Simultaneous bilateral total hip arthroplasties do not lead to higher complication or allogeneic transfusion rates compared to unilateral procedures

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Abstract

Purpose About 20 % of patients undergoing a primary total hip arthroplasty could undergo a second contralateral procedure within five years. The possibility to perform simultaneous bilateral hip replacements instead of two-stage surgery could reduce hospitalisation time and patient management costs, but concerns exist because of risks related to massive blood loss and possible increase in complication rates. The purpose of this study is to assess the veracity of these concerns.

Methods Parameters like blood loss, transfused blood units, total hospital length of stay (surgical and rehabilitation) and presence of in-hospital complications were collected from surgery reports of two different groups of patients. The first group comprised patients undergoing simultaneous bilateral total hip arthroplasty ($n=63$), while the second group consisted of patients undergoing unilateral surgery ($n=97$). Occurrence of complications within six post-operative months was assessed by phone interview.

Results No differences were observed in complication, revision and mortality rates between the study groups. On the contrary, blood loss was significantly higher in the bilateral group, but the application of appropriate transfusion protocols reduced the use of allogeneic blood transfusion to the levels recorded for unilateral patients. Moreover, the difference in length of hospital stay (about two days) between the two groups was not clinically relevant.

Conclusions Our data show that simultaneous bilateral procedures do not lead to higher complication or allogeneic transfusion rates in comparison to unilateral hip replacement, and that, in

cases of bilateral disease, they could significantly reduce the total length of hospital stay and, therefore, patient management costs.

Keywords Simultaneous bilateral hip replacement · Two stage surgery · Total hip arthroplasty · Contralateral procedure

Introduction

Osteoarthritis (OA) of the hip joint has an estimated prevalence of 7.7 % of the Italian adult population older than 65 years [1] and 4.4 % of the US population older than 55 years [2]. Total hip arthroplasty (THA) is considered one of the most effective and definitive treatments for OA [3] and for many other hip joint pathologies such as rheumatoid arthritis, ankylosing spondylitis and osteonecrosis. For these reasons, THA is a very common orthopaedic procedure, and reported odds to undergo a second, contralateral surgery, after a first one, range between 16 and 85 % [4–7]. In these cases, a one-stage, simultaneous bilateral joint replacement could be a valid solution in terms of a reduced total length of hospital stays (LHS), rehabilitation time, surgery-related risks and patient management costs [8–12], without impairing the functional outcome [13–15]. Published studies about these kinds of procedures are not very common, and the few of them report both benefits and concerns. In fact, an increase of the operative time could have worsening effects on intra-operative blood loss and incidence of complications, such as infections, thrombosis or pulmonary embolism [16–18]. Nevertheless, many of these papers present several limitations, such as low number of cases, non-standardised procedures and lack of reliable control groups. Between 2001 and 2011, a total of 63 patients (126 prostheses) underwent one-stage simultaneous bilateral THA (bil-THA) at our institute. All of these patients were treated by the same orthopaedic surgeon and the same anaesthesiologist. We evaluated this group of patients until six months follow-up and compared it with a control

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group made up of 97 patients, who underwent a unilateral THA (uni-THA) procedure between 2006 and 2011 by the same surgical team at the same institute. The surgical and rehabilitative records of both patient groups were analysed by independent researchers who collected all available data, with special attention to post-operative complications, blood losses, frequency of transfusion and rate of infections. Moreover, patients were interviewed by phone to assess the eventual prosthesis revisions and any complications. Our working hypothesis is that simultaneous bil-THA is a valid solution, in carefully selected patients whose hip joints are both symptomatic, to reduce surgery-related risks and costs.

Materials and methods

Patient selection and data collection

A total of 63 patients underwent simultaneous bil-THA at our institute between 2001 and 2011. Surgical and rehabilitative reports of these patients were analysed by independent researchers, and data were manually reported in a database. Collected parameters included: patient age and gender; post-operative blood loss (shed blood volume); patients' body mass index (BMI); use of units of blood transfusions; use of shed blood reinfusion; haemoglobin (Hb) concentrations; co-morbidities; length of hospital and rehabilitation stays; and immediate post-operative complications. Follow-up was performed by phone interview to determine the presence of midterm complications and prosthesis revisions. Hb concentrations were evaluated at three time points: basal (15–21 days before surgery, and before autologous donation if performed), post-operative (within six hours after surgery, before shed blood reinfusion if administrated) and on surgical discharge day (between two and 14 days after surgery). Additional Hb evaluations were performed before and after blood transfusion if administrated. These data were compared to a similarly composed database with data about 97 patients that underwent uni-THA at our institute. Initially, about 10 % of patients ($n=130$) were randomly selected from the computer database [19] made up of 1,224 patients treated by the same surgeon between 2006 and 2011 (years with computerised surgery reports). After this selection, only 97 of 130 patients had an age range and American Society of Anesthesiologists (ASA) class matching the simultaneous bil-THA group and were actually included in the study. We did not use consecutive cases to reduce the possible bias due to surgical technique development that occurred over the study years. Twenty-two patients in this group underwent a second, contralateral, primary THA at our institute within five years from the first procedure. Their data (as the sum of both procedures) were collected in a third database to form a two-stage bil-THA control group.

Surgical technique

Patients considered suitable for bilateral procedures, in cases of bilateral disease and good general physical status (ASA score 1 or 2 and absence of severe co-morbidities), freely decided to undergo a simultaneous or a staged bil-THA. All procedures were performed by the same orthopaedic surgeon. Starting from 2004 the minimally invasive surgical technique (MIS) was applied. A modified posterolateral approach, passing through the quadratus femoris and gemellus inferior muscles, or an anterolateral Rottinger approach was applied to minimise muscular damage, followed by neck-preserving implantation of short stems. The average operating time was 40 minutes for unilateral procedures and 90 minutes for bilateral ones.

Anaesthesiology and transfusion

All patients underwent hypotensive spinal anaesthesia, administered by the same anaesthesiologist. In patients undergoing bil-THA, spinal anaesthesia was continuous, through a catheter, in contrast to uni-THA where a one-shot administration was performed. Drains were placed in each patient. All decisions about blood transfusion and reinfusion were taken by the same transfusion team leader; in particular shed blood was reinfused if drainage volume reached 300 ml within six hours after surgery, and allogeneic or autologous blood units were transfused when Hb concentration fell to 8 g/dl or if anaemia symptoms developed. Before reinfusion, shed blood was washed by Autolog™ (Medtronic, Minneapolis, MN, USA) and separated from the supernatant by Dry Wash™ (Euroset, Medolla, MO, Italy) in order to increase the number of red blood cells and reduce volume. Patients who participated in the pre-operative autologous blood donation (PABD) programme donated one or two units of blood between 15 and 21 days before surgery. The programme did not include pharmacological support (erythropoietin administration). Administration of enoxaparin, starting from the day of surgery, was applied as anti-thrombotic prophylaxis in all patients.

Statistical analysis

Data are presented as means and 95 % confidence interval (lower limit to upper limit). Statistical analysis was performed by GraphPad Prism v5.0 software (GraphPad Software Inc., La Jolla, CA, USA). The Kolmogorov-Smirnov normality test was applied to assess normal distribution of values. Hb values, hospital length of stays, patient's age, BMI, blood loss and reinfusion volumes, and number of blood units transfused in different groups were compared by unpaired two-tailed *t* test or, in the case of non-normally distributed values, two-tailed Mann-Whitney test.

Presence of co-morbidities, complications, revisions, ASA class 1 and 2 patients, percentage of transfusions and male to female ratio in the different groups were analysed by two-tailed Fisher's exact test. The significance level was set at a *p* value less than 0.05.

Results

Patients' demographics and study groups' composition

The patients were sorted into two groups: patients undergoing a primary simultaneous bil-THA (63 cases) and patients undergoing a primary uni-THA (97 cases). The two groups did not differ in terms of patients' age, gender, presence of co-morbidities and general physical status (ASA class and basal Hb concentration). Table 1 summarises this information. Another subgroup was made up of 22 uni-THA patients that underwent a second primary THA (two-stage THA) on the contralateral joint at our institute. Data about this group are presented as the sum of both surgeries.

Blood loss and transfusion rates in uni-THA and bil-THA

Blood loss was greatly and significantly higher in the bil-THA than uni-THA group, and post-operative Hb loss was consistent with this observation (Table 2). On this basis, we expected to find much more frequent transfusions in this group rather than in others; instead, we observed a comparable allogeneic blood unit usage between bil- and uni-THA groups. This was probably due to the extensive use of PABD and a post-operative blood cell salvage (PCS) system after bilateral procedures, which were indeed statistically more frequent, and higher in volumes, in the bil-THA group than in the control group. The effectiveness of these techniques was confirmed by the net peri-operative Hb loss (Hb basal concentration

minus Hb concentration at discharge; Table 2), which was just slightly, but not significantly, higher in the bil-THA groups. Table 3 summarises these data. Remarkably two-stage THA patients did not differ in volumes of blood loss [820 (678–962) ml; *p*=0.2] in comparison with simultaneous bil-THA patients.

Moreover, since the bil-THA group included surgeries performed before 2004 (without MIS), blood loss in this group is probably overestimated. In fact, volumes of blood losses were significantly higher before 2004 [1,313 (1,016–1,606) ml] then after MIS introduction [885 (772–998) ml; *p*=0.002].

Length of hospital stays in uni-THA and bil-THA groups

Total LHS, i.e. the sum of rehabilitative and surgical stays, was evaluated after simultaneous bilateral, unilateral and staged bilateral THA procedures. Statistical analysis confirmed that patients undergoing a simultaneous bilateral procedure statistically spent more days in hospital than uni-THA ones. The mean difference between these groups is about two days (95 % confidence interval range from 12 to 13.7 days in uni-THA and from 14 to 16.2 in bil-THA). Remarkably, two-stage THA patients had a much longer total hospital stay compared to the bil-THA group; the 95 % confidence interval for this value ranges between 23.2 and 25.2 days. Figure 1 reports these findings. As expected, two-stage patients had about double LHS of uni-THA, and no statistical difference was observed between two times uni-THA and two-stage THA patients' LHS. Once again, LHS was significantly higher before MIS introduction, with means of 17.3 days (15.1–19.5) and 13.8 days (12.8–14.8) in patients operated before and after 2004, respectively (*p*=0.002). Nowadays then, the difference between simultaneous bilateral and unilateral procedures in terms of LHS would be trivial, just about 1 day (*p*=0.026).

Table 1 Patients' demographic and baseline characteristics in simultaneous bil-THA and uni-THA groups

	Bil-THA	Uni-THA	<i>p</i> =
Male to female ratio	0.8	1.1	0.33
Average age	55.8 (53.2–58.4)	53.4 (50.2–56.6)	0.43
Basal Hb (g/dl)	13.7 (13.3–14.2)	14.2 (13.8–14.4)	0.11
Average BMI	25.8 (24.7–26.9)	26.2 (25.1–27.3)	0.61
ASA 1 to ASA 2 ratio	0.4	0.2	0.07
Co-morbidities			
Hypertension (%; <i>n</i>)	20; 10	30.2; 29	0.23
Cardiovascular diseases (%; <i>n</i>)	14; 7	23.9; 23	0.2
Renal diseases (%; <i>n</i>)	2; 1	5.2; 5	0.66
Diabetes (%; <i>n</i>)	6; 3	9.4; 9	0.75

When applicable, the 95 % confidence interval is indicated as lower limit to upper limit

Table 2 Blood and Hb concentration losses after bilateral and uni-THA procedures

	Bil-THA	Uni-THA	<i>p</i>
Blood loss (ml)	989 (863–1,115)	462 (417–506)	<0.0001
Post-operative Hb loss (g/dl)	3.71 (4.30–3.13)	2.68 (2.48–2.88)	<0.0001
Perioperative Hb loss (g/dl)	4.74 (4.24–5.25)	4.66 (4.20–5.13)	=0.38

The 95 % confidence interval is reported as lower limit to upper limit

Complications and revisions after uni-THA and bil-THA

The frequency of revision was compared by number of prostheses between uni- and bil-THA patients. In all of the 221 cases (information missing for one patient in the bil-THA group) only three revisions were performed and no significant difference was observed between groups (two cases, 1.6 % in bil-THA and 1.1 % in uni-THA; $p=1$).

Immediate post-operative complications were observed in both groups (Fig. 2). Major systemic complications (rates of 1 % in bil-THA and 3.1 % in uni-THA; $p=0.7$) coincided with symptomatic cardiovascular events: atrial fibrillation (two cases), alteration of cardiac repolarisation (one case) and carotid kinking (one case), while major local complications (bil-THA 4 %; uni-THA 0 %; $p=0.11$) included infection (one caused by *Staphylococcus epidermidis*, resolved with oral antibiotic administration) and wound dehiscence (one solved by surgical revision of the wound). Minor systemic complications (bil-THA 4 %; uni-THA 1 %; $p=0.23$) included cases of collapse (one) and dyspnoea (two), while in the minor local group (bil-THA 10 %; uni-THA 17.5 %; $p=0.26$) comprised cases of phlebitis (two), lower limb oedema (six), lower limb paraesthesia (two), operated limb swelling (three), sciatica (one) and pain (eight). Additional symptoms, but not included in the evaluation, were gastrointestinal distress (17), vertigo (three), hypertension (one), urinary tract symptoms (five), hypotension (nine) and hypoglycaemia (one). Remarkably, rates of adverse events

were similar between uni- and bil-THA patients in all analysed groups. This similar incidence of complications was observed also within six months after surgery (Fig. 2), when just three major events (one systemic and two local) and seven minor local complications arose. The only major systemic episode was one thrombosis (resolved after a few weeks), while at the local level one case of joint infection (resolved after antibiotic treatment) and one of wound surgical revision were observed. Concerning the minor complications, with local manifestation, cases of hip tendonitis (one), lower limb paraesthesia (one) and some persistent pain (five) were observed (Fig. 2).

Mortality rates were similar between groups (bil-THA 3 %, two cases, both nine years after the procedure; uni-THA 1 %, one case, three years after surgery; $p=1$), and cases were not related to THA procedures.

Discussion

Interest in simultaneous bil-THA is growing year by year, due to the large percentage of patients with joints that are both symptomatic and the related possibility to reduce costs, hospital stay and rehabilitation time without influencing the surgical outcome [10, 12, 14]. Reports concerning these procedures are rare, and the few published studies report contentions, not definitive conclusions, and are often characterised by a poorly reliable control group. Besides

Table 3 Transfusion (or reinfusion) rates and blood use in simultaneous bilateral and uni-THA

	Bil-THA	Uni-THA	<i>p</i>
Patients without PABD, transfused with homologous blood (%; <i>n</i>)	62.5; 5	23.4; 11	=0.04
Patients with PABD, transfused with homologous blood (%; <i>n</i>)	7.1; 3	6; 3	=1
All patients, transfused with homologous blood (%; <i>n</i>)	16; 8	14.4; 14	=0.81
Patient with PABD, transfused with autologous blood (%; <i>n</i>)	80.1; 34	56; 28	=0.01
Patients reinfused with shed blood (%; <i>n</i>)	82; 41	47.7; 46	<0.0001
No. of homologous units/no. of transfused patients	1.5 (1.0–1.9)	1.4 (1.0–1.8)	=0.66
No. of autologous units/no. of transfused patients	1.6 (1.48–1.82)	1 (1–1)	<0.0001
Shed blood reinfused volume (ml)	449 (371–528)	328 (281–384)	=0.02

When applicable, the 95 % confidence interval is reported as lower limit to upper limit

The sample includes 47 patients without PABD in the uni-THA group and 8 patients in the bil-THA group and 50 patients with PABD in the uni-THA group and 42 patients in the bil-THA group

Fig. 1 Total length of hospital stays (surgery and rehabilitation) for different groups of patients. Data about two-stage THA patients are reported as the sum of both surgeries. *** $p<0.0001$, simultaneous bilateral versus unilateral or two-stage procedures

the cited advantages, some authors reported higher risks in simultaneous bilateral procedures, due to longer operative time and massive blood loss [11, 17, 20]. The limitations of our study include the retrospective design, the absence of measures evaluating complication severity and the reliance on administrative data. Moreover, a known bias is the presence in the bil-THA group of patients operated on before 2004, and therefore before introduction of the MIS technique, causing an overestimation of blood loss and LHS in this group. In contrast, all operations in this study were performed by the same orthopaedic surgeon, assisted by the same anaesthesiologist, thus ensuring standardised procedures. In our study, the control group, uni-THA, was formed by randomly selected patients undergoing THA, with comparable sex, age and ASA score to the bil-THA group. Roughly 20 % of patients in the control group underwent a second, contralateral surgery within 3 years of the first one, and this percentage is consistent with the latest reports in the literature [5]. These patients allowed us to consider parameters like total blood loss and total hospital stays, in order to better understand differences between staged and simultaneous bil-THA. Our findings demonstrate that concerns about massive blood loss in simultaneous procedures are well grounded, but, at the same time, that a programme of

PABD would be sufficient [20], together with the application of a post-operative PCS system and a careful process of patient selection, to limit transfusion of allogeneic blood to levels of uni-THA ones. Interestingly, these practices of autologous blood reinfusion are often reported as unuseful in unilateral procedures, while they appear crucial in bilateral ones [21, 22]. The net peri-operative Hb loss is consistent with observed transfusion rates, since no statistical differences were found between patients that underwent uni- and bil-THA. Moreover, new studies have shown that tranexamic acid could reduce peri-operative blood loss [23]. Therefore, recently, we began performing administration of tranexamic acid, especially in patients who fail to complete the PABD programme, in order to further decrease the use of allogeneic blood transfusion. Unfortunately, the results of this procedure are not available yet, but evidence of its effectiveness is already present in the literature as reported by similar studies [24]. On the aspect of immediate post-operative and six month complications, we did not find any difference between unilateral and bilateral procedures, as also reported in the literature [9, 14]. Interestingly, the number of prosthesis revisions was also similar between our study groups, while some authors reported an increase of revision procedures after simultaneous bil-THA [17]. Total LHS, surgical and rehabilitative, is just slightly longer (about two days) in bilateral procedures than unilateral, but remarkably shorter in bil-THA in comparison to two-stage THA (about ten days). Moreover, considering only patients operated with MIS (2004–2011), the LHS of uni- and bil-THA groups is similar. This observation is sufficient to underline a reduction of patient management costs, when both joints are affected, as already demonstrated by other authors [8, 25].

In conclusion, our data confirm that, with modern surgical and transfusion techniques, simultaneous bil-THA are equally safe procedures as unilateral ones in healthy patients (ASA class 1 or 2); in fact, despite the higher blood losses, there are no difference in terms of respiratory complications, major cardiac events (ischaemia and arrhythmia), thromboembolic events (deep vein thrombosis and pulmonary embolism), stroke, surgical site infection and rate of allogeneic transfusions.

Fig. 2 In-hospital and 6-month complication rates in uni- and bil-THA groups. No significant differences were observed between the two groups at any time point

Conflict of interest The authors declare that they have no conflict of interest.

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