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CLINICAL STUDY

Isolated acetabular revision with modular trabecular titanium implants using tap-out tap-in technique of femoral cemented monoblock reinsertion

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ABSTRACT

OBJECTIVES: To evaluate the role of isolated acetabular revision with modular trabecular titanium implants using simple extraction and reinsertion of femoral monoblock cemented stem (tap-out tap-in technique).

BACKROUND: In the past years, we face the burden of revising hip arthroplasties in predominantly elderly population.

METHODS: Single institution retrospective analysis of 17 hips in 16 patients with previous cemented total hip arthroplasty implanted between 1988 and 2007. These patients underwent isolated acetabular revision between 2010 and 2018 using modular acetabular Delta Trabecular Titanium (TT) system (Limacorporate S.p.a, Udine, Italy) with impaction bone grafting and reverse reamed allografts. Non-modular polished cemented stems (Poldi-Čech monoblock) were reinserted without additional cementing.

RESULTS**:** Out of the total cohort (17 hips), 14 hips showed no signs of loosening or graft resorption as well as no femoral loosening during the median follow-up period of 5.1 (2 to 8.5 years). In one patient, fracture of cranial acetabular module occurred 4 months after the revision, one patient sustained two hip dislocations, and one patient developed deep infection resulting in permanent implant removal.

CONCLUSION**:** Isolated acetabular revision using modular trabecular titanium implant with reinsertion of the original non-modular monoblock cemented femoral stem is a safe and effective technique in adequately selected patients *(Tab. 3, Fig. 4, Ref. 30)*. Text in PDF *www.elis.sk*

KEY WORDS: in-cement revision, tap-out tap-in, isolated acetabular revision, femoral cemented monoblock.

Abbreviations: THA – total hip arthroplasty, UHMWPE – ultra-high molecular weight polyethylene, TT – trabecular titanium.

Introduction

Total hip arthroplasty (THA) has been one of the most successful interventions of all orthopaedic surgeries for more than 6 decades. Successful THA leads to pain relief, and in most of the cases, it enables non-restricted postoperative mobility. When *in situ* long enough, all hip replacements will eventually fail because of infection, fracture, dislocation or combination of normal tribological and biological processes, such as loosening and wear (1). Aseptic loosening of the acetabular component in total hip arthroplasty replacements occurs more frequently than the loosening of the femoral component. In up to 30 % of aseptic revisions only the acetabular component is reimplanted as contrasted to 14 % of cases with isolated femoral component revision (2).

Even today, we still encounter failed cemented cups with well-fixed cemented stems without a modular head (monoblock design), which represents the initial THA implant design.

When dealing with isolated acetabular revision with stable, well-fixed cemented monoblock stem, three revision scenarios are possible.

Leaving the monoblock stem in position is associated with technical discomfort, significantly limits the approach to the acetabulum and extends the time of surgery.

Second possibility is to extract the well-fixed femoral stem and cement. The surgery is prolonged with increased blood loss and the risk of perioperative fractures is enhanced. Therefore, a highly individual approach is needed in case of acetabular revision with a well-fixed cemented stem.

Considering risks and benefits of previous surgical options, a third option was chosen for a selected cohort of elderly patients. It consisted of a simple extraction and reinsertion of the original femoral monoblock component into the intact cement bed, without using a new layer of cement (tap-out tap-in or in-cement technique) (3, 4). This technique is only suitable in selected cases for a well-fixed stem and preserved cement mantle.

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Material and methods

In this work, we retrospectively evaluated a group of 17 hip surgeries (16 patients) who underwent isolated reimplantation of the acetabular component by the method of extraction and reinsertion of the original femoral component. This is the so-called tap-out tap-in method of retaining the original femoral component. These patients represent 6.5 % of the total number of total hip arthroplasty revisions performed at 2nd University Department of Orthopaedic and Trauma Surgery, Comenius University, Faculty of Medicine.

All patients had undergone primary cemented THA with femoral Poldi-Čech monoblock component, all with a head size of 32 mm. This is a Müller-type stem ("banana stem") modification according to the design of Čech and Beznoska manufactured since 1972 (Fig. 1) (5). Stems used in our patients were third-generation implants of this endoprosthesis, with a centrum-collum-diaphysis (CCD) angle of 144°, implanted with acetabular component made of ultra-high molecular weight polyethylene (UHMWPE).

The indication for revision surgery was an isolated acetabular aseptic loosening (Fig. 2). Preoperative elimination of septic loosening was performed using standard clinical and laboratory procedures. Bone scan and leukocyte scan was performed in each patient to rule out the periprosthetic infection.

Primary surgeries had been carried out between 1988 and 2007. Revision surgeries were performed between 2010 and 2018. All revisions were performed by the senior author. The median time up to the revision of loosened cemented acetabular polyethylene component was 19 years (range 8–25 years). The revision group included 16 patients, 15 females and 1 male. Their median age was 75 years (range 58–88 years) (Tab. 1).

Fig. 1. Femoral monoblock Poldi-Čech cemented stem after extraction.

Fig. 2. Failure of the acetabular component of cemented THA with a well-fixed cemented monomonoblock stem.

The median patient follow-up time after revision surgery was 5.1 years with a range from 2 to 8.5 years. The median follow-up period of the fate of cemented stems from the primary surgery was 24 years (range 13–31 years). Patients underwent standard X-ray examinations 6 weeks, 3 months, 6 months and 12 months after reimplantation. Subsequently, patients were clinically and radiologically examined every year. Postoperative complications, radiographic loosening and surgical revisions were recorded. Periprosthetic radiolucency wider than 2 mm and/or progressive radiolucency were considered as a sign of cemented femoral component loosening (6). Radiographic criteria were used to describe cup

Tab. 1. Study group characteristics of patients after tap-out tap-in isolated acetabular THA revision.

Study group characteristics	
Number of patients	16
Number of surgeries	17
Median age (years)	75 (58–88)
Gender ratio (females : males)	15:1
Primary surgeries (period)	1988–2007
Revision surgeries (period)	2010–2018
Median time from index surgery to revision (years)	19 (8–25)
Median follow-up from index surgery (years)	24 (13–31)
Median follow-up from revision (years)	5.1 (2–8.5)

Tab. 2. Overview of acetabular defects and Delta implants used in isolated acetabular THA revision.

Cases (hips)	Defect type (Paprosky)	Delta cup (type)	Delta cup diameter (mm)	Cranial augment size (mm)	Acetabulum inclination correction	Cup offset correction (mm)
1	2A	TT	52			
2	2A	TT	52		UHMWPE 20°	
3	3A	One TT	56			5 mm
4	3B	One TT	54	12 mm	UHMWPE 20°	
5	3B	Revision TT	62			5 mm
6	3B	One TT	50	12 mm	UHMWPE 20°	
7	2B	One TT	52		UHMWPE 20°	
8	3B	One TT	52		UHMWPE 20°	
9	3A	Revision TT	54	12 mm		
10	3A	One TT	50	12 mm	metal spacer 20°	
11	2B	One TT	50			5 mm
12	2A	One TT	50		metal spacer 20°	
13	3A	One TT	50	12 mm	metal spacer 20°	
14	2A	One TT	56		metal spacer 10°	
15	3A	One TT	50	12 mm		
16	3A	One TT	62	12 mm	metal spacer 10°	
17	3A	One TT	58	12 mm	metal spacer 10°	

failure as follows: migration of 5 mm either horizontally or vertically, radiolucent lines of 2 mm or more in all DeLee and Charnley zones, and screw fractures or variation of cup angle greater than 5°. Radiographs were screened for progressive radiolucent lines (7, 8). Clinical outcome assessment was done using Harris Hip Score (HHS). A paired t-test was used to compare preoperative HHS and last postoperative HHS. Statistical analysis was performed using Microsoft Excel Software. The outcome measurement was assessed by surgeon who did not perform any of the surgeries.

Patients were operated using an anterolateral approach. The stability and position of the femoral component was evaluated perioperatively. This methodology was planned and performed in a selected group of elderly patients only if the femoral component had been clinically stable and radiologically fixed. In isolated reimplantation of the acetabular component, the femoral cemented stem was removed at the beginning of the procedure, after arthrotomy and arthroplasty dislocation, using femoral extraction instrument and a hammer. This ensured a better surgical approach for the revision of the acetabular component. Prior to the stem extraction, the upper lateral portion of the cement was removed to prevent disruption of the cement mantle. The femoral component was thoroughly inspected and dried before reinsertion. The surface of the femoral component head was carefully assessed for the signs of wear. A sterile light source was used to check the integrity of the cement mantle. It was not necessary to use a new layer of cement when inserting the same femoral component.

In our revision method, we tried to ensure the stability of the hip joint using Delta Trabecular Titanium (TT) modular acetabular revision implant (Limacorporate S.p.a, Udine, Italy) (Fig. 3). The correct centre of rotation was achieved using internal (spacers and inserts) and external acetabular component modularity (cranial module or augment). Average size of implanted cups was 54 mm (range 50 – 62 mm).

To fill the acetabular bone defect, we used a layer of fresh frozen allografts in all patients using impaction bone grafting and reverse reaming. Subsequently, the revision cup with trabecular titanium surface was implanted.

Types 2A, 2B, 3A and 3B according to Paprosky classification were present. Delta One TT implant was used in most of cases (13 patients). Delta TT implant was implanted in 2 patients (2A defects), Delta Revision TT in 2 patients with 3A and 3B defects. Cranial hemispherical module screwed to trabecular titanium cup of 12-mm or 18-mm thickness can be used to fill segmentary acetabular defects. In the study group, only 12-mm modules were used in 8 cases with the Delta-One-TT implant for Paprosky type 3 defects (6 x defect 3A, 2 x defect 3B) (Tab. 2).

To ensure the stability of THA in a single-component acetabular revision, an internal modularity using angled metal spacers of 10° and 20°, protruded polyethylene liners (angled 20°) and 5-mm offset metal acetabular spacers were optionally used. We used 10° metal spacers in 3 patients, 20° metal spacers in 3 patients, metal spacers with a 5-mm offset were used in 2 patients. Protruded (20° angled) polyethylene liners were used in 5 patients.

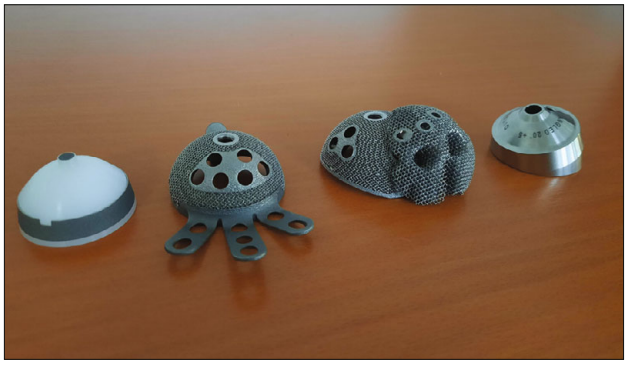

Fig. 3. Implants of Delta acetabular revision system (polyethylene liner, Delta Revision TT, Delta TT with cranial module, 20° angled spacer).

Results

None of the reinserted femoral stems that were revised using tap-out tap-in technique did show signs of clinical or radiological loosening. Solid cement retention of femoral stems was preserved without radiographic signs of subsidence. None of patients needed revision for stem loosening, fracture or other mechanical failure of the femoral component. Radiologically we have found no signs of aseptic loosening due to osteolysis (PE wear) from bearing between old femoral head and new 32-mm UHMWPE coupling. We observed no development of granuloma or radiographic signs of lateralisation of the head of the original femoral stem in the reimplanted polyethylene insert.

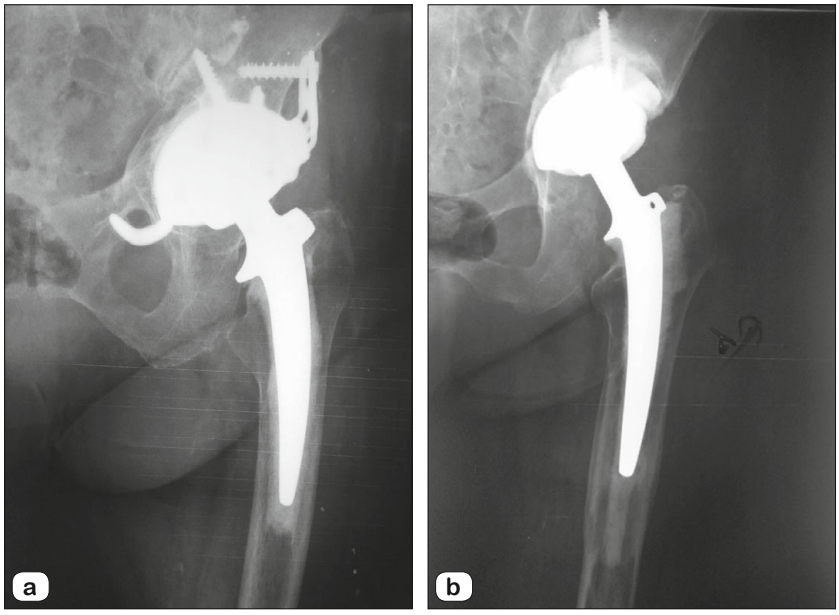

Fig. 4. a, b. Revised Delta Revision TT cup (a) and Delta TT cup with cranial module (b), tap-out, tap-in technique.

In one patient we had to exchange the new acetabular component due to fracture of the lateral part of the cranial module 4 months after the index revision surgery. The solution resided again in the tap-out tap-in technique for femoral stem revision with implantation of new Delta Revision TT acetabulum. Second revision THA ended up with an ongoing satisfactory outcome.

One patient required THA extraction due to deep periprosthetic infection 2 months after revision surgery. In one patient, there were two episodes of dislocation of THA probably due to a significant weight loss of 24 kg, and despite the implanted 20° polyethylene liner. Uncomplicated closed reductions under anaesthesia were performed.

We did not observe aseptic loosening of the new trabecular titanium acetabular component in remaining hips during the follow-up period from 2 years up to 8.5 years. We did not radiologically observe resorption of bone graft layer in any of revised acetabular components (Figs 4 a, b).

Tab. 3. Complications and functional outcome in patients after isolated acetabular revision with trabecular titanium cups using tap-out tap-in technique of cemented femoral stem reinsertion.

Complications	
Neurovascular injury, DVT	0
Dislocations	1
Early infection	1
Late infection	0
Acetabular loosening	1
Femoral loosening	0
Functional outcome	
Harris hip score (preoperative)	37 (30–51)
Harris hip score (last follow-up)	74 (48–85)

The mean Harris Hip Score (HHS) improved from 37 (range 30 – 51) points preoperatively to 74 (range 48 – 85) points during the follow-up period ($p < 0.001$) (Tab. 3).

Discussion

Despite modern trends in the use of uncemented implants, the cemented hip endoprosthesis is still considered to be a successful THA method with survival rates over 90 % after 10 years (9).

Aseptic loosening is the most frequent reason for THA revision surgery. In an isolated component revision, either acetabular or femoral reimplantation, we need to rule out the loosening of the other component. In preoperative planning, which is mandatory in revision THA surgery, it is advisable to maintain a certain degree of caution when considering the possibility of preserving one of the components. Adequate stability of the retained component must be precisely verified during surgery.

The main reason for failure of total hip replacement is the mechanical wear and polyethylene oxidation associated with direct reduction of polyethylene thickness and producing polyethylene debris. Small particles of polyethylene debris cause inflammatory reactions leading to osteolysis, followed by loosening of THA components from the bone or cement mantle (10).

In our patients, all with evident acetabular failure, no significant X-ray signs of loosening of the cemented monoblock femoral stem with a 32-mm non-modular head were present.

Therefore, the possibility of revision using modern ultra-high molecular weight polyethylene articulation encouraged us to preserve the original femoral component, especially in elderly patients.

We performed simple reinsertion of femoral monoblock from the Czech manufacturer Poldi. There are reports of excellent results with survival rates over 80 % in up to 20 years of follow-up (5,11).

Štedrý et al, in a group of 192 patients (199 hips) with cemented Poldi THA operated in 1983, reported 1 % of revisions for late septic loosening, 0.5 % for isolated aseptic stem loosening, 2.6 % for aseptic loosening of both components and 10.7 % for aseptic loosening of acetabular component on average 8.3 years after surgery (12). In their retrospective analysis, Rozkydal and Janíček published 90 THA with a Poldi-Čech monoblock implanted between 1974 and 1984. After the mean follow-up of 28 years (range 25–38 years), there were 69 stems still *in situ*, among them only 5 hips with radiographic finding of aseptic loosening, while the resting 64 were stable. Authors report polyethylene wear and acetabular loosening to be the most common reasons for THA revision (13).

The decision to maintain the original, moreover non-modular monoblock femoral stem, should be advocated in an effort to eliminate risks related to the extraction of a well-fixed implant

(14–16). There are technical difficulties associated with the danger of bone perforation and periprosthetic fracture of the femur during the extraction of the cement in an osteoporotic terrain, particularly in elderly patients. Intraoperative fractures represent up to 5–12 % of all periprosthetic fractures (17). Extraction of the original cement is a time-consuming procedure associated with substantial bleeding from the femoral canal. The age of the patient must be taken into account when indicating the type of surgery. It is necessary to consider the overall biological condition, perioperative risk and systemic reserves of the patient. Time of surgery and blood loss are significant factors carrying the risks of deterioration of physical and cognitive functions, especially in elderly patients over 70 years (18–20).

In our case, the reinsertion of the original cemented stem is based upon the assumption that the cement mantle of the endoprosthesis does not have an adhesive function in polished cemented stems. When applied correctly, it plays the role of a precise bed in which the implant has a minimal possibility of movement. Careful removal of the original implant needs to be followed by checking out the integrity of the cement layer (21). Another possibility of the preservation of the cemented stem is to use an additional thin layer of low-viscosity cement when reinserting the same stem (cement-in-cement technique). Alternatively, a new smaller component using standard cement may be implanted. In this way there is a moderate possibility of influencing the position and orientation of the new femoral component (22, 23). Data from 1,179 revision cases using these techniques from the Swedish Arthroplasty Register describe 91 % of Exeter stems and 85 % of Lubinus stems without the need for revision after 6 years (22).

Several relevant resources are available to confirm the reliability of cement-in-cement technique.

In a retrospective study, Judl et al evaluated a cohort of 66 cases of isolated cup loosening. In 25 hips, the original femoral Poldi component was preserved. A new implant was chosen whenever the original femoral component showed mechanical damage. In all cases, authors used new additional cement (cement-in-cement technique). The overall reimplantation success rate was 81.7 % for an average follow-up of 50.2 months (11). Sandiford et al retrospectively evaluated 24 patients with the mean age of 67.5 years with cement-in-cement revision. Aseptic loosening was not observed in any patient and the survival rate after five years was 91.7 % (24).

Single-component THA revisions are at higher risk of dislocation (25). The technical limit of the tap-out tap-in (or in-cement) method is the inability to influence the position and orientation of the femoral component to maintain the stability of THA (3). In case of THA revision where a monoblock femoral cemented stem is present, we do not have the option to modify the offset and diameter by head exchange. Therefore, it is necessary to influence arthroplasty stability and limb length by the position of the revised acetabular component. Our aim was to lateralise and to caudalise the centre of rotation, which we managed using bone allografts in the first phase of acetabular revision. We have seen convincing bone graft healing and bone remodelling in THA revisions using impaction bone grafting with trabecular titanium implants. External modularity of this system enabled us to caudalise the centre of rotation with 12-mm cranial modules by filling rim bone defects. Internal modularity of the system allowed us to increase the offset by 5 mm, as well as to influence the inclination by 10° and 20°, either with a metal spacer or directly with a PE liner. This modularity helps us to restore the muscle tension during the surgery, as well as to prevent possible impingement of components. A disadvantage of increased lateralization of the centre of rotation may be a raise in the load on the cup construction (26). An anterolateral approach for THA is recommended to reduce the number of dislocations (27, 28). In general, the experience with modular trabecular metal implants is satisfactory (8). Munegato et al evaluated 36 patients using the same implant (Delta Revision TT) at an average of 40 months of follow-up (range 12-91 months) with no finding of implant failure (29).

In mid-term follow-up, we were aware of early complications, especially those associated with the stability of the prosthesis. We noticed one septic complication requiring endoprosthesis removal and one recurrent dislocation in contribution of a significant weight loss of 24 kilograms after surgery, which resolved after second closed reduction. In our group, we recorded one early fracture of the cranial module out of eight used. We conclude it was probably based on the technical mistake due to overtightening the screws connecting the module to the cup. We did not observe late aseptic failure of the modular acetabular implant. We did not observe a clinically apparent injury to the pelvic neurovascular structures when drilling and screwing the fixation acetabular screws of the cups. There was no intraoperative fracture, which is a concern during cement removal or stem insertion during femoral revision, especially in elderly population.

There are relatively few reports in the literature presenting simple reinsertion of stable cemented stem (tap-out tap-in technique). McDougal et al reviews 23 hip revisions with an average follow-up of 67 months (range 12–128 months). Apart from two cases of infection, they did not observe any loosening of femoral component (4). Probably the largest cohort was described by Nabors et al, 42 patients with follow-up from 2 to 10 years. In 4 out of 42 cases a new femoral stem was used. Two stems were asymptomatically loosened, cement rupture was observed in two patients, and one patient required revision due to dislocations (30). None of known sources discusses a homogeneous group of the same non-modular monoblock implants. Reported cohorts contain cases of various cemented stems, often not reporting the head modularity. In some cases, however, the new implant was of the same type as the old replaced one. The use of a modular trabecular titanium acetabular revision system has not been previously reported in these cases.

To the best of our knowledge in the current literature there is no study reporting on the reimplantation of original cemented monoblock femoral stems with the tap-out tap-in method in combination with a modular trabecular titanium acetabular implant in an isolated acetabular revision as a favourable approach.

During revision surgeries of an isolated acetabular loosening, it is always necessary to keep in mind that the devoted favourable fate of a new femoral implant may not be guaranteed as well.

Conclusion

We conclude that using the modular trabecular titanium acetabular revision implants may advocate the reinsertion of a well-fixed monoblock cemented stem when performing isolated acetabular revision of failed total hip arthroplasty in selected elderly patients. A significant advantage of the retained cemented femoral stem lies in its better resistance to early loading as compared to a new cementless stem, especially in elderly patients with limited cooperation and high risk of intraoperative complications.

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