared to traditional stemmed THA (*1,7,16*). This could result in less favorable outcomes, especially when one-stage bilateral operations are performed. This study described a detailed blood management strategy for metal-on-metal HRA procedures and compared the clinical outcomes between rapidly two-stage bilateral and unilateral HRA. This study demonstrates that a comprehensive blood management program, developed by combining many different techniques into one comprehensive program, can limit blood loss to a point where a surgeon can avoid the need for

transfusion (both autologous and allogenic) when performing HRA. Also, this study has demonstrated that rapidly two-stage HRA operations, if bilateral is required, can be done safely in the same week without added risk.

Few studies reported the clinical outcomes related to blood management after hip resurfacing (*14,15,16*). In one study of 232 consecutive Birmingham hip resurfacings, McMinn *et al* compared posterior standard and MIS hip resurfacing, but did not report blood loss and transfusion rates (*15*). In a small comparison study of 25 HRA's with an anterior-lateral MIS approach and 25 HRA's with a standard anterior-lateral approach, Mont *et al* reported that the MIS technique reduced the intraoperative blood loss substantially (566 cc *vs.* 683 cc), resulted in less blood transfusion (1.5 units *vs.* 1 unit) and a shorter length of hospital stay (3 days vs. 3.2 days) (*16*). The intra-operative blood loss, transfusion rate and hospital stay reported in our study were lower than those reported in the other two studies of MIS HRA (*15,16*). In our study, no blood transfusion was required in 50 rapidly two-stage bilateral and 100 unilateral HRA using this blood management program. Average intraoperative blood loss was similar per hip for each group in our study. Because no drain was used, no additional blood loss was recorded postoperatively. The Hgb did predictably drop to a lower level after rapidly two-stage bilateral surgery, but it was still safe and did not result in a higher complication rate than observed in unilateral cases in this study.

A bipolar tissue sealer has been proven to be an effective method to reduce blood loss. In a randomized study, Marulanda *et al* reported that a bipolar tissue sealer could reduce blood loss during a THA procedure by 40% and the transfusion rate by 73% without adversely affecting the postoperative clinical outcomes (*13*). Garvin *et al* found that the tissue sealer significantly decreased the overall risk of blood transfusion in revision THA without increasing the complication rates (*6*). A prospectively randomized study of 50 primary total knee arthroplasties showed a bipolar sealer significantly reduced the postoperative and total blood loss compared to conventional electrocautery method (*12*). A cell saver is another effective method to significantly decrease the rate of allogeneic blood transfusion (*5,6,22*). In this study, a bipolar tissue sealer was routinely utilized in all procedures and a cell saver was used to recycle blood in a small number of patients, who met the criteria described in our protocol above. We speculate that a tissue sealer is a more effective component for preventing blood transfusion than a cell saver because the tissue sealer results in less intraoperative and post-operative blood loss instead of returning the damaged blood with use of the cell saver. It is interesting to note that the cell saver volumes returned in this study were less than half the amount reported in those studies of stemmed THA that did not employ a tissue sealer (*17*). However, there are differences between HRA and THA surgical procedures and it therefore should be awared when directly comparing the present study to a stemmed THA study.

Although autologous blood is safer than allogenic blood, there are still inherent risks associated with autologous blood transfusion. Clerical error (*21*), loss of clotting factor function (*4*), release of harmful degradation products of blood known as the "storage lesion", and a decrease in the oxygen carrying capacity of the stored blood have all been documented (*10*). In our opinion, it is better to employ Epo and avoid autologous blood transfusion. Epo has been found to be effective in decreasing transfusion requirements after THA. Stowell *et al* compared the safety and efficacy of autologous blood vs. Epo in a randomized study. They found that preoperative autologous blood collection resulted in a lower Hgb level prior to surgery ; 71.2% patients in the group who donated blood preoperatively required autologous blood transfusion perioperatively and this group also had a higher rate of additional allogenic blood transfusion compared to the Epo group (19.2% *vs.* 12.9%) (*20*). Furthermore, the autologous group was transfused more units of allogenic blood (79 units *vs.* 54 units) and had lower Hgb level at discharge compared to the Epo group. Hardwick *et al* also found similar results (*8*).

Several studies have reported that simultaneous bilateral THA had a significantly increased complication rate compared to unilateral THA (*2,9,18*). Parvizi *et al* reported that simultaneous bilateral

THA had a lower Hgb level, a higher volume of total blood loss and higher blood transfusion rates compared to unilateral THA (*18*). Berend *et al* also reported a significantly higher pulmonary complication rate for bilateral THA (*2*). In our study, rapidly two-stage bilateral hip resurfacing predictably led to a greater drop in the Hgb postoperatively than unilateral resurfacing, but when a comprehensive blood management program was employed, transfusion could still be completely avoided, and neither the surgical nor the medical complication rate was increased. The average hospital stay was much shorter compared to other studies at 2 days per hip (4 days per patient) for bilateral patients and 1.8 days per hip for the unilateral patients in this study. The total complication rate was 4% for both the rapidly two-stage bilateral and unilateral group, this was lower than previously reported in bilateral THA and resurfacing studies, which normally had more than 8% complication rate (*2,9,18*).

There are certain limitations in this study. Its major weakness is the limited patient population. This study showed that there was no need for blood transfusion under the current blood management program. However, to more accurately determine the precise transfusion rate, a larger number of patients would need to be studied. In summary, when a comprehensive blood management program is employed, all types of blood transfusion can be avoided and two-stage bilateral HRA, if required, can be performed in the same week cost effectively without a significant difference in the complication rate or clinical outcome compared to unilateral HRA.

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