One-stage total hip arthroplasty and "light-bulb" procedure for bilateral non-traumatic osteonecrosis of femoral head in different stages

Pei Liu[1], Qi-Dong Zhang[2], Yang Wang[1], Zi-Qi Xia[1], Fei-Fan Lu[3], Zhao-Hui Liu[2], Wei-Guo Wang[2], Wan-Shou Guo[2]

[1]Beijing University of Chinese Medicine, Beijing 100029, China;
[2]Department of Orthopedic Surgery, Beijing Key Lab Immune-Mediated Inflammatory Diseases, China-Japan Friendship Hospital, Beijing 100029, China;
[3]China-Japan Friendship School of Clinical Medicine, Peking University, Beijing 100029, China.

To the Editor: Clinically, it is not rare for patients with bilateral non-traumatic osteonecrosis of femoral head (NONFH) first presenting to an orthopedic surgeon with one hip that requires total hip arthroplasty (THA) and another asymptomatic or less symptomatic one that potentially needs hip preservation surgery. Theoretically, the to-be-preserved hip should be treated prior to, or at least simultaneously with, the THA side. Yet, some patients may reject treatment of the asymptomatic or less symptomatic side due to their doubt on the necessity of undergoing a surgery or concerning over its safety. We hypothesized that one-stage THA for one hip and contralateral "light-bulb" procedure for the contralateral side can yield benefits for these patients.

This study was approved by the Ethics Committee of the China-Japan Friendship Hospital (2015-SFZX-N). A consecutive series of 26 patients with bilateral NONFH who underwent the aforementioned procedure were involved between January 2013 and January 2018 at our hospital. The etiologies were steroid-induced in 17 patients (65.4%) and alcohol-induced in 9 patients (34.6%), with a 30.8 months of follow-up. The control group included 26 age-, gender-, etiology-, stage-, extent-, and follow-up-matched patients undergoing staged surgery during the same period [Table 1].

NONFH was diagnosed based on the symptoms, physical signs, past medical history, related risk factors and imaging data of the patients. Patients who presented with hips in Association Research Circulation Osseous (ARCO) stage II or IIIa were included for hip preservation surgery, and those who were in ARCO stage IV or in ARCO stage IIIb and IIIc with complaints of serious pain were also included for THA. Patients who were excluded from receiving hip preservation surgery were: (1) over-aged, mainly above 50 years; (2) unable to stop corticosteroids administration due to corticosteroid-dependent diseases; (3) failed to quit alcohol abuse. Patients with less than 18 years were excluded from receiving THA.

Under general anesthesia, THA was performed firstly, during which the patients were put in a lateral decubitus position, and a posterolateral approach was adopted. The DePuy prostheses (Johnson & Johnson, USA) with cementless technique were utilized. After then, the "light-bulb" procedure was carried out through a direct anterior approach (DAA). Autogenous fresh cancellous bone used for grafting was harvested from the resected femoral head, femur neck, and proximal femur. The insufficient grafting bone will be supplemented with PRODENSE™ (Wright Medical Group, USA) to prevent donor site morbidity. For the staged surgery, the same procedures were performed except that the necrotic area after debridement was filled with combination of PRODENSE™ and cancellous bone was harvested from the bone window during "light-bulb" procedure. The interval in the two-stage group ranged from 6 to 24 months (median 11 months).

After surgery, clinical and radiological follow-up were conducted at the interval of 3 months in the first year and 6 months in the subsequent years. The clinical follow-up based on pre- and post-operative Harris Hip Score (HHS) difference. The radiological follow-up consisted of imaging taken at each visit including the anteroposterior and frog-leg lateral views of the bilateral hips. Clinical failure was defined as HHS $\leq$ 70 points or conversion to THA for

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Pei Liu and Qi-Dong Zhang contributed equally to this work.

Correspondence to: Dr. Wan-Shou Guo, Department of Orthopedics Surgery, Beijing Key Lab Immune-Mediated Inflammatory Diseases, China-Japan Friendship Hospital, No. 2, Yinghuadong Road, Chaoyang District, Beijing 100029, China
E-Mail: wanshoug@sina.com

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Table 1: Comparison of clinical data of patients with one-stage surgery and two-stage surgery.

Data	One-stage surgery ($n = 26$)	Two-stage surgery ($n = 26$)	*P*
Gender (male/female)	19/7	21/5	0.510
Age (years)	38.77 ± 6.66	38.35 ± 5.37	0.802
Etiology (steroid/alcohol)	16/10	15/11	0.777
Operation time (min)	157.69 ± 28.51	124.38 ± 14.94	<0.001
Hospital stay (days)	11.77 ± 2.58	14.85 ± 2.13	<0.001
Blood loss (mL)	373.08 ± 106.20	387.50 ± 78.25	0.497
Complications	1 (3.8)	2 (7.7)	1.000
Costs (RMB Yuan)	79,769.23 ± 13,087.10	91,034.62 ± 4496.35	<0.001
Follow-up (months)	30.8 (24.0–37.0)	30.0 (25.0–30.0)	0.655
HHS in THA side			
Pre-operation	50.50 ± 7.73	49.62 ± 5.47	0.636
Post-operation	93.58 ± 2.99	94.04 ± 2.01	0.518
HHS in hip preservation side			
Pre-operation	68.81 ± 7.43	68.12 ± 7.93	0.747
Post-operation	82.54 ± 13.29	78.08 ± 11.62	0.203

Data were expressed as mean ± standard deviation, *n*, *n* (%), and median (interquartile range). HHS: Harris hip Score; THA: Total hip arthroplasty.

any reason. Radiographic failure was defined as the collapse > 2 mm or premature osteoarthritis.

Compared with two-stage unilateral surgery, the simultaneous bilateral surgery could be performed in safety. There was no significant difference in total blood loss between the two groups (373.08 ± 106.20 mL *vs.* 387.50 ± 78.25 mL, $P = 0.497$). The one-stage group was associated with longer operative time (157.69 ± 28.51 min *vs.* 124.38 ± 14.94 min, $P < 0.001$). However, increased operative time did not translate into more complications, which in the two groups were 1 of 26 (3.8%) and 2 of 26 (7.7%) respectively ($P = 1.000$). For the THA side, the latest follow-up showed no statistical difference in clinical and radiological results. HHS increased from 50.50 ± 7.73 points to 93.58 ± 2.99 points in the one-stage group and from 49.62 ± 5.47 points to 94.04 ± 2.01 points in the two-stage group. In terms of radiology, neither group reported loosening or revision of the hip prosthesis. For the hip preservation side, clinical and radiographic results were better in the one-stage group. At the final follow-up, the clinical outcomes exhibited excellent or good results in 19 of 26 (73.1%) patients in the one-stage group and 12 of 26 (46.2%) patients in the two-stage group ($P = 0.048$). Radiological examination discovered no progression of necrosis in 17 (65.4%) and 9 (34.6%) patients in the two groups respectively ($P = 0.027$); progression in stage and/or extent (< 2 mm collapse) with minimal or mild symptoms in five (19.2%) patients in the one-stage and six (23.1%) patients in the two-stage groups ($P = 0.734$). In the one-stage group, four (15.4%) patients experienced conversion to THA, and there were 11 (42.3%) patients in the two-stage group ($P = 0.032$). Moreover, medical expenses and the length of hospital stay were significantly reduced in the one-stage group. There was a cost reduction of 11,000 RMB Yuan per case (79,769.23 ± 13,087.10 RMB Yuan *vs.* 91,034.62 ± 4496.35 RMB Yuan, $P < 0.001$), which constituted 13% of the overall expenses. The hospital stays of both groups are 11.77 ± 2.58 days and 14.84 ± 2.13 days, respectively ($P < 0.001$).

For young, active patients presenting with NONFH, hip preservation procedure is the prior therapeutic method, with the awareness that a subsequent THA may be unavoidable.[1] It is recommended to avoid treatment schemes that have a high risk of developing complications or compromising to future THA.[2] The "light-bulb" procedure initially reported by Rosenwasser *et al*[3] has achieved outstanding clinical effects. Mont *et al*[4] reported an 86% success rate of clinical treatment with a mean of 48 months' follow-up, which outperformed the results obtained in our study (success rate: 71.15%; excellent and good rates: 59.62%). "Light-bulb" procedure via DAA is less invasive, and covers an average operative time less than 1 h with moderate loss of blood. In the case of surgery failure, it does not increase operative difficulty of THA.

The factors underlying success of the one-stage treatment are the following. First, early intervention is the key to success, and one-stage treatment avoids unnecessary delay during hip preservation surgery.[5] Second, autologous bone grafting can stimulate bone formation, support the subchondral bone and articular cartilage. Third, the preserved hip is allowed to engage in early non-weight-bearing exercises as the weight is distributed to the THA side. Some limitations should be acknowledged. First, the limited sample sizes and retrospective methods have weakened the objective evaluation. Second, the procedures discussed in this study only applied to a specific subset of patients. Third, two kinds of bone grafting materials (autologous bone and synthetic bone substitute) were utilized, which could introduce heterogeneities, and long-term follow-up was necessary.

The present study revealed that one-stage THA and contralateral "light-bulb" procedure could benefit a special group of patients with bilateral NONFH. For the salvaged hip, the clinical and radiographic outcomes were significantly better in one-stage surgery, and decreased the rate of conversion to THA. Meanwhile, it could be performed in safety, and was cost-effective. While

these outcomes may not mean the requirement for immediate clinical changes, future research spurred by these findings may eventually lead to clinical changes, if these are effective.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

None.

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