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A Novel Fast Mobile-Window Small Incision Technique for Hip Arthroplasty in the Elderly and Comparison with Conventional Incision

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Background: We deeloped a novel technique – fast mobile-window small incision (FMWSI) – a modification of minimally invasive surgery for total hip arthroplasty, which we believe is particularly suited to elderly patients with hip fractures. The present article aimed to introduce this technique and compare the clinical effects between the FMWSI technique and conventional incision (CI) for hip arthroplasty in elderly patients.

Material/Methods: This study included 240 consecutive patients who underwent hip arthroplasty. Half received total hip arthroplasty and half received hemi hip arthroplasty. The 120 patients in each group were further divided into FMWSI and CI groups. The following parameters were compared between the FMWSI and CI groups: length of incision, operation time, bleeding volume, drainage volume, postoperative ambulation time, and Harris score.

Results: Compared with the CI group, the FMWSI group had a significantly shorter incision length, operation time, and postoperative ambulation time, as well as lower bleeding and drainage volumes, irrespective of whether the treatment was total or hemi hip arthroplasty ($P<0.05$). However, no significant difference was found in the Harris score between the FMWSI and CI groups ($P>0.05$).

Conclusions: The novel FMWSI technique introduced in this study is a useful method for hip arthroplasty, especially for elderly patients with poor constitutions or tolerance to surgery.

MeSH Keywords: Arthroplasty, Replacement, Hip • Housing for the Elderly • Incisor

Abbreviations: **FMWSI** – fast mobile-window small incision; **CI** – conventional incision; **THAR** – total hip arthroplasty; **HHAR** – hemi hip arthroplasty; **SD** – standard deviation

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Background

Hip fracture is an important public health problem because it has become very common, especially among older individuals. The worldwide annual number of hip fractures was estimated at 1.66 million in 1990, and this is expected to increase to 6.26 million by 2050 [1,2]. In Asia, hip fractures accounted for 26% of all fractures in 1990, and this value is expected to rise to 37% by 2025 and to 45% by 2050 [3]. Further, 310 000 hospital admissions in the United States were for hip fractures, which accounted for 30% of all hospitalized patients [4]. The increased incidence of hip fractures imposes a remarkable economic and social burden [5,6].

At present, hip arthroplasty is the most widely used treatment for femoral neck fractures [7–10]. However, for the elderly, artificial hip replacement is a difficult surgery because of the many associated complications, making the prognosis poor. Specifically, these patients cannot tolerate the long operation time because they have poor organ function, reduced physiological reserve, and concomitant cardiovascular, respiratory, and endocrine diseases. Therefore, a novel surgical procedure with a short operation time and fast wound healing is greatly needed.

In the present study, we introduce a novel method we developed, known as the fast mobile-window small incision (FMWSI) technique, and compare the clinical outcomes between FMWSI and conventional incision (CI).

Material and Methods

Patients

The study procedure was approved by the Ethics Committee of Yanan Hospital of Kunming Medical University. Informed consent was obtained from each patient included in the study and the study protocol conforms to the ethics guidelines of the 1975 Declaration of Helsinki. Between June 2010 and June 2014, 240 elderly patients with femoral neck fractures were consecutively enrolled from Yanan Hospital of Kunming Medical University. Femoral neck fracture was diagnosed and confirmed by clinical and X-ray examination. The inclusion criteria were as follows: (a) patients with age {≥60 years who are capable of walking before injury; (b) patients with Garden-III and -IV fractures; and (c) patients without absolute contraindications to surgical intervention. We excluded patients with serious medical diseases, gluteus medius strength less than 3, pathological fractures caused by other diseases such as cancer, and previous local infection. Among them, 120 patients underwent total hip arthroplasty (THAR) and 120 patients underwent hemi hip arthroplasty (HHAR) at 2–10 days following injury. Patients who received THAR and HHAR were randomly divided into 2 groups according to the incision type: FMWSI and conventional incision CI.

Perioperative management

Before surgery, skin traction was performed, primary coexisting diseases were well-controlled (hemoglobin {≥90 g/L, fasting blood sugar <8.0 mmol/L), and electrolyte disorder, malnutrition, and hypoalbuminemia were corrected. After surgery, regular broad-spectrum antibiotics were administered for 2–3 days and anticoagulant drugs for 1 month. The negative-pressure drainage tube was removed 24–48 h following surgery. All patients were encouraged to actively exercise their quadriceps femoris muscles. At 1–7 days after surgery, all patients were permitted to walk with a cane and the gradually with full weight-bearing.

Surgical procedure

The procedure was performed under general anesthesia or combined spinal-epidural anesthesia. Patients were placed in the lateral decubitus position. The CI operation was routinely performed with an incision length of 15–20 cm. The FMWSI procedure was carried out as follows: A slightly curved incision was made along the lower edge of the greater trochanter via a modified lateral approach and with the surface of the greater trochanter as the center. The incision length was 6.5–10 cm, and two-thirds of the incision was located at the edge of the proximal end of the greater trochanter. Throughout the surgery, the visual operative field was fully exposed by appropriately moving the operation window rather than increasing the incision length. The fascia was stripped off to show external rotation muscles. The muscles were cut in the vicinity of the greater trochanter without damaging the gluteus medius. The joint capsule was then split in a T-shaped fashion to expose the femoral head and neck. The femoral head was removed after truncation of the femoral neck at 1 cm above the femur. The femoral prosthesis was implanted. The incision was closed following resetting the hip joint, indwelling negative-pressure drainage tube, and suturing the joint capsule and muscles (Figure 1).

The Harris score was used to assess hip joint function 6 weeks after the operation. The following indicators of clinical outcome were compared between groups: length of incision, operation time, bleeding volume, drainage volume, postoperative ambulation time, and Harris score.

Statistical analysis

All data were analyzed by using the SPSS software package version 13.0 (SPSS Inc., Chicago, IL, USA). The measurement data are expressed as mean ± standard deviation (SD), and

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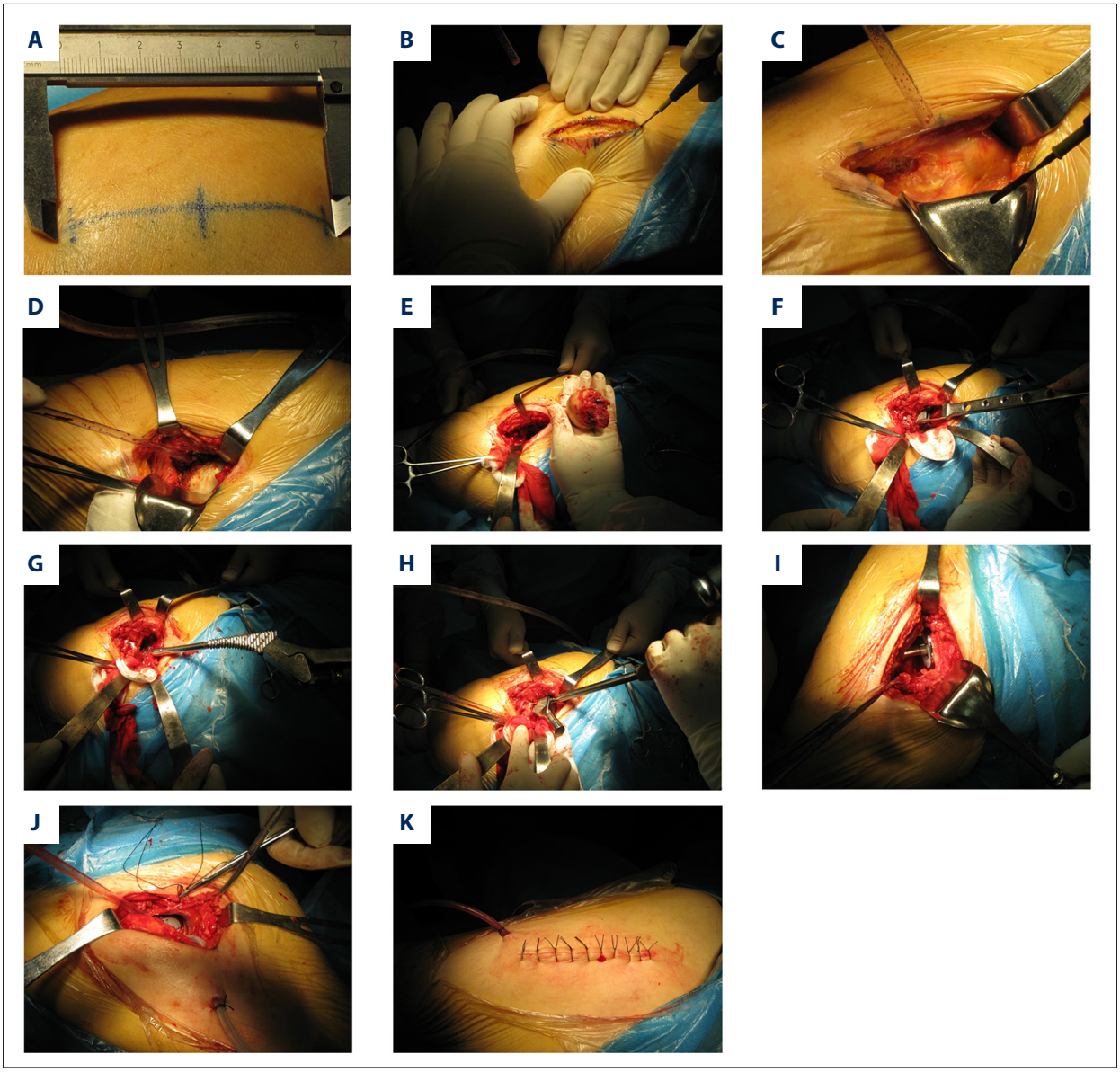

Figure 1. Fast mobile-window small incision procedure. (**A**) Incision length. (**B**) Incision. (**C**) Visual operative field exposed by appropriately moving the window. (**D**) Exposure of the femoral head. (**E**) Removal of the femoral head. (**F**) A slit is cut in the medullary cavity of the proximal femur. (**G**) The mold of the femoral prosthesis is tested. (**H**) The femoral prosthesis is placed. (**I**) The hip joint is reset. (**J**) The joint capsule is sutured. (**K**) The incision is closed.

differences between groups were analyzed using Student's *t*-test or Fisher's exact test. Pearson correlation was performed to analyze the relationship between length of the incision and perioperative outcomes of FMWSI and CI. A *P* value less than 0.05 was considered statistically significant.

Results

Table 1 presents patient characteristics. The FMWSI and CI groups were well matched and showed no significant difference in age, sex, time from injury to operation, fracture type, and complication rate ($P>0.05$). Table 2 summarizes the pre-, peri-, and postoperative complications. With regard to the postoperative outcomes of patients who underwent THAR, the FMWSI group needed significantly shorter incisions and had a shorter surgery time and postoperative ambulation time than the CI group ($P<0.05$). Moreover, the bleeding and drainage volumes were significantly lower in the FMWSI group than the CI group ($P<0.05$). Patients who underwent HHAR showed similar results in terms of these parameters ($P<0.05$). However, for patients who underwent THAR and HHAR, the Harris score

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Table 1. Patient characteristics.

Patients	THAR		HHAR	
	FMWSI (n=60)	CI (n=60)	FMWSI (n=60)	CI (n=60)
Age (years, mean ±SD)	64±4	65±3	75±5	73±4
Gender (%)				
Male	39%	37%	35%	41%
Female	61%	63%	65%	59%
Time from injury to operation (days, mean ±SD)	5±2	4±2	6±4	5±1
Time from admission to surgery (days, mean ±SD)	4.5±2	3.5±2	5±2	4±1
Fracture types (%)				
Subcapital	32%	42%	35%	45%
Central	55%	50%	59%	50%
Basal	13%	8%	6%	5%
Garden's classification (%)				
III	65%	70%	73%	72%
IV	35%	30%	27%	28%
Cause of injury (%)				
Falls	78%	67%	67%	77%
Vehicular accidents	15%	15%	18%	12%
Falls from a height	5%	10%	12%	9%
Unknown	2%	8%	3%	2%

SD – standard deviation; THAR – total hip arthroplasty; HHAR – hemi hip arthroplasty; FMWSI – fast mobile window small incision; CI – conventional incision.

Table 2. The pre, peri, and post-operative complications.

Complications	THAR		HHAR	
	FMWSI (n=60)	CI (n=60)	FMWSI (n=60)	CI (n=60)
Pre-operative, %				
Hypertension	37%	35%	36%	29%
Mild anemia	24%	24%	27%	24%
Diabetes mellitus	19%	22%	19%	25%
Mild/moderate cardiac insufficiency	15%	11%	15%	15%
Mild obstructive respiratory insufficiency	5%	8%	3%	7%
Peri-operative, %				
Periprothesic fracture, Vancouver type B1	1.7%	–	–	–
Post-operative, %				
Luxation	–	–	1.7%	–
Periprothesic fracture, Vancouver type B1	–	1.7%	–	–
Periprothesic fracture, Vancouver type C	1.7%	1.7%	–	1.7%

THAR – total hip arthroplasty; HHAR – hemi hip arthroplasty; FMWSI – fast mobile window small incision; CI – conventional incision.

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Table 3. Comparison of perioperative outcomes between FMWSI and CI.

Parameters	THAR			HHAR		
	FMWSI (n=60)	CI (n=60)	*P* value	FMWSI (n=60)	CI (n=60)	*P* value
Length of incision (cm, mean ±SD)	8.66±0.62	18.64±1.82	<0.05	8.12±1.62	15.32±3.42	<0.05
Time of surgery (min, mean ±SD)	70.12±14.52	106.08±16.24	<0.05	40.68±15.14	60.46±20.32	<0.05
Bleeding volume (ml, mean ±SD)	230.34±76.26	385.36±82.64	<0.05	70.62±50.24	253.24±38.26	<0.05
Drainage volume (ml, mean ±SD)	170.64±31.76	262.84±64.32	<0.05	80.56±21.64	124.82±33.52	<0.05
Postoperative ambulation time (days, mean ±SD)	3.68±1.52	9.64±2.24	<0.05	2.28±1.24	5.64±2.52	<0.05
Harris score (mean ±SD)	89.4±3.8	88.6±3.4	>0.05	93.2±4.2	91.6±3.8	>0.05

FMWSI – fast mobile window small incision; CI – conventional incision; SD – standard deviation; THAR – total hip arthroplasty; HHAR – hemi hip arthroplasty.

did not differ significantly between the FMWSI and CI groups ($P>0.05$) (Table 3). After stratification analysis according to fracture type and Garden's classification, similar results were also observed (Tables 4, 5). As shown in Table 6, the incision length was positively associated with time of surgery, bleeding volume, drainage volume, and postoperative ambulation time ($r>0.8$, $P<0.01$). A case of FMWSI treatment is shown in Figure 2.

Discussion

Mortality following hip fracture is clearly increasing with the growing elderly population [11], despite numerous efforts to reduce the mortality rate and improve operative outcomes. Studies have been carried out both in clinical settings and as animal experiments, involving strategies such as multicomponent home-based physical rehabilitation programs, implant removal, tissue engineering technology, and the minimal incision technique [12–16].

The average incision length in conventional artificial hip replacement surgery is 22 cm. Although large incisions provide a broad operative view, they destroy small blood vessels and cause lower limb swelling, deep vein thrombosis, and infection because of the extended exposure time [17]. Moreover, muscle tissue is extensively damaged during the surgery; therefore, recovery is slow and early postoperative rehabilitation is difficult [11]. Since the minimal incision technique was first reported in 2003, this approach has found widespread use in clinical practice [16,18], with advantages like reduced soft tissue damage, surgery time, pain, and incidences of deep vein thrombosis and pulmonary embolism, as well as fast recovery [19,20]. Additionally, Vicente et al reported that the minimally invasive posterior approach to THA may be associated with low total estimated bleeding and intraoperative bleeding [17], and Dorr et al reported that minimally invasive THA may lead to better early pain control and early home discharge and unassisted ambulation [21]. These findings collectively indicate that reducing the operation wound in hip arthroplasty is of great value, especially for elderly patients with peri-operative complications.

In the present study, we developed a novel minimal incision technique that is fast and involves a mobile operative window. During the operation, the skin was pulled only up to the point required and to the maximum extent that was naturally possible, whereby the stretch reaction of the skin and its surrounding soft tissues was reduced. Additionally, we achieved adequate surgical exposure by moving the operation window rather than enlarging the original incision. Because of the minimally invasive incision, important muscle tissues were not damaged and the external rotator was repaired by *in situ* restoration, whereby the stability of the hip joint could be maintained to the maximum extent and the possibility of postoperative dislocation was reduced [22,23]. In our comparison of 240 elderly patients who underwent THAR or HHAR via the CI and FMWSI techniques, we found that patients in the FMWSI group needed shorter incisions than in the CI group. They also had shorter surgery times and postoperative ambulation times, and lower bleeding and drainage volumes.

Incision length is not the only factor that affects treatment outcome; other such factors are the general condition of the patient, the severity of comorbidities, and the skill of the surgeon. Therefore, the FMWSI technique may not be suitable in all cases. For example, for patients with severely deformed hip joints, obsolete fractures, muscle contracture, and obesity, or those requiring revision hip arthroplasty, it may be difficult to achieve adequate surgical exposure, and incision extension would usually be required.

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Table 4. Stratification analysis of perioperative outcomes between FMWSI and CI according to fracture types.

Parameters	Subcapital					
	THAR			HHAR		
	FMWSI	CI	*P* value	FMWSI	CI	*P* value
Length of incision (cm, mean ±SD)	8.55±0.44	18.49±1.75	<0.05	8.18±1.65	16.2±2.95	<0.05
Time of surgery (min, mean ±SD)	70.3±10.3	107.5±17.2	<0.05	40.3±14.8	61.4±19.8	<0.05
Bleeding volume (ml, mean ±SD)	237.1±70.5	386.8±80.8	<0.05	71.0±48.5	256.8±35.8	<0.05
Drainage volume (ml, mean ±SD)	175.9±31.4	263.1±66.9	<0.05	78.4±22.7	123.9±30.5	<0.05
Postoperative ambulation time (days, mean ±SD)	3.82±1.63	9.87±1.11	<0.05	2.37±1.21	5.74±1.98	<0.05
Harris score (mean ±SD)	90.4±2.85	88.7±3.6	>0.05	93.8±4.0	91.6±3.7	>0.05
Parameters	**Central**					
	THAR			HHAR		
	FMWSI	CI	*P* value	FMWSI	CI	*P* value
Length of incision (cm, mean ±SD)	8.58±0.59	18.1±1.92	<0.05	8.11±1.64	15.0±3.21	<0.05
Time of surgery (min, mean ±SD)	73.5±15.8	104.5±14.4	<0.05	40.9±16.2	58.2±22.6	<0.05
Bleeding volume (ml, mean ±SD)	223.0±77.0	384.1±84.1	<0.05	68.2±50.4	249.2±38.9	<0.05
Drainage volume (ml, mean ±SD)	170.5±28.9	262.6±61.5	<0.05	80.9±22.2	122.3±35.4	<0.05
Postoperative ambulation time (days, mean ±SD)	3.59±1.02	9.6±1.8	<0.05	2.18±1.32	5.75±2.65	<0.05
Harris score (mean ±SD)	91.4±2.22	88.6±3.2	>0.05	93.5±3.8	91..5±3.9	>0.05
Parameters	**Basal**					
	THAR			HHAR		
	FMWSI	CI	*P* value	FMWSI	CI	*P* value
Length of incision (cm, mean ±SD)	8.75±0.45	18.69±1.75	<0.05	8.06±1.44	14.7±3.3	<0.05
Time of surgery (min, mean ±SD)	68.1±15.2	106.2±14.3	<0.05	40.3±14.7	63.2±19.6	<0.05
Bleeding volume (ml, mean ±SD)	229.4±72.1	385.6±80.3	<0.05	72.6±55.8	262.7±40.4	<0.05
Drainage volume (ml, mean ±SD)	166.5±30.2	262.7±70.1	<0.05	81.9±20.1	134.8±41.9	<0.05
Postoperative ambulation time (days, mean ±SD)	3.53±1.34	9.42±2.5	<0.05	2.28±1.03	6.02±3.32	<0.05
Harris score (mean ±SD)	88.6±3.5	88.1±3.2	>0.05	91.7±4.4	90.9±3.63	>0.05

FMWSI – fast mobile window small incision; CI – conventional incision; SD – standard deviation; THAR – total hip arthroplasty; HHAR – hemi hip arthroplasty.

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Table 5. Stratification analysis of perioperative outcomes between FMWSI and CI according to Garden's classification.

Parameters	Garden stage III					
	THAR			HHAR		
	FMWSI	CI	*P* value	FMWSI	CI	*P* value
Length of incision (cm, mean ±SD)	8.62±0.74	18.68±1.85	<0.05	8.12±1.64	15.7±3.02	<0.05
Time of surgery (min, mean ±SD)	70.6±14.3	106.5±16.1	<0.05	40.4±15.11	62.8±18.97	<0.05
Bleeding volume (ml, mean ±SD)	227.1±73.3	386.8±81.8	<0.05	72.5±50.67	257.8±40.32	<0.05
Drainage volume (ml, mean ±SD)	170.2±32.4	264.4±60.7	<0.05	81.1±22.3	125.6±30.24	<0.05
Postoperative ambulation time (days, mean ±SD)	3.70±1.53	9.66±1.61	<0.05	2.15±0.87	5.51±1.99	<0.05
Harris score (mean ±SD)	88.8±3.95	88.2±3.7	>0.05	93.4±3.6	91.7±3.8	>0.05
Parameters	**Garden stage IV**					
	THAR			HHAR		
	FMWSI	CI	*P* value	FMWSI	CI	*P* value
Length of incision (cm, mean ±SD)	8.68±0.5	18.54±1.82	<0.05	8.15±1.6	15.0±2.87	<0.05
Time of surgery (min, mean ±SD)	69.5±15.2	105.3±16.4	<0.05	41.23±15.8	58.8±20.02	<0.05
Bleeding volume (ml, mean ±SD)	233.0±79.2	384.0±83.1	<0.05	68.82±42.5	248.8±37.76	<0.05
Drainage volume (ml, mean ±SD)	170.8±30.9	256.6±67.5	<0.05	80.54±20.5	124.2±31.54	<0.05
Postoperative ambulation time (days, mean ±SD)	3.66±1.52	9.62±2.38	<0.05	2.2±1.21	5.76±2.61	<0.05
Harris score (mean ±SD)	90.2±3.72	88.6±3.2	>0.05	93.3±4.1	91.6±3.7	>0.05

FMWSI – fast mobile window small incision; CI – conventional incision; SD – standard deviation; THAR – total hip arthroplasty; HHAR – hemi hip arthroplasty.

Table 6. Correlation analysis between length of incision and perioperative outcomes of FMWSI and CI.

Parameters	Length of incision			
	THAR		HHAR	
	r	*P* value	r	*P* value
Time of surgery	0.95	<0.01	0.83	<0.01
Bleeding volume	0.94	<0.01	0.95	<0.01
Drainage volume	0.91	<0.01	0.88	<0.01
Postoperative ambulation time	0.98	<0.01	0.93	<0.01
Harris score	0.10	>0.05	0.30	>0.05

FMWSI – fast mobile window small incision; CI – conventional incision; THAR – total hip arthroplasty; HHAR – hemi hip arthroplasty.

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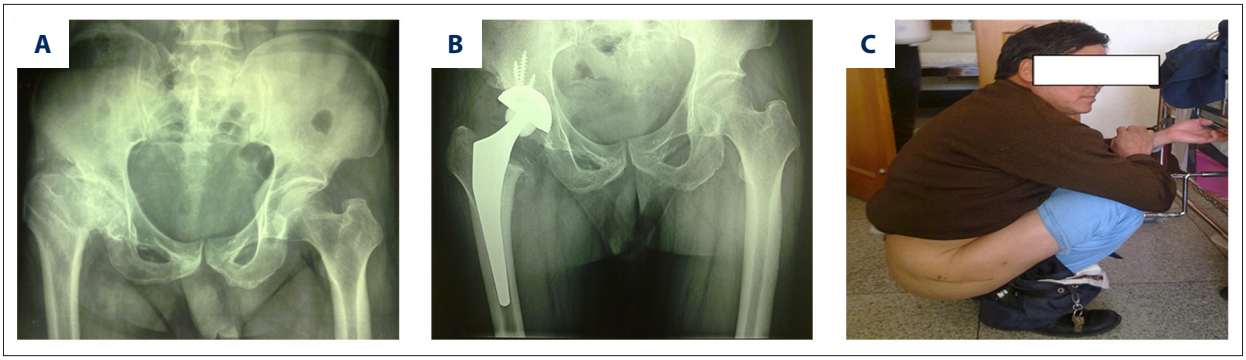

Figure 2. A case of fast mobile-window small incision treatment. (**A**) A 57-year-old man with osteonecrosis of the right femoral head; preoperative X-ray. (**B**) X-ray after operation. (**C**) Functional recovery at 6 weeks after the operation.

Conclusions

In conclusion, the novel FMWSI technique is a useful method for hip arthroplasty, especially for elderly patients with poor general health and poor tolerance to surgery. Our findings need to be confirmed in future studies that evaluate the long-term outcomes of this novel FMWSI technique.

Competing interests

The authors declare that they have no competing interests.

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References:

1. Cooper C, Campion G, Melton LJ 3{rd: Hip fractures in the elderly: A world-wide projection. Osteoporos Int, 1992; 2(6): 285–89
2. Kannus P, Parkkari J, Sievanen H et al: Epidemiology of hip fractures. Bone, 1996; 18(1 Suppl): 57S–63S
3. Gullberg B, Johnell O, Kanis JA: World-wide projections for hip fracture. Osteoporos Int, 1997; 7(5): 407–13
4. Huddleston JM, Whitford KJ: Medical care of elderly patients with hip fractures. Mayo Clin Proc, 2001; 76(3): 295–98
5. Marques A, Lourenco O, da Silva JA et al: The burden of osteoporotic hip fractures in Portugal: costs, health related quality of life and mortality. Osteoporos Int, 2015; 26(11): 2623–30
6. Lawrence TM, White CT, Wenn R et al: The current hospital costs of treating hip fractures. Injury, 2005; 36(1): 88–91; discussion 92
7. McKinley JC, Robinson CM: Treatment of displaced intracapsular hip fractures with total hip arthroplasty: Comparison of primary arthroplasty with early salvage arthroplasty after failed internal fixation. J Bone Joint Surg Am, 2002; 84-A(11): 2010–15
8. Li H, Chen F, Wang Z et al: Comparison of clinical efficacy between modular cementless stem prostheses and coated cementless long-stem prostheses on bone defect in hip revision arthroplasty. Med Sci Monit, 2016; 22: 670–77
9. Henry BM, Wrazen W, Hynnekleiv L et al: Health-related quality-of-life and functional outcomes in short-stem versus standard-stem total hip arthroplasty: An 18-month follow-up cohort study. Med Sci Monit, 2016; 22: 4406–14
10. Li L, Yu M, Ma R et al: Initial stability of subtrochanteric oblique osteotomy in uncemented total hip arthroplasty: A preliminary finite element study. Med Sci Monit, 2015; 21: 1969–75
11. Kanis JA, Oden A, Johnell O et al: The components of excess mortality after hip fracture. Bone, 2003; 32(5): 468–73
12. Salpakoski A, Tormakangas T, Edgren J et al: Effects of a multicomponent home-based physical rehabilitation program on mobility recovery after hip fracture: A randomized controlled trial. J Am Med Dir Assoc, 2014; 15(5): 361–68
13. Zielinski SM, Heetveld MJ, Bhandari M et al: Implant removal after internal fixation of a femoral neck fracture: Effects on physical functioning. J Orthop Trauma, 2015; 29(9): e285–92
14. Liu P, Guo L, Huang L et al: Effect of semisynthetic extracellular matrix-like hydrogel containing hepatocyte growth factor on repair of femoral neck defect in rabbits. Int J Clin Exp Med, 2015; 8(5): 7374–80
15. Goldstein WM, Ali R, Branson JJ et al: Comparison of patient satisfaction with incision cosmesis after standard and minimally invasive total hip arthroplasty. Orthopedics, 2008; 31(4): 368
16. Berry DJ, Berger RA, Callaghan JJ et al: Minimally invasive total hip arthroplasty. Development, early results, and a critical analysis. Presented at the Annual Meeting of the American Orthopaedic Association, Charleston, South Carolina, USA, June 14, 2003. J Bone Joint Surg Am, 2003; 85-A(11): 2235–46
17. Vicente JR, Croci AT, Camargo OP: Blood loss in the minimally invasive posterior approach to total hip arthroplasty: A comparative study. Clinics (Sao Paulo), 2008; 63(3): 351–56
18. Berger RA: Total hip arthroplasty using the minimally invasive two-incision approach. Clin Orthop Relat Res, 2003; (417): 232–41
19. Yoon TR, Park KS, Song EK et al: New two-incision minimally invasive total hip arthroplasty: Comparison with the one-incision method. J Orthop Sci, 2009; 14(2): 155–60
20. Moskal JT: Anterior approach in THA improves outcomes: Affirms. Orthopedics, 2011; 34(9): e456–58
21. Dorr LD, Maheshwari AV, Long WT et al: Early pain relief and function after posterior minimally invasive and conventional total hip arthroplasty. A prospective, randomized, blinded study. J Bone Joint Surg Am, 2007; 89(6): 1153–60
22. Taylor F, Wright M, Zhu M: Hemiarthroplasty of the hip with and without cement: A randomized clinical trial. J Bone Joint Surg Am, 2012; 94(7): 577–83
23. Zhang Y, Tang Y, Zhang C et al: Modified posterior soft tissue repair for the prevention of early postoperative dislocation in total hip arthroplasty. Int Orthop, 2013; 37(6): 1039–44

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