

ORIGINAL**Middle-term outcome and complications after primary total hip arthroplasty using a contemporary titanium tapered wedge cementless femoral stem**Yuto Sugimine¹, Shunji Nakano¹, Hitoshi Goto¹, Ryosuke Sato¹, Tetsuya Enishi², Tomohiro Goto¹, and Koichi Sairyo³¹Department of Orthopedics, Tokushima Municipal Hospital, Tokushima, Japan, ²Department of Rehabilitation Medicine, Tokushima Municipal Hospital, Tokushima, Japan, ³Department of Orthopedics, Institute of Biomedical Sciences, Tokushima University Graduate School, Tokushima, Japan

Abstract : The purpose of this study is to evaluate the results and intraoperative or postoperative complications of primary total hip arthroplasty (THA) using a contemporary tapered wedge titanium femoral component. A total of 213 THAs in 187 patients were followed up more than 5 years (mean, 102 months; range, 60-150). The mean age at surgery was 64.2 years (range, 20-89 years). These patients were clinically evaluated using the JOA scoring system and radiographically host bone reactions around the implants, as well as femoral loosening. The mean JOA score improved from 49 (range, 21-75) to 92 (range, 59-100). All 12 patients with poor results (JOA < 75) coexisted with cerebral, spinal, joint, and musculoskeletal disorders. At the final follow-up, implant survival was 100%. Complications occurred in 23 hips. They consisted of 12 hips with intra-operative fractures, 2 hips with sciatic nerve palsy, one hip with infections, 3 hips with recurrent dislocations, and 8 hips with aseptic cup loosening. In conclusion, we have shown excellent survival rate of the contemporary tapered wedge stem in primary THA; however, patients with coexisting diseases could not acquire sufficient improvement in hip function and ambulatory ability. *J. Med. Invest.* 70 : 471-475, August, 2023

Keywords : hip, joint replacement, total hip arthroplasty**INTRODUCTION**

Previous studies reported that cementless femoral stems have excellent results during long-term periods, except for metal-on-metal total hip arthroplasty (THA) (1-4). Various types of cementless stems associated with excellent clinical and radiographic outcomes are currently available worldwide (5, 6). In July 2009, our institute began using a taper wedged cementless femoral stem (Accolade TMZF stem : Stryker Orthopaedics : Mahwah NJ, USA) for THA. Several reports of this stem documented excellent results during the short to middle-term period and other papers stated concerning migration with initial instability, initial rotational instability and distal femoral cortical hypertrophy relating to thigh pain but did not document in detail about complications and unsatisfied results (7-10). Overall, we have good impression of outcome of THA with using this stem. However, we have several patients with unsatisfactory result and feeling although we have succeeded THA procedure and have found no abnormal findings in the serial radiographs. We suspected one of background factors of decreasing clinical hip score was presence of coexisting diseases at preoperative time or occurrence of coexisting diseases during follow up periods although there was no apparent abnormal findings and symptoms around hip joint.

The purpose of the current study was to evaluate the results of primary THA using a stem with 5- to 12-year follow up. We also investigated complications and the background of poor results with relationship of coexisting diseases and walking as well as

activities of daily living (ADL) function.

MATERIAL AND METHODS

We retrospectively evaluated the clinical and radiographic results at pre-operation, after 3-month, 6-month postoperatively and annual follow-up. Between 2009 and 2014, 273 consecutive primary cementless THAs using contemporary titanium tapered wedge cementless femoral stem were performed in 242 patients by the same senior surgeon in our hospital and were retrospectively followed up. Ten patients died (mean follow-up period, 27.0 months) regardless of the operation within 5 years postoperatively. They underwent no revision surgery and had no evidence of radiological failure. A total of 43 patients (mean follow-up period, 33.7 months) were lost to follow-up within 5 years, of whom 33 declined to attend for review and the remaining 10 patients had no contact with us by telephone. The mean age of the remaining 187 patients with 213 hips was 65 years (20-89 years) at the time of the operation, with 167 female and 20 males. There were 181 osteoarthritic hips, 14 idiopathic osteonecrosis of the femoral head, 7 rapidly destructive coxarthrosis, 5 osteoarthrititis after osteotomy, 5 rheumatoid arthritis, and 1 post-traumatic osteoarthrititis. All operations were performed in a vertical laminar flow theater with an aspiration head cover.

The direct lateral approach described by Hardinge (11) was used in all patients. We used the Accolade TMZF stem, which consisted of a beta titanium tapered wedge alloy stem with a PureFix HA coating proximally. We excluded cases with severe deformity or highly dislocation hip, which required peritrochanteric osteotomy and other types of femoral prosthesis. We used a Trident cup (Stryker Orthopaedics : Mahwah NJ, USA) for 121 hips and a Tritanium cup (Stryker Orthopaedics : Mahwah NJ, USA) for 92 hips. The cup was press-fit after 1 mm under size reaming, and supplemental screws were used as needed.

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Concerning the articular surface, cross-linked polyethylene on the ceramic interface was used in all but seven cases with ceramic-on-ceramic interface.

Clinical outcomes were assessed according to the Japanese Orthopaedics Association (JOA) scoring system (12), which consist of pain (40 points), mobility (20 points), gait (20 points), and activities of daily living (20 points). The results were categorized as excellent (95-100 points), good (85-94 points), fair (75-84 points), or poor (< 75 points). Owing to investigate how coexisting cerebral, spinal, musculoskeletal diseases disturbed the improvement of hip function and ambulence ability after THA and leaded to unsatisfactory results and feelings, we classified two groups to compared clinical outcomes, that is, 89 hips with coexisting cerebral, spinal, musculoskeletal diseases and 124 hips with no coexisting diseases. We defined coexisting diseases as diseases disturb the improvement of hip function and ambulence ability except hip diseases. Coexisting disease and concerning about necessity of walking aids investigated at the latest follow up time. The onset of these coexisting disease doesn't matter.

We investigated complications occurring perioperative or during the follow-up period, especially periprosthetic fracture, nerve injury, dislocation, and infection.

Radiological outcomes were assessed using serial plain hip A-P view radiography according to a Gruen zoning system (13). Preoperative radiographs were evaluated the shape of the proximal femoral canal (14), and immediate postoperative radiographs were evaluated for stem positioning (neutral, varus, valgus) (15). Follow-up radiographs were assessed ectopic ossification (16) and host bone response such as spot welds, cortical hypertrophy, stress shielding (17) and subsidence.

The intraobserver and interobserver reliabilities of radiographic evaluation were assessed in 30 randomly selected patients. All measurements were performed twice by two independent observers who were blinded to the results reported by the other observers. The intraobserver and interobserver reliability were measured on the basis of the intraclass correlational coefficient (ICC) for stem alignment and kappa coefficient for other parameters. Statistically significant differences between coexisting diseases and no coexisting diseases groups were examined using the unpaired Student's t-test. Statistical significance was set at $p < 0.05$.

The study had ethical approval and all patients gave informed consent.

RESULTS

One hundred and eighty-seven patients (77.3%) were followed up for more than 5 years postoperatively.

Clinical evaluation was available in 187 patients with 213 hips at a mean of 102 months (range, 60–150 months). The mean JOA score improved from 49 (range, 21-75) to 92 (range, 59-100) at the most recent follow up, which did not have a subsequent revision for changing the stem implant. The result at the latest follow up was excellent in 121 hips, good in 46 hips, fair in 34 hips, and poor in 12 hips (11 patients). The all 11 patients had symptoms related to cerebral, spinal, and musculoskeletal disorders which were unrelated to THA surgery. Eight patients received revision surgery. Some patients with the poor results tended to suffer from pain and muscular weakness of lower extremities. In some cases, cerebral, spinal, musculoskeletal diseases led discomfort around the hip joint or gait disturbance as well as reduction in locomotive function in daily life. As shown in Table 1, the coexisting disease group was significantly older at the operative age and at the latest follow-up age and significantly lower pre JOA score (especially gait score and ADL score) at final follow-up than the no coexisting disease group. At the latest follow up time in this current study, 154 hips (mean age of 69.8 years) were able to walk without aids and 59 hips (mean age of 80.3 years) used one or two canes or wheel walker. Complications occurred in 23 hips (Table 2). Intraoperative fracture occurred in 12 hips, which consisted of 4 femoral shaft fractures and 8 greater trochanteric fractures. None of the femoral shaft fracture cases had sinking of the stem implant. One of the greater trochanteric fracture cases had no fusion. Sciatic nerve palsy presented immediately after the operation in two patients. One patient showed complete improvement within 6 months, but the other had a few weaknesses in dorsiflexion of the ankle and toes. Superficial infection

Table 2. Post-operative complications

Complication	Number (%)
Intra-operative fracture	12 (4.8)
Recurrent dislocation	3 (1.2)
Infection	1 (0.4)
Sciatic nerve palsy	2 (0.8)
Acetabular cup loosening	6 (2.4)
Total	24 (9.6)

Table 1. significant difference between coexisting disease group and no coexisting disease group

	Total	coexisting disease	no coexisting disease
Hips number	213	91	122
Mean age years at the operation (range)*	64.2 (20 to 89)	70.3 (20 to 89)	60.0 (29 to 89)
Mean age years at latest follow-up (range)*	72.7 (32 to 95)	78.5 (32 to 95)	68.3 (36 to 89)
Pre-operative JOA score*(S.D.)	49.3	46.4 (10.8)	51.7 (11.8)
Gait score*(S.D.)	9.0	7.5 (3.9)	10.2 (4.0)
ADL score*(S.D.)	13.0	12.1 (2.6)	13.4 (2.8)
Latest follow-up JOA score*(S.D.)	91.8	83.8 (9.60)	97.7 (3.41)
Gait score*(S.D.)	15.8	10.8 (6.25)	19.6 (1.32)
ADL score*(S.D.)	17.8	15.0 (3.38)	19.9 (9.26)

*t-test $p < 0.01$

occurred in one patient at one week postoperatively. Three patients had a dislocation at 4 months, 2 and 8 years postoperatively. In the first case, the anteversion of the acetabular metal cup was decreased, an elevated liner was used, and the diameter of the ceramic head was increased from 28 mm to 32 mm. In the second and third cases, the dual-mobility system and neck length were increased to 8 mm. None of the cases required stem change due to malposition of the stem. No further dislocations were observed.

We experienced 6 hips with aseptic cup loosening consisting of one Trident cup and five Tritanium cup cases. One patient with the Trident cup was not able to acquire good initial fixation owing to poor bone quality due to rapidly destructive coxarthrosis. She underwent revision surgery with Trabecular metal cup (Zimmer Biomet : Kalamazoo MI, USA) filled with allograft or trabecular metal augmentation 5 years after primary surgery. Four patients with the Tritanium cup converted to a trabecular cup with allograft or trabecular metal augment at 3, 7, 7.5 and 9 years postoperatively. The remaining one patient was refused to undergo revision surgery.

Radiographs were available for evaluation in 213 hips at a mean follow-up of 101 (60–148) months. The shape of proximal femoral canal was classified as 154 hips normal type, 34 champagne-flute type and 25 stovepipe type. The stems in neutral alignment were 182 hips, valgus alignment were 31 hips (normal : champagne-flute : stovepipe type canal ; 23 : 6 : 2). The valgus alignments weren't progress in all cases.

Grade I or II heterotopic ossification (16) was observed in 30 hips. Four patients of grade III were not clinically significant.

According to Engh's criteria (17), all the stems were biologically stable. There was no evidence of progressive osteolysis in proximal or distal around the stem on the radiographs.

In 213 hips, there was no radiolucency around the proximal HA sleeve portion of the stem. There was stress shielding above these load-bearing areas, most commonly involving zones 1 and 7 in 144 hips.

A radiolucent line was found around the distal aspect of the stem in 31 hips. Cortical hypertrophy was observed around the stem of 70 hips. This predominantly involved zones 2, 3, 5, and 6. Endosteal spot welds were noted in 208 hips. No hips had been revised for femoral loosening at the final follow-up, but one stem had a 5 mm subsidence within one month postoperatively, and thereafter, no progression was observed (Fig 1).

The intraobserver and interobserver reliability, as measured on the basis of the ICC and kappa coefficient were shown to be at reliable levels.

DISCUSSION

Tapered wedge cementless femoral components have been used more than 25 years. Several reports have documented excellent short and middle-term outcomes of Accolade TMZF stem (7, 8). On the other hand, some papers stated things to focus

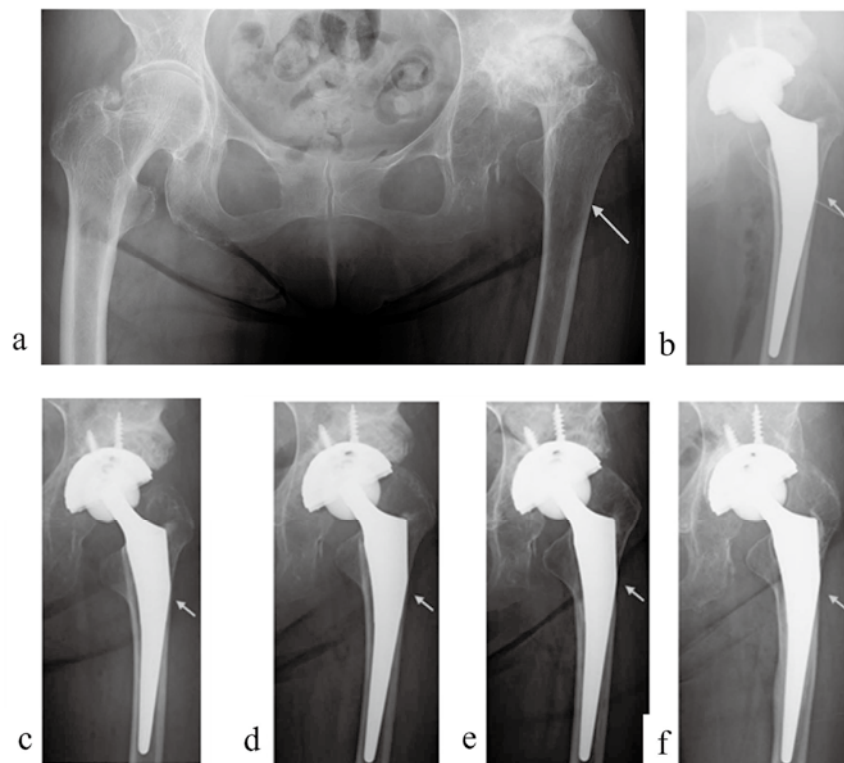


Figure 1. 65 y. o. female dislocated hip osteoarthritis

a : Preoperative plain A-P view : The cortex in the left femur was less thin than that in the right femur.

b : Immediate postoperative X-ray showed that the cortical thickness of zone 2 was very thin.

c : One week postoperatively, X-ray showed that the cortical thickness of zone 2 was thinner than that of the immediate postoperative one.

d : One month postoperatively, X-ray showed 5 mm of the stem subsidence and cortical defect of zone 2

e : One year postoperatively, X-ray showed spot welds of zone 6

f : Eleven years postoperatively at final follow-up, X-ray showed cortical hypertrophy of zone 3 and 5. Subsidence did not progress since one month postoperatively.

Arrow show areas to focus on.

on migration with initial instability and host bone reactions relating to thigh pain (9, 10). Other studies have documented the characteristics of tapered wedge femoral components compared to different types of stems or femoral geometry (19, 20). Our current study with 8.5 years (5 years to 12.5 years) follows up had almost same good result as previous reports (7, 8). Although we recognized the stem as excellent as previous reports of THA using the stem (7, 8), we have several patients with the poor clinical results and experienced several complications in the current study.

Radiographic evaluation showed endosteal spot welds confirmed 93% (207 hips) referred to rigid fixation. Based on radiographic results of periprosthetic bone reaction in the current study, we confirmed that the stem was a good material for biological fixation.

Elderly people tend to suffer from various diseases and have decreased locomotive function because of degenerative joint deformity, lower leg dysfunction, equilibrium disturbance or reduced muscle strength (20, 21). In the current study, 137 patients with 155 hips (mean age, 69.7 years) were able to walk without aids and 50 patients with 58 hips (mean age, 80.6 years) used cane or wheel walker at the latest follow-up. The mean age at the latest follow-up was 73 (range, 32-95) years old and 58 patients with 63 hips (30%) belonged to elderly persons more than 80 years old. We suggest that elderly patients aged > 80 years tend to have decreased walking ability and respond to walking assist items. Therefore, we had better consider the importance of walking and ADL function in the JOA score or apply other clinical scoring systems taking low grade weight concerning walking and ADL function.

Lamb *et al.* (22) documented that intra-operative periprosthetic fractures, as a well-known complication of THA, increase the risk of stem revision and mortality. Several studies have reported that femoral component design and length affect the incidence of intraoperative periprosthetic fractures (18, 23). In the current study, the majority of complications were intraoperative periprosthetic fractures, of which 12 hips consisted of seven normal, four valgus positions, and one varus position of the stem. The femoral canal morphology consisted of three stovepipe type, one champagne-flute type, and eight normal femoral canals. The abnormal position of the stem and abnormal femoral canal morphology were important factors leading to fracture, with excessive eccentric loading around the proximal femoral cortex. I suggested that we must select the proper shape of the stem with better adaptation to the morphology of the femoral canal by pre-operative planning using 3 dimensional CT (24, 25). As the stem tended to be inserted in the valgus position for patients with a stovepipe canal shape, we might select other stems, that is, distal fixed-type stems or cemented stems. For prevention of intraoperative fracture, especially in elderly patients with severe osteoporosis, we had better take careful maneuvering of the rasping and stem insertion, and considering the selection of other kinds of stems, especially in cases with stovepipe-type femoral canal.

We performed three revision surgeries for recurrent dislocations. Some papers (8) have documented that initial rotational instability and stem neck anteversion may be affected by dislocation events. Intraoperative findings of the anteversion angle of the stem were within the correct angle. All cases had a revised cup component and head but no need for a stem. We think that all complications did not occur by reason of usage of this stem and could be prevented by performing careful surgical technique.

There are some limitations in this study. First, we had radiographic evaluation using only A-P view.

Radiographs were routinely reviewed using serial A-P view of the hip for evaluation in our institute ; if necessary, we have

lateral view of the operated joint. The accolade stem is a straight tapered single-wedged stem, which is designed to engage metaphyseal cortical bone in one plane, medial to lateral, categorized into type 1 according to Khanuja *et al.*'s classification (5). Therefore, we think that the evaluation using A-P radiography is more useful than lateral radiography and that it is enough to evaluate the stability and fixation of the stem. Second, we used two kinds of acetabular cups, that is, Trident cup and Tritanium cup. According to a previous report, the latter cup had a significantly higher rate of radiolucent line occurrence around the cup than the former cup (26). Other papers (27-29) have documented revision surgery for aseptic loosening of the Tritanium cup. Although cup components were not documented in this study in detail, aseptic cup loosening occurred in five Tritanium cups. Therefore, the type of cup component may have any influence on clinical outcomes. Third, almost one third of patients of our current study were more than 80 years old at the latest follow-up. Because of many coexisting diseases or diseases and poorly daily activity, they could not visit our hospital's annual follow-up day. Therefore, it may be difficult to estimate the clinical outcomes of primary THA using this stem correctly during a long-term period (more than 10 years).

This study has some limitations. First, the definition of coexisting disease is ambiguous. We defined coexisting diseases as diseases disturb the improvement of hip function and ambulation ability except hip diseases. However, this is subjective and not considered how much the diseases influence hip function or ambulation. Second, the onset of coexisting diseases are not investigated because it is cross-sectional study. We investigated existence of coexisting diseases at the final follow-up only.

In conclusion, we have shown good clinical outcomes of primary THA using a contemporary tapered wedge titanium femoral component, which was performed by a senior hip surgeon. We have an almost good impression of the stem, which provided reliable osteointegration that was durable at a mean of 8.5 years of follow-up. However, we experienced several complications associated with this stem and several patients who felt unsatisfying results with successful THA procedure at the latest follow up time. After THA, elderly patients with cerebral, spinal, and musculoskeletal disorders could not acquire sufficient improvement in ambulatory ability and locomotive function.

CONFLICT OF INTERESTS

All authors declare that they have no conflicts of interest.

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