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Can hip resurfacing be safely revised with short-stem total hip arthroplasty? A case series of six patients

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ABSTRACT

Background: The usage of short stems in primary total hip arthroplasty (THA) has constantly gained popularity over the last decade, however, to date, short stems are not eligible to be used as revision implants. The aim of this study was to retrospectively evaluate the outcome of revision surgery of failed hip resurfacing arthroplasty (HRA) using short-stem THA.

Methods: In a single center, retrospective analysis, 6 consecutive patients who were treated with a calcar-guided short stem after failure of HRA were evaluated. The mean follow-up was 3.25 years (SD 0.45). Patient reported outcome measurements (PROMs) were recorded using the Harris hip score (HHS) and The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC). The health status was evaluated by the EQ-5D-5L score. Pain and satisfaction were obtained using the visual analogue scale (VAS). Radiographic analysis was performed by evaluating osteolysis, stress shielding, alignement and signs of aseptic loosening. Complications were documented.

Results: At last follow-up, clinical outcome was excellent (HHS $\geq$ 90) in 5 patients and good (HHS = 87) in 1 patient. The mean WOMAC score was 5.73% (SD 3.66%). The mean EQ-5D-5L index was 0.914 (SD 0.07). Pain and satisfaction on VAS was 1.83 (SD 5.18) and 8.67 (SD 0.94), respectively. Radiologically, no signs of subsidence, aseptic loosening, stress shielding and fracture were obvious. No major complications occurred. To date, no further revision surgery was needed.

Conclusions: The outcomes of the present case series propose that HRA can be safely revised using short-stem THA in a selected patient group. Clinical and radiological results are encouraging. Based on the present data, short stems may be considered as a revision implant for failed HRA for experienced surgeons.

1. Introduction

Total hip arthroplasty (THA) for patients with osteoarthritis of the hip is one of the most successful procedures in surgery[1] but long-term survivorship in young patients has been shown to be inferior compared to older patients, most likely related to higher activity levels.[2,3] Broad concerns about the potential bone loss during future revision, along with difficult procedures and restricted functional outcome, have led to an increase of the usage of bone-preserving implants, such as hip resurfacing arthroplasty (HRA) and short-stem THA.

HRA proposed benefits including improved proprioception, increased stability and femoral bone preservation compared to THA.[4] While early results of HRA have been promising, recently, there has been a widespread concern regarding large-diameter metal-on-metal (MoM) articulations. Complications, such as increased metal debris and metallosis have been reported, leading to a high rate of revision surgery.[5,6]

Although HRA primarily conserves femoral bone stock, to date it remains controversial whether revision procedures are actually simplified by the primary use of HRA.[7] Due to marked metallosis, besides damage to the acetabular bone stock, also damage to the metaphyseal bone stock is likely,[5,8] thus, revision surgery may be quite challenging.

To date, almost all reports on revision procedures of HRA have been performed using conventional stems.[9,10]

At the same time, short-stem THA has constantly gained popularity

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over the last decade, with a great variety of different stem designs having been introduced to the market.[11] Again, one major goal of using short stems is the preservation of bone in order to facilitate potential revision surgery in the future.[12] Preserving bone stock potentially enables the use of primary implants, should a revision become necessary, without the need of using revision stems.[2,5]

To our best knowledge, only one case report of revision surgery of HRA using a short stem has been published so far.[13] As revision surgery of HRA using a short stem is to be considered off-label use, given the various manufacturers recommendations regarding indications, short stems are not eligible to be used as revision implants. Subsequently, numbers of cases are scarce and clinical outcomes as well as risks and complications of revision surgery using a short stem are unknown. Therefore, the aim of the study was to investigate short-term clinical results and complications of revision surgery of failed HRA using a short stem in a consecutive case series.

Our hypothesis was, that HRA can be safely revised using short-stem THA.

2. Methods

This research has been approved by the IRB of the author's affiliated institutions. In this retrospective case series 6 consecutive patients were included, for whom revision surgery of failed HRA was performed using short-stem THA in the years of 2016 and 2017 at a single institution (Table 1).

All patients with at least 2 years of follow-up were included. Written consent to participate has been obtained from all patients prior to inclusion.

Initial HRA was performed between 2004 and 2013 in different clinical centers. Mean time before revision was 10.6 years (range 4–13 years). Indication criteria for the choice of a short stem as a revision implant were failed HRA due to aseptic loosening and wear with metallosis providing sufficient femoral bone stock in the metaphysis.

There were four females and two males. Mean patient age at revision was 57.7 years (range 38–65 years). In all patients the calcar-guided short stem optimys (Mathys, Ltd. Bettlach, Switzerland) was used for revision surgery.

For the acetabular component either a cementless primary press-fit component or a revision cup was used. Details will be described in the results section. All procedures were preformed using a minimally invasive, antero-lateral approach. The indication for revision surgery was aseptic loosening in all cases (n = 6), often accompanied by metallosis (n = 3) and acetabular bone defects (n = 3), providing loss of function and severe pain (n = 6).

For clinical examination, patient reported outcome measurements (PROMs) were obtained at last follow-up, such as the Harris hip score (HHS; range from ≥90 = excellent to <70 = poor), the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC; range from 0% = best to 100% = worst) as well as pain (0 = no pain to 10 = worst pain possible) and satisfaction (10 = best to 0 = worst) on the visual analogue scale (VAS).

For health status, the EQ-5D-5L (EuroQol Group) was used.[14] Pre-und postoperative antero-posterior imaging was performed using a standardized technique.

All statistical analyses were performed using Excel (Microsoft). Data are reported by median and range or by mean and standard deviation (SD).

3. Results

Between 2016 und 2017, six patients underwent revision THA using a calcar-guided short stem optimys (Mathys, Ltd. Bettlach, Switzerland). The mean follow-up was 3.25 ± 0.45 years (range 2.7–4.0 years) and the mean age at revision surgery was 57.67 ± 23.14 (range 38–65 years). Mean HHS was 93.33 ± 4.23 (range 87–100), the outcome of five patients was excellent (HHS ≥90), except for one patient, which was good (HHS 87). The mean WOMAC Score was 5.73% ± 3.66% (range 1.0%–12.5%). Mean pain on VAS was 1.83 ± 5.18 (range 0–6) and mean satisfaction on VAS was 8.67 ± 0.94 (range 7–10). However, one patient was still in pain (pain on VAS 6), due to an ilio-sacral joint syndrome and a sequestrectomy after a nucleus pulposus prolapse in the lumbar section of spine. The clinical outcomes are summarized in Table 2 (Table 2).

There has been no further revision surgery so far. During follow-up, no major complications occurred. Radiologically, no signs of subsidence, aseptic loosening, stress shielding and fracture were obvious (Fig. 1).

A short description of each case is shown below.

Patient 1 A 65-year-old female presented with limited hip mobility and pain at hip rotation since 2016. Initially HRA with a Birmingham Hip Resurfacing (BHR) was performed in 2004. After diagnosis with acetabular loosening and acetabular bone defect, a revision using the optimys short stem combined with a revision cup (Delta One Revision; Lima, Ltd. Villanova di San Daniele del Friuli Udine, Italy) was performed. At last follow-up the outcome was excellent (HHS 95) and the patient reported no pain. No complications occurred.

Patient 2 A 65-year-old male whose symptoms had deteriorated significantly with pain. The clinical examination showed a hip rotation stiffness and a hip extension deficit of 10°. Initially a BHR was performed in 2007. The imaging revealed a loose prosthesis with an acetabular bone defect and metallosis. An acetabular bone plastic and a cementless revision cup (Delta One Revision; Lima), combined with the optimys short stem was performed (Fig. 2). At last follow up, the outcome was excellent (HHS 90) with full range of motion. No complications occurred.

Patient 3 A 60-year-old male presented with increasing pain,

Table 2
Functional scores.

	Follow up (Years)	HHS (In %)	WOMAC (Index)	EQ-5D-5L	Pain (VAS)	Satisfaction (VAS)
Pat. 1	4.0	95	3.1	0.918	0	9
Pat. 2	3.5	90	12.5	0.828	3	8
Pat. 3	3.3	100	1.0	1.000	1	10
Pat. 4	3.3	96	6.3	1.000	0	9
Pat. 5	2.7	92	4.2	0.910	1	7
Pat. 6	2.7	87	7.3	0.828	6	9

HHS, Harris Hip Score; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index; EQ-5D-5L, health status by the EuroQol Group; VAS, visual analogue scales.

Table 1
Patient characteristics at surgery.

	Year of Surgery	Initial Prosthesis	Side	Gender	Age	BMI	Dorr	Indication
Pat. 1	2016	BHR, Smith&Nephew	left	female	65	25.1	B	acetabular loosening with bone defect
Pat. 2	2016	BHR, Smith&Nephew	left	male	65	27.7	B	loosening of all components with bone defect, metallosis
Pat. 3	2017	Cormet, Corin	right	male	60	26.3	A	femoral loosening
Pat. 4	2017	Durom, Zimmer	left	female	63	25.5	B	femoral loosening, metallosis
Pat. 5	2017	Alphanorm, Corin	right	female	55	28.6	A	acetabular loosening with bone defect
Pat. 6	2017	unknown	left	female	38	21.9	B	loosening, metallosis

BHR, Birmingham Hip Resurfacing; BMI, Body-Mass-Index; Dorr, femoral bone classification.

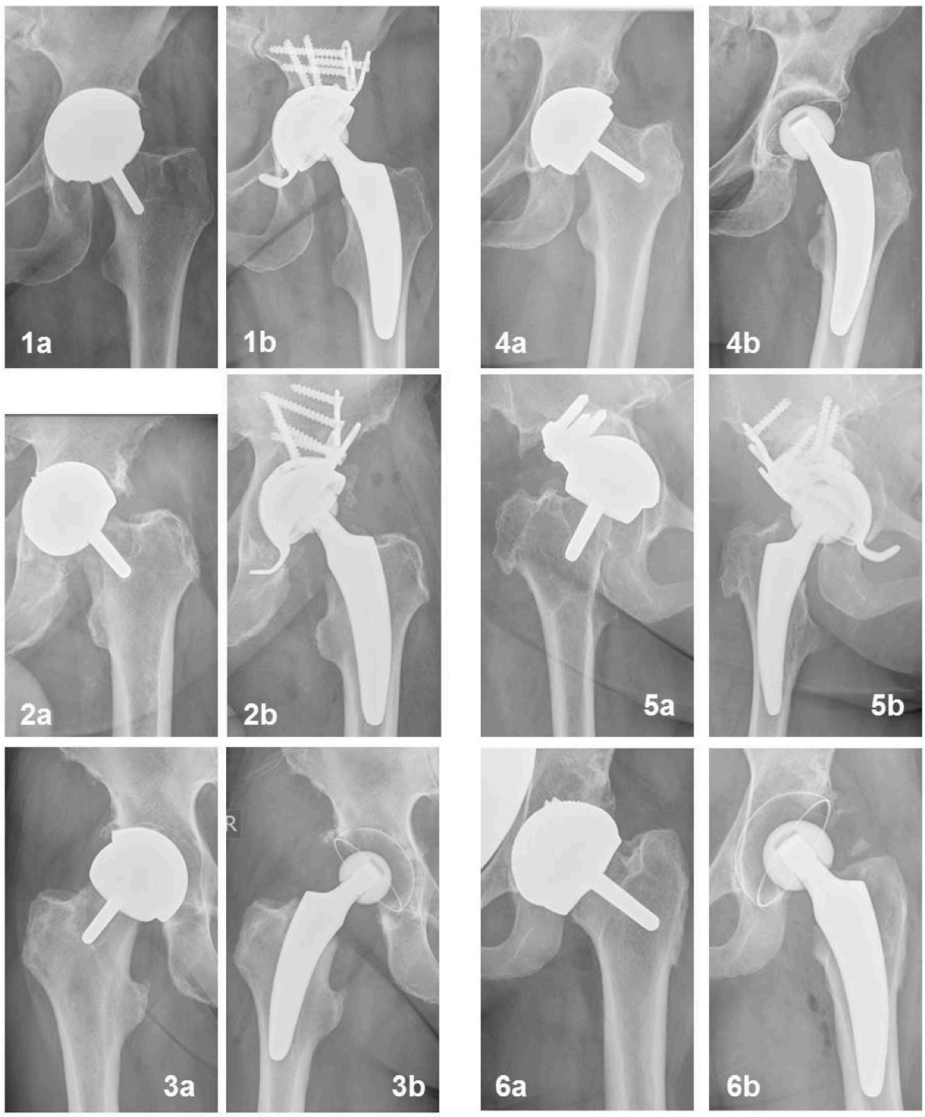

Fig. 1. Radiographs of all patients (1–6; a: preoperatively, b: postoperatively).

especially at hip rotation along with activity limitation. Initially HRA was done in 2005. Revision was performed with a primary mono-block press-fit cup (RM Pressfit vitamys; Mathys, Ltd. Bettlach, Switzerland), combined with the optiyms short stem (Fig. 2). At last follow-up, the outcome was excellent (HHS 100). No complications occurred.

Patient 4 A 63-year-old female whose symptoms had deteriorated significantly with strongest pain with a total hip flexion of 50° and a hip rotation stiffness. Initially HRA was done in 2005. The preoperative diagnosis showed aseptic loosening with metallosis. Revision surgery involved the optimys short stem with a cemented PE cup (Durasul; Zimmer Biomet, Ltd. Warsaw, USA). At last follow-up the outcome was excellent (HHS 96) and the range of motion was restored. No complications occurred.

Patient 5 A 55-year-old female who presented with increasing pain. The imaging revealed a HRA with loosening and an acetabular bone defect. Intraoperatively a cementless revision cup (Delta One Revision; Lima), without an acetabular bone plastic was sufficient in combination with the optimys short stem. At last follow-up, the outcome was excellent (HHS 92) and the pain was 1 on VAS. No complications occurred.

Patient 6 A 38-year-old female presented with increasing pain and limited pain free walking distance. She had sustained a hip dysplasia in her childhood. Initially, HRA was done in 2013. Revision surgery was performed after the diagnosis of aseptic loosening and metallosis using a cementless pressfit monoblock cup (RM Pressfit vitamys; Mathys), and the optimys short stem. Following revision surgery she was very satisfied (VAS 9) and had a sufficient range of motion. However, she continued to report on pain under load (VAS 6) with mild limping along with lower back pain. During follow up she developed an ilio-sacral joint syndrome. Despite this, at last follow-up, her HHS was 87. No further complications occurred.

4. Discussion

Preservation of bone stock is of utmost importance in modern THA, in particular taking into account that patients become increasingly younger of age, thus most likely experiencing one or more revision surgeries during their lifetime.[13] Although to date the usage of short stems in revision THA is to be considered off-label use, it may, however, offer the opportunity of saving as much femoral bone stock as possible with regards to further future revisions in assorted patients. The present consecutive case series aimed to investigate the outcomes of revision THA using a short stem in patients with failed HRA. The present results suggest that HRA can be safely revised using short-stem THA in a selected patient group.

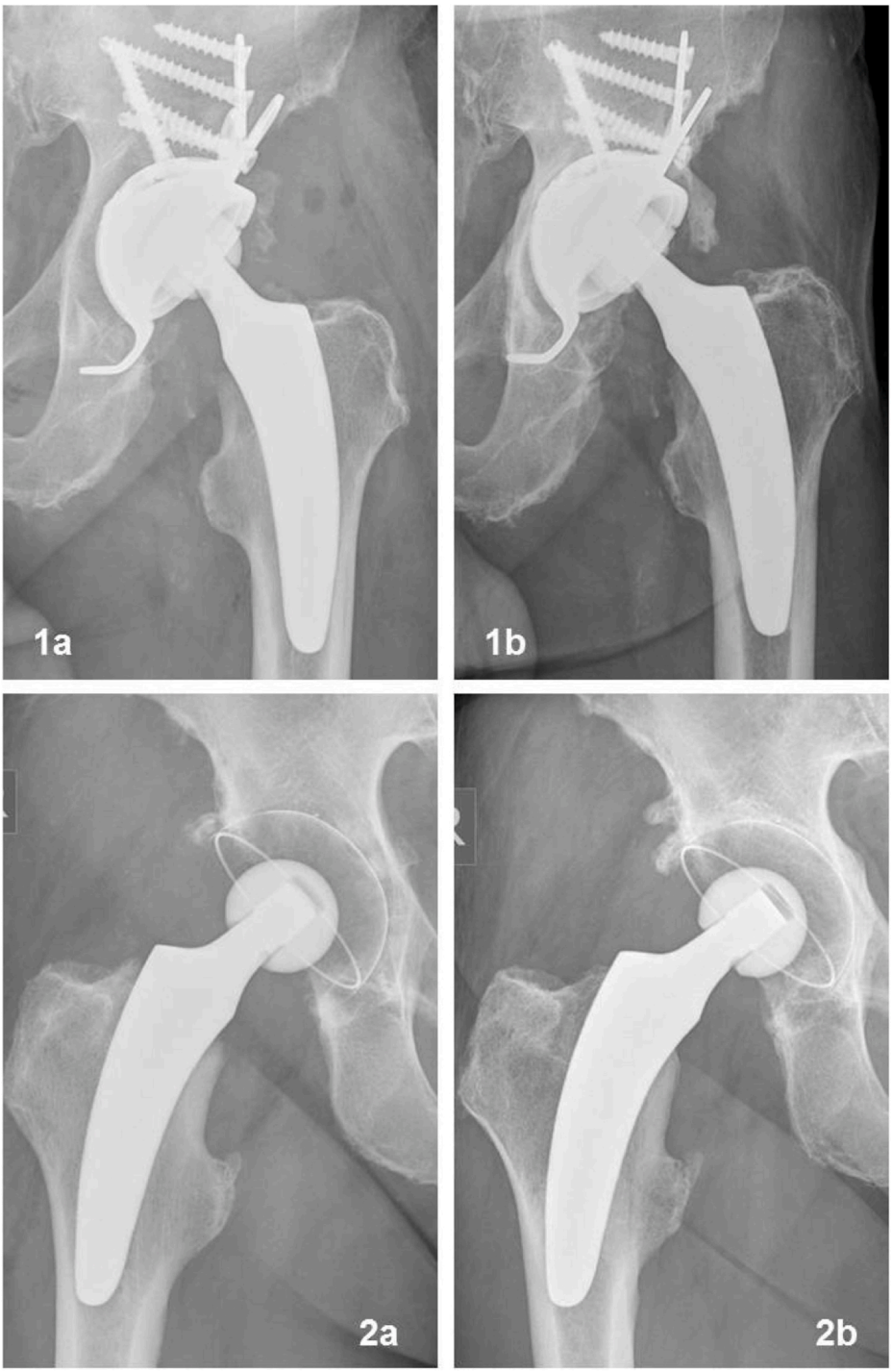

Fig. 2. Radiographs of patient 2 and 3 (a: postoperatively, b: at last follow-up).

Early results of contemporary HRA have shown success rates above 97.8% at a mean of 5 years in the young, active population.[15] Just recently, Amstutz and Le Duff found a 15-year Kaplan-Meier survivorship in a cohort of 109 patients with the Conserve Plus HRA (Microport Orthopedics, Arlington, USA) of 93.7%.[16] They concluded that HRA is a viable solution with many advantages for all kinds of active patients. Despite these good early results, also complications have been noted involving local and systemic reactions associated with the MoM bearings.[17] MoM HRA have been associated with an unacceptably high early- and mid-term failure rate due to an adverse reaction to metal debris, as especially seen in women and small implant sizes.[18,19] Metallosis, pseudotumor formation and tissue damage is likely to result in severe pain around the hip joint, often making revision surgery necessary.[20] Therefore, HRA has lost favor with many surgeons during the last decade.[21]

To date, revision THA of HRA has mainly been reported using conventional straight stems. Several studies investigated the outcomes of the conversion of HRA to conventional THA over the last decade. Already in 2010, Sandiford et al. analysed in a prospective study the early functional results and satisfaction of a cohort of patients who underwent conversion of a hip resurfacing to conventional THA.[10] Mainly, Synergy and Echelon stems (Smith & Nephew, Warwick, UK) were used as revision implants. All patients reported relief of pain and excellent satisfaction scores.

However, patients who undergo conversion of HRA to THA have been reported to be at increased risk of requiring a further revision surgery.[9] In those cases of a further revision following conventional THA, often a complex surgery using revision implants is needed, due to severe defects of the bone stock.[22] While there are several challenges in performing revision THA, in particular femoral bone loss represents a major problem and complicates stable stem fixation.[23]

Given that many patients with a failed HRA are less than 60 years of age,[13] in modern THA a decisive long-term strategy for further revisions, including also contemporary implant designs, seems crucial. In many cases, HRA, given its particular design, primarily preserves the metaphyseal femoral bone stock and thereby, in theory, allows revision surgery with a short-stem design.

Primary short-stem THA increasingly presents as an alternative to conventional THA due to potential advantages regarding preservation of bone and soft-tissue. The short and curved designs potentially facilitate the preparation of the femoral cavity and the insertion of the stem.[24] Thus, faster postoperative mobilization and a reduced hospital stay has been reported for short stems.[25] Additionally, short-stem THA has been shown to be associated with less blood loss and lower transfusion rates compared to conventional THA.[26] Recently, a systemic review and meta-analysis of randomised controlled trials comparing short stems with conventional stems found superior bone remodelling of short-stem THA and similar survival rates as well as clinical outcomes.[27]

To date, however, almost no data is available regarding revision of HRA with a short stem. Schmidutz et al.[13] reported a case report of one patient with failed HRA, which was revised at three years due to a traumatic dislocation of the acetabular component following a falling incident two months earlier. Intraoperatively, a massive metallosis of the periprosthetic tissue was found, and both the femoral and acetabular components were found damaged, making the removal of all components necessary.[13] As the femoral bone was found to be intact, the osteotomy was performed directly below the femoral component and a metaphyseal-anchored short stem (Metha, B. Braun Aesculap, Tuttlingen, Germany) was used as revision implant. At the two year follow up, Schmidutz et al. reported a good clinical outcome (HHS 86) and a stable implant position.[13] The particular design of the Metha stem requires a high osteotomy level closely under the femoral head. The preservation of the femoral neck ring is crucial in order to achieve a stable anchorage of the implant. Schmidutz et al. concluded in their case report, that if those prerequisites are met during revision surgery, sufficient primary stability of the short stem can be achieved and the usage as a revision implant can be considered.[13]

To date, various short-stem designs are available on the market, providing distinct differences regarding stem length, level of osteotomy and insertion technique. Khanuja et al. proposed four categories of short stems: femoral neck only, calcar loading, lateral flare calcar loading and shortened tapered stems.[11] The short stem used in the present investigation, however, cannot be easily classified, since it can be both calcar loading and diaphyseal anchoring, depending on the individual stem alignment according to the patient's anatomy.[24,28] Particularly in Europe, the term "calcar-guided" short stem has been established.[29]

Regarding the successful achievement of sufficient primary stability revising HRA, the design properties of calcar-guided short stems, given the individualized meta-diaphyseal anchorage, may therefore account for a safe procedure. Even in those cases with partial damage to the metaphyseal bone stock, an additional diaphyseal fixation can be applied to achieve a high stability.

The results of the present investigation confirm these assumptions. While there were encouraging clinical results found in all of the included patients with high satisfaction rates, radiologically no signs of impaired primary and secondary stability as well as loosening were found. In none of the cases further revision surgery was needed leading to a short-stem survival-rate of 100% at last follow-up.

However, to safely use this type of stem design, especially in those cases where osteolysis due to metal debris must be presumed, distinct knowledge about the individualized implantation technique in calcar-guided short-stem THA is required. Therefore, revision surgery using this type of stem should be reserved for surgeons who are experienced in short-stem THA. Additionally, revision surgery of HRA using a short-stem should not be considered as the standard procedure and alternative femoral components should be also be considered. However, during the study period between 2016 and 2017 no further revisions of HRA were performed, thus, all failed HRA were revised using a short stem at our department.

Besides the adequate choice of the femoral component, in revision surgery of failed HRA also the preservation of the acetabular bone stock plays a decisive role. While there is evidence that HRA primarily conserves bone on the femoral side, it has early been suggested that it removes more acetabular bone.[30] While preparation of the femoral component is similar to conventional hip arthroplasty during revision surgery, revision of the acetabular component can be a technically demanding procedure with the risk of acetabular bone loss. These previous assumptions are in line with the findings of the present investigation. Although a special acetabular cup cutter (endoCupcut; Endocon, Neckargemuend, Germany) was used in all cases, in the present series in three hips a revision cup, fixed with additional screws, was needed in order to account for bone defects and to achieve a stable anchorage. In one case a cemented component was used. Only in two of the included hips a cementless primary component could be implanted during revision. At last follow-up, however, none of the acetabular components showed signs of loosening and no further revision was needed.

Some limitations have to be acknowledged. The major weakness of the present series is the small number of patients. However, to date, revision surgery using short-stem THA is scarce. Given the fact, that manufacturers do not include revision procedures as recommended indications for their products it poses high legal risks for the surgeons. Therefore, also small series may play an important role providing new insights to the orthopaedic community. A second weakness is the short follow-up. However, it is of great importance to evaluate new implants and new indications at the early stages in order to obtain data that may help predict their survival and potentially detect undesirable results. Thirdly, since in the present series only one particular short-stem design was used, the results cannot be simply transferred to deviant further short-stem designs.

5. Conclusion

Based on the present data, short stems may be considered as a revision implant for failed HRA for experienced surgeons. In this regard, the preservation of most of the metaphyseal femoral bone stock after primary implant removal should be considered a mandatory requirement. However, while the lack of complications and 100% survival at last follow-up in this series is encouraging, still caution should be used in drawing final conclusions from the present results as the follow-up is relatively short and long-term results are necessary. As the popularity of short-stem THA will further increase, so will potentially the number of revisions, which are performed using short-stem designs. This will provide larger series and also provide further data based on different component designs.

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Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: KPK and PR are medical advisors for Mathys Ltd., Bettlach, Switzerland. All other authors declare that they have no conflict of interest.

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