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Original Article

Comparison of two different stems for total hip arthroplasty

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Abstract: Background: Total hip arthroplasty (THA) is the golden standard in treating severe osteoarthritis, which has not responded to conservative treatment. This study aimed to evaluate and compare the therapeutic results of THA using Short-stem and Standard-stem prostheses. Methods: The study was a randomized clinical trial without a control group that was performed in 2020. A total number of 156 patients were recruited over three years. Patients were divided into two groups. The first group was treated with a Short-stem prosthesis and the second group was treated with a Standard-stem prosthesis. Patients were visited according to a schedule. At each visit, a control graph was prepared and the condition of the bone prosthesis and its position were examined. Also, the status of cane use and weightlifting were evaluated. Clinical signs such as pain, lameness, and the ability to climb stairs were assessed and recorded based on the Harris scale. Patients were also evaluated for surgical complications such as infection or limb length discrepancy. Results: Data of 140 patients were analyzed. The mean age of patients was 60.2 ± 6.38 years. The amount of bleeding in the short-stem group was significantly lower than the standard-stem group (380.17 ml versus 430.13 ml, P = 0.001). In both groups, there was a significant increase in Harris score after the end of the study compared to before the operations. Furthermore, Harris's mean score was higher in the short-stem group compared to standard-stem group. However, these significant differences were observed only in the sixth week (P < 0.0001) and the third month (P < 0.0001). Conclusion: The use of Short-stem prosthesis in the short term can play a role in improving patient performance but in the long term evaluations, there is no apparent difference with the use of Standard-stem prostheses.

Keywords: Total hip arthroplasty, total hip prosthesis, short-stem

Introduction

Degenerative joint diseases involving the hip joint, such as osteoarthritis, aseptic necrosis, and rheumatoid arthritis, can cause significant disabilities for the patient [1]. Although their initial treatment is conservative and pharmacological, in the severe stages, the only life-saving treatment is a total hip arthroplasty (THA) to return the patient to normal life [2, 3]. Osteoarthritis procedure is also the most common indication of this operation. It is currently estimated that 400,000 THA surgeries are performed annually worldwide [4, 5]. Based on various studies, prostheses use to completely replace the hip joint is also associated with problems. Such issues have led to the design of novel prostheses, including Short-stem types [6, 7].

Short-stem hip prostheses are designed for fixation in the proximal femur, and recently these prostheses have been widely developed in the design and successful use of Short-stem hip prostheses [8]. Successful use of short-stem hip prostheses depends on preoperative indications and the anatomical condition of the bone. The femoral Short-stem prosthesis, also called the metaphyseal stem, is designed to overcome the weakness of standard non-cemented prostheses and improve the therapeutic results of prostheses [9, 10].

Most of the studies that were performed on therapeutic results of these prostheses have indicated that duration of operation, peri-operative complications along with post-operative clinical functions and pain are the most important factors affecting the long term prognosis of

patients [10]. In the THA, clinical and radiological follow-up is also necessary to investigate the complications and intervene promptly and on the other hand, to evaluate the patient's abilities and achieve the goal of treatment. This goal is the patient's return to normal life and normal physical activity [11].

As mentioned above, it is necessary to evaluate new prostheses (including Short-stem) more carefully and scientifically and to be examined their clinical outcomes and compare them with previously used prostheses (Standard-stem). It is also possible to determine the course of patients' functional improvement by continuously monitoring of the patients with the help of standard criteria such as Harris hip score (HHS). This study aimed to evaluate and compare the therapeutic results of THA using Short-stem and Standard-stem prostheses. To date, some previous studies have compared different surgical techniques and various prostheses but so far, very few studies have compared the use of Short-stem and Standard-stem prostheses for THA surgeries. To the best of our knowledge, previous studies have been conducted on a limited number of patients and they were mostly cross-sectional studies but here we aimed to perform a randomized clinical trial.

Methods and material

Study design

The study was a randomized clinical trial without a control group that was performed in 2020 in Tehran. A total number of 156 patients were recruited over three years (from April 2017 to April 2020) from patients referred to Imam Khomeini Hospital and Azar clinic, Tehran. All these patients were candidates for THA. The study protocol was approved by the Research Committee of Tehran University of Medical Sciences and the Ethics committee has confirmed it.

Inclusion and exclusion criteria

Patients were entered based on inclusion and exclusion criteria. Our inclusion criteria were: Having the necessary conditions for THA such as non-inflammatory degenerative joint diseases including advanced osteoarthritis and avascular necrosis of the femur, skeletal system maturity, existence of physical conditions that provide adequate support to the prosthesis and signing the written informed consent to participate in this study. The exclusion criteria also were: previous femoral surgery, poor bone quality resulting from conditions such as cancer, congenital dislocation of the hip, metabolic bone diseases in the upper part of the femur or pelvis, previous correction osteotomy of the femur, osteoporosis, osteomyelitis, disorders, the neuromuscular or vascular extent that could cause troubles such as joint neuropathy or the absence of a musculoskeletal support structure or any conditions that could lead to a lack of proper skeletal fixation, active or chronic infection of the hip, sensitivity to materials used in prosthetics such as cobalt, chromium and nickel, presence of tumors or local bone cysts, peri-prosthetic fracture during or after surgery, pregnancy and death of the patient.

Study population

Sampling was performed in a non-probabilistic and accessible manner until the number of samples was completed. After explaining the treatment protocols to the patients and obtaining written informed consent, the patients were randomly divided into two groups of 78 based on the balanced block randomization method. Demographic data of all patients including age and gender were collected. The variables in the Harris hip score (HHS) including pain, lameness, the use of canes and support devices, the distance that patient can walk, the comfort of sitting on a chair, the ability to use public transportation, ability to climb stairs, comfort in wearing socks and shoes, deformity and joint range of motion were also collected from all patient before interventions.

Pre-operative assessments

The length of the limb and considering its correction during the operation, determining the size and position of the acetabular part, determining the size and position of the femur were also measured before surgeries. Anterior-posterior and lateral radiographs of the pelvis and femur were also obtained that provided a better evaluation of the femoral neck's length when both femurs were in internal rotation. Simple X-rays were also useful in determining the appropriate size of the acetabular joint. The axial view also helped to determine femoral anteversion and prosthesis size. For better surgical planning, special patterns similar to

patient graphs were drawn before the operation.

Operative procedures

The first group was treated with a Short-stem prosthesis and the second group was treated with a Standard-stem prosthesis (Zimmer, Inc., Warsaw, IN, USA). The surgical method was consistent with the surgeon's expertise but in most cases was associated with femoral neck osteotomy. Osteotomy typically begrimed at the base of the femoral neck with a 45-degree incline and, after preparing the femoral canal, opened the medulla into the resection surface in the posterior middle third so that it was in line with the femoral axis. The height of an osteotomy varied depending on the anatomy and the method of surgery. Then the Trial reduction was performed in such a way that at the same time as the rasp was placed in the femoral canal, its handle was out and the appropriate test heads were tested.

If the selected items were correct, the distance between the lesser trochanter and the taper matched the pre-operation calculation. Also at this stage, joint stability and pressure on soft tissue were evaluated. After removing the rasp, a suitable stem was placed and pushed in to stabilize the cortical contact. After installation, the range of motion of the joint and the stability of the joint was checked again. Finally, the surgical incision was sutured depending on the technique. Operation time and amount of intraoperative bleeding were measured and recorded by calculating the total volume of suctioned blood and gases consumed (each completely blood gas was considered equivalent to 200 ml). After the operations, antibiotics and anticoagulants were used as prophylaxis to prevent infection and embolism. Hemobag drainage was checked for up to 48 hours and then removed according to the physician's decision.

Post-operative assessments

Postoperative supportive strategies depended on the individual characteristics of the patients and their bone quality. Early weighting was possible with the physician's permission. According to the protocol of returning the patient to his normal habits, the patient's movements started even a day after the operations. The cane was used as long as patients could walk safely and without lameness.

Patients were visited according to the following schedule: two weeks, six weeks, three months, six months, and 12 months after surgeries. At each visit, a control graph was prepared and the condition of the bone prosthesis and its position were examined. Also, the status of cane use and weightlifting were evaluated. Clinical signs such as pain, lameness, and the ability to climb stairs were assessed and recorded based on the Harris scale. Patients were also evaluated for surgical complications such as infection or limb length discrepancy.

Statistical analysis

After completing the checklists, the information obtained from the patients was entered into SPSS software (version 24, IBM Corporation, Armonk, NY). After a general descriptive analysis, the differences between the two groups in terms of preoperative demographic variables, if quantitative or qualitative, were determined using the Student's t-test and the square-Chi test, respectively. Regarding the value of the Harris score, the Student's t-test was used in each period to compare the two groups, which was obtained from the repeated measures test (Repeated measures). The value of $P < 0.05$ was considered significant.

Result

Population

A total number of 156 patients entered the study and were divided into 2 groups of 78 patients. Sixteen patients excluded from short-term group due to: previous femoral surgery (n = 3), osteoporosis (n = 1), peri-prosthetic fracture during or after surgery (n = 1), losing to follow up (n = 9) and death (n = 2). Finally, data of 140 patients were analyzed. Sixty-eight patients were in the Short-stem group (30 males, 38 females) and 72 individuals in the Standard-stem group (32 males, 40 females). CONSORT flow diagram of patients is illustrated in **Figure 1**.

Demographic data

The mean age of patients was 60.2 ± 6.38 years (42-87 years). A total number of 78 women (55.7%) and 62 men (44.3%) participated in this study. The patient's body mass index (BMI) was 24.36 ± 2.10 kg/m^2. Elderly osteoarthritis was the most common underlying dis-

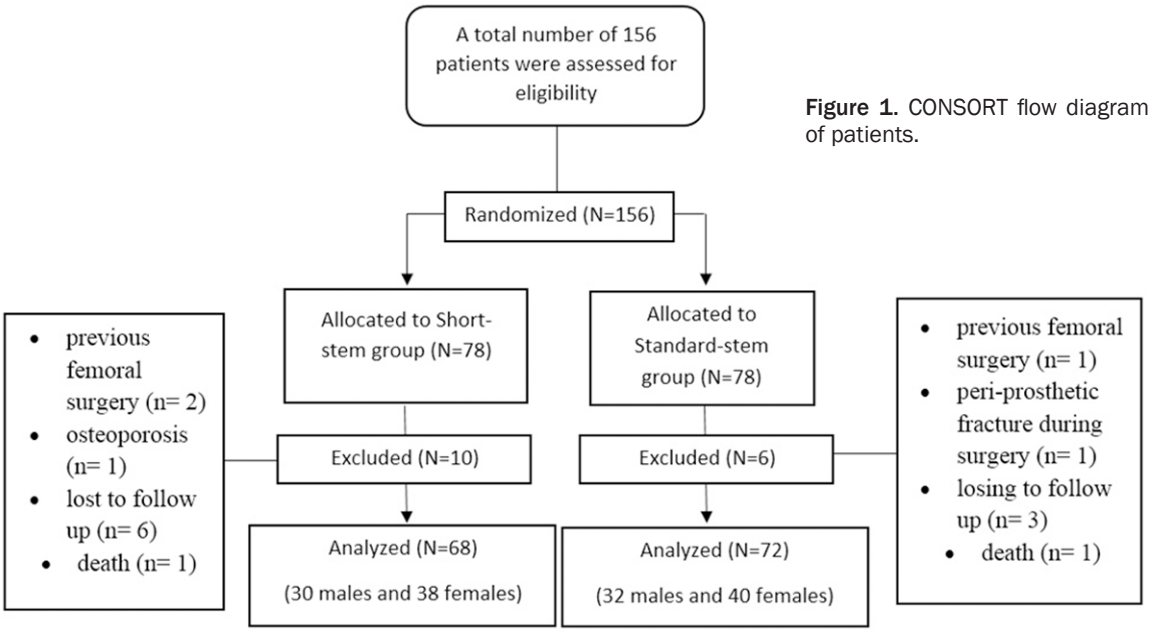

Figure 1. CONSORT flow diagram of patients.

Table 1. Comparison of demographic data of patients

Variable		Short-stem (n = 68)	Standard-stem (n = 72)	*P*-value
Age (Mean ± SD) (years)		59.81 ± 7.21	60.22 ± 6.54	0.327
Gender (n (%))	Male	30 (44.1)	32 (44.4)	0.822
	Female	38 (55.9)	40 (55.6)	
BMI (Mean ± SD) (kg/m^2)		24.20 ± 3.12	24.52 ± 4.08	0.627
Past medical history (n (%))	Elderly osteoarthritis	19 (27.9)	20 (27.7)	0.482
	Avascular necrosis	7 (10.3)	9 (12.5)	
	Post-traumatic osteoarthritis	7 (10.3)	4 (5.5)	
	Hip dysplasia	1 (1.5)	3 (4.2)	

ease for THA (55.6%). It was followed by avascular necrosis (22.8%), post-traumatic osteoarthritis (15.8%) and hip dysplasia (5.7%), respectively.

Due to the possible effects of age, sex, body mass index, comorbidities such as diabetes, and the underlying disease that caused the surgery, the mean values obtained in the two groups were compared on the therapeutic outcomes after the operation. There was no statistically significant difference in any of these demographic variables between the two groups, and the two groups were similar (**Table 1**).

Operation evaluations

There was one case of death six months after surgery in the short-stem group but the main cause of death was unrelated to our surgery. The mean duration of operation in the short-stem group was 114.35 minutes and in the standard-stem group was 117.23 minutes, but there was no statistically significant difference between the two groups (P = 0.063). By evaluation of the amount of bleeding during the operation, it was demonstrated that the amount of bleeding in the short-stem group was significantly lower than the standard-stem group (380.17 ml versus 430.13 ml, P = 0.001).

Harris hip scores

Table 2 also shows the average score of Harris in the studied periods. In both groups, there was a significant increase in Harris score after the end of the study compared to before the operations. Furthermore, Harris's mean score was higher in the short-stem group compared

Table 2. Comparison of Harris score in different measuring times

Variable	Initial	2 weeks	6 weeks	3 months	6 months	12 months	*P*-value
Short-stem (Mean ± SD)	42.15 ± 5.6	63.21 ± 5.5	75.23 ± 6.9	86.73 ± 4.1	90.28 ± 4.8	93.88 ± 6.3	< 0.0001
Standard-stem (Mean ± SD)	43.75 ± 7.8	63.42 ± 4.7	71.30 ± 8.4	82.31 ± 5.0	88.36 ± 2.4	90.73 ± 3.3	< 0.0001
P-value	0.233	0.072	< 0.0001	< 0.0001	0.063	0.077	

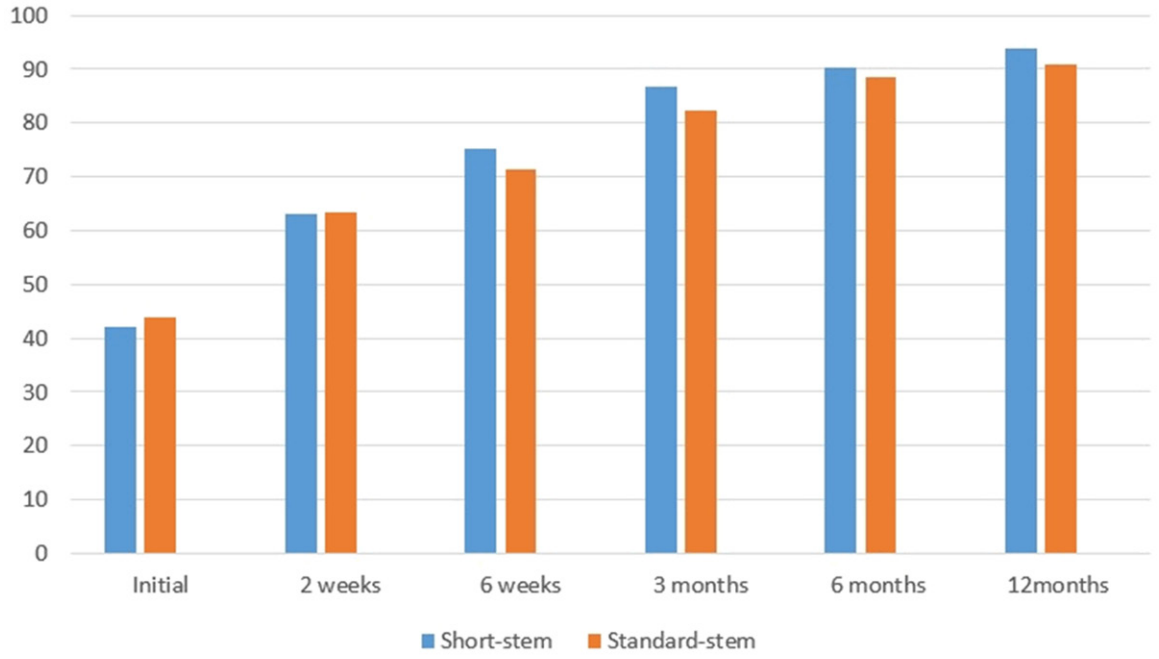

Figure 2. Comparison of Harris score in patients.

to standard-stem group. However, these significant differences were observed only in the sixth week (P < 0.0001) and the third month (P < 0.0001). These data are also indicated in **Figure 2**.

Discussion

Here in the present study, we evaluated and compared the results of two THA methods using Short-stem and Standard-stem techniques. Our data showed that the amount of bleeding in the short-stem group was significantly lower than standard-stem group. We also showed that there was a significant increase in Harris score after the end of the study in both groups but Harris's mean score was higher in the short-stem group compared to standard-stem group. Harris score evaluates clinical signs such as pain, lameness, and the ability to climb stairs in patients [12]. These findings showed that using the short-stem prosthesis is associated with better therapeutic results.

Studies indicated that the most common cause of THA is severe osteoarthritis, which accounts for 70% of cases [13]. Other causes include congenital dysplasia, trauma, Paget's disease, osteonecrosis of the femoral head, SLE, ankylosing spondylitis, and rheumatoid arthritis [14]. Variable studies have shown that in almost 90% of patients who have been properly selected for this procedure, the pain will be completely ameliorated and the joint functions will significantly improve [15]. Various factors are effective in the success rate of this operation, some of which are mentioned below: surgery method, implant type, implant fixation method, patient age, and weight, body mass index, and patient activity level. Long-term fixation and proper performance along with erosion resistance are essential for successful hip replacement. Important parameters for comparing the results of different joint replacement procedures with each other include the survival rate of radiographic examination and clinical results. In these cases, the success or failure of one method over another

can be evaluated. In the present study, the most common cause of surgery was osteoarthritis followed by avascular necrosis and hip dysplasia that was consistent with the findings of similar studies.

In this study, the mean age of patients was generally 61 years, which was consistent with the Sivanathan study [16]. In some studies, the mean age of the patients was less than 50 years, although only the Short-stem prosthesis was used. The young age of patients due to higher bone density plays a significant role in better stability or fixation of Short-stem prostheses [9, 17]. Therefore, in the present study, to eliminate this factor, the necessary similarity was performed between the two groups.

The presence of underlying diseases such as diabetes can be useful in the prognosis of surgery in a patient's gait and complications such as thromboembolism. Therefore, in addition to factors such as age and body mass index, patients in the two groups were matched for underlying problems such as diabetes. There was no significant difference in the duration of surgery between the two groups. It may be concluded that since the orientation is less than the anteversion of the femoral neck in the lateral position and the posterolateral approach is less than the supine and the lateral or anterior approach, the accuracy of the Short-stem prosthesis placement causes that equal time is spent with the installation of the Standard-stem prosthesis. However, in studies of Short-stem prostheses, the duration of surgery in the supine and lateral approaches have been shorter [18, 19].

In the present study, due to the novelty and less use of the Short-stem prosthesis, the cases performed with this prosthesis were done with more accuracy, which caused a relatively long time so that it was found that in the end, no significant difference was achieved between the two groups in terms of the duration of the operation. In terms of the amount of bleeding during the operation, the findings obtained from the study showed a significant difference between the two groups, so that in the Short-stem group, the amount of bleeding was less. This seems to be the cause of fewer soft tissue manipulation and damage to it during prosthesis placement in this group [20, 21].

The results of the present study showed that hip surgery had acceptable follow-up results in both groups. However, in all follow-up cases, the mean HHS in the Short-stem group was higher than the Standard-stem group. Although at six weeks and three months after HHS in the short-stem group, there was a statistically significant difference with the standard-stem group ($P < 0.001$), but at longer follow-up times, the difference was reduced so that at the end of the study (12-month follow-up time) there was a slight difference between the two groups (93.88 vs. 90.73). Also, in most of the studies that investigated the postoperative consequences of Short-stem prostheses alone, due to the patient's position during surgery, a significant reduction was observed in surgery duration and also bleeding during surgery [22, 23].

Conclusion

A noteworthy point in this study was the difference in therapeutic outcomes between the two prostheses used in the short term, which over time, this difference disappeared and similar results were obtained in a one-year follow-up. Finally, according to the findings of the study, it can be said that the use of Short-stem prosthesis in the short term can play a role in improving patient performance but in the long term evaluations, there is no apparent difference with the use of Standard-stem prostheses.

Disclosure of conflict of interest

None.

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References

[1] Fusco M, Skaper SD, Coaccioli S, Varrassi G and Paladini A. Degenerative joint diseases and neuroinflammation. Pain Pract 2017; 17: 522-532.

[2] Esposito CI, Miller TT, Kim HJ, Barlow BT, Wright TM, Padgett DE, Jerabek SA and Mayman DJ. Does degenerative lumbar spine disease influence femoroacetabular flexion in patients undergoing total hip arthroplasty? Clin Orthop Relat Res 2016; 474: 1788-1797.

[3] Investigators H. Total hip arthroplasty or hemiarthroplasty for hip fracture. N Engl J Med 2019; 381: 2199-2208.
[4] van Beers LW, Van Oldenrijk J, Scholtes VA, Geerdink CH, Niers BB, Runne W, Bhandari M and Poolman RW. Curved versus straight stem uncemented total hip arthroplasty osteoarthritis multicenter trial (CUSTOM): design of a prospective blinded randomised controlled multicentre trial. BMJ Open 2016; 6: e010472.
[5] Agarwal N, To K and Khan W. Cost effectiveness analyses of total hip arthroplasty for hip osteoarthritis: a PRISMA systematic review. Int J Clin Pract 2020; 75: e13806.
[6] Badarudeen S, Shu AC, Ong KL, Baykal D, Lau E and Malkani AL. Complications after revision total hip arthroplasty in the medicare population. J Arthroplasty 2017; 32: 1954-1958.
[7] Yan SG, Weber P, Steinbrück A, Hua X, Jansson V and Schmidutz F. Periprosthetic bone remodelling of short-stem total hip arthroplasty: a systematic review. Int Orthop 2018; 42: 2077-2086.
[8] Liang HD, Yang WY, Pan JK, Huang HT, Luo MH, Zeng LF and Liu J. Are short-stem prostheses superior to conventional stem prostheses in primary total hip arthroplasty? A systematic review and meta-analysis of randomised controlled trials. BMJ Open 2018; 8: e021649.
[9] Capone A, Bienati F, Torchia S, Podda D and Marongiu G. Short stem total hip arthroplasty for osteonecrosis of the femoral head in patients 60 years or younger: a 3-to 10-year follow-up study. BMC Musculoskelet Disord 2017; 18: 301.
[10] Koyano G, Jinno T, Koga D, Yamauchi Y, Muneta T and Okawa A. Comparison of bone remodeling between an anatomic short stem and a straight stem in 1-stage bilateral total hip arthroplasty. J Arthroplasty 2017; 32: 594-600.
[11] Costa ML, Achten J, Foguet P and Parsons NR. Comparison of hip function and quality of life of total hip arthroplasty and resurfacing arthroplasty in the treatment of young patients with arthritis of the hip joint at 5 years. BMJ Open 2018; 8: e018849.
[12] Chahal J, Van Thiel GS, Mather RC 3rd, Lee S, Song SH, Davis AM, Salata M and Nho SJ. The patient acceptable symptomatic state for the modified harris hip score and hip outcome score among patients undergoing surgical treatment for femoroacetabular impingement. Am J Sports Med 2015; 43: 1844-1849.
[13] Khurana S, Nobel TB, Merkow JS, Walsh M and Egol KA. Total hip arthroplasty for posttraumatic osteoarthritis of the hip fares worse than THA for primary osteoarthritis. Am J Orthop 2015; 44: 321.
[14] Post ZD, Orozco F, Diaz-Ledezma C, Hozack WJ and Ong A. Direct anterior approach for total hip arthroplasty: indications, technique, and results. J Am Acad Orthop Surg 2014; 22: 595-603.
[15] Lungu E, Maftoon S, Vendittoli PA and Desmeules F. A systematic review of preoperative determinants of patient-reported pain and physical function up to 2 years following primary unilateral total hip arthroplasty. Orthop Traumatol Surg Res 2016; 102: 397-403.
[16] Sivananthan S, Arif M and Choon D. Small stem Exeter total hip replacement: clinical and radiological follow-up over a minimum of 2.5 years. J Orthop Surg 2003; 11: 148-153.
[17] Del Piccolo N, Carubbi C, Mazzotta A, Sabbioni G, Filanti M, Stagni C and Dallari D. Return to sports activity with short stems or standard stems in total hip arthroplasty in patients less than 50 years old. Hip Int 2016; 26 Suppl 1: S48-S51.
[18] Amenabar T, Marimuthu K, Hawdon G, Gildone A and McMahon S. Total hip arthroplasty using a short-stem prosthesis: restoration of hip anatomy. J Orthop Surg 2015; 23: 90-94.
[19] Tian S, Goswami K, Manrique J, Blevins K, Azboy I and Hozack WJ. Direct anterior approach total hip arthroplasty using a morphometrically optimized femoral stem, a conventional operating table, without fluoroscopy. J Arthroplasty 2019; 34: 327-332.
[20] Chan JK, Harry L, Williams G and Nanchahal J. Soft tissue reconstruction of open fractures of the lower limb: muscle versus fasciocutaneous flaps. Plast Reconstr Surg 2012; 130: 284e-295e.
[21] Huo SC, Wang F, Dong LJ, Wei W, Zeng JQ, Huang HX, Han QM and Duan RQ. Short-stem prostheses in primary total hip arthroplasty: a meta-analysis of randomized controlled trials. Medicine 2016; 95: e5215.
[22] Park MS, Yoon SJ, Choi SM, Cho HM, Chung W and Kang KR. Comparison of the outcomes after primary total hip arthroplasty using a short stem between the modified anterolateral approach and direct anterior approach with a standard operation table. J Korean Orthop Assoc 2019; 54: 244-253.
[23] Lazovic D, Dunai F and Zigan R. Navigated modular short-stem total hip arthroplasty by a less invasive technique. Interactive Surgery 2008; 3: 170-178.