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Abstract

Aim: The aim of this study was to assess the clinical and radiological outcomes of an antiprotrusio acetabular cage (APC) when used in the surgical treatment of periacetabular bone metastases.

Methods: This retrospective cohort study of a prospectively collected database identified 56 patients who underwent acetabular reconstruction for periacetabular bone metastasis or haematological malignancy using a single APC between 2009 – 2020. Mean follow-up was 20 months (1 - 143). Primary outcome measure was implant survival. Post-operative radiographs were analysed for implant loosening and failure. Patient and implant survival was assessed using a competing risk analysis. Secondary parameters included primary malignancy, oncological treatment, operative factors, length of admission and post-operative complications.

Results: Thirty-three patients died during the study period at a mean of 15 months post-operative (range 1 – 63). There were no cases of radiological implant loosening or failure. Acetabular component survival was 100%. Three patients (5.4%) underwent further intervention, of which two (3.6%) required revision: one closed reduction for dislocation, one femoral component revision for dislocation and one debridement and implant retention for prosthetic joint infection. Using death as a competing risk, at 100 months, the probability of revision was 0.036 and the risk of death was 0.84.

Conclusion: With appropriate patient selection the antiprotrusio cage offers good implant longevity with reasonable perioperative complication rate in this high risk surgical group when managing metastatic disease or haematological malignancy around the acetabulum.

Introduction

Bone metastases and haematological malignancy (BMHM) frequently involve the periacetabular region[1] and can be a source of significant pain and functional impairment for patients. Due to improvements in oncological treatment patients with cancer are living longer and symptomatic BMHM are becoming more prevalent and limiting patients' quality of life.[2 - 3] Management requires a multidisciplinary team approach and patients may benefit from timely surgical intervention.[4 - 5]

A variety of surgical procedures have been described [5] reflecting the spectrum of disease and heterogeneity in patients and management. One of the earliest and most commonly employed techniques was described by Harrington in 1981 [6] using a combination of Steinmann pins and a cemented acetabular component. Good early outcomes are presented in the literature, however, a failure rate of 9% has been reported, particularly in patients with a prognosis beyond 5 years.[2,7] Alternative procedures have been described including porous implants, trabecular augments, pelvic cones, custom endoprostheses and acetabular cages. [2, 8 - 10] However, these are typically palliative procedures aimed at improving quality of life,[11] and in patients with limited physiological reserve more complex surgery carries higher complication rates.[1]

The surgical goals when undertaking surgery for BMHM are to achieve a robust reconstruction that will alleviate pain, prevent fracture and permit immediate weightbearing, with implant longevity beyond the patient's lifespan and a minimum of surgical insult. The anti-protrusio acetabular cage (APC) construct, where a cage is fixed with screws to the pelvis and a cup cemented within the cage, has been proved successful in the context of non-malignant acetabular bone loss.[12] Biomechanical analysis demonstrated higher stiffness and load to failure compared to a standard acetabular component in an intact pelvis.[13] At present, there is limited evidence within the literature examining the results of this technique for periacetabular BMHM. The benefits of APCs in periacetabular BMHM are the surgical flexibility in reconstruction and ability to undertake surgery through a standard arthroplasty approach to minimise surgical insult.

We aimed to assess the longevity of a specific APC (Stryker Restoration Graft Augmentation Prosthesis (GAP) II cage (Stryker, Newbury, UK)) to assess whether this represents an appropriate reconstruction method in periacetabular BMHM. Thus far, there is no literature reporting its use in this context.

Methods

Institutional approval was obtained for this study. This retrospective cohort study using our prospectively collated arthroplasty database identified 56 patients undergoing pelvic reconstruction for BMHM using the Restoration GAP II acetabular cage undertaken by the senior authors (MPK, PSY) between 2009 – 2020. These cases were performed at a tertiary referral centre affiliated to a national oncology centre. Any patient presenting with painful lesions around the acetabulum, or with large deposits at risk of pathological fractures were considered for surgery. Life expectancy was taken in to account when considering surgery; if less than 6 weeks surgery was not offered. Those with life expectancy six weeks to three months were considered on a case by case basis for palliative surgery. These factors, including ongoing chemoradiotherapy, were discussed at an oncology multidisciplinary team (MDT) meeting. The extent of acetabular disease was then assessed to confirm suitability for the Restoration GAP II cage. Patients were excluded if there was extensive acetabular destruction, particular involving the inferior aspect of the acetabulum which would prevent stable fixation with the cage flange. These patients would then be considered for an ice-cream cone implant. Patients with uncontained defects or acetabular fracture were still considered for the Restoration GAP II cage but additional fixation, for example plate fixation of the ilium, would be considered.

Radiographs and medical records were examined. Primary outcome measure was acetabular implant survivorship, with failure defined as acetabular revision. Secondary outcome measures included implant migration or loosening, complications and patient survival. Additional measures included Age, American Association of Anaethesiologists (ASA) score, body mass index (BMI), diagnosis, oncological treatment, operative time, blood transfusion requirement and length of hospital stay. Follow-up occurred post-operatively at 6 weeks and as indicated thereafter around systemic therapy, aiming for review at one year and annually thereafter, with clinical and radiographic assessment. Two authors (JWK, OFA) independently assessed the most recent available radiographs of the pelvis and hip in two planes and compared with the initial post-operative radiographs to identify evidence of implant subsidence or loosening. MDT discussion was undertaken for each patient on the merits of post-operative radiotherapy for local disease control considering tumour radiosensitivity, extent of tumour, patient prognosis, residual symptoms and wound healing.

All surgery was undertaken by one or both of the two senior authors (MPK, PSY). Pre-operative embolisation was performed when the primary malignancy was renal cell carcinoma or if there was a significant soft tissue component. Patients were positioned in the lateral decubitus position. Antibiotic prophylaxis and tranexamic acid were given at induction. A lateral curvilinear incision and posterior approach to hip with proximal extension was performed to facilitate outer table exposure. Femoral neck osteotomy and acetabular exposure was undertaken with release of reflected head of rectus femoral and gluteal attachments to outer table to facilitate placement of implant flanges. Metastatic deposits were identified and curettage back to normal cancellous bone where possible and accessible. The acetabulum was reamed sequentially to remove remaining subchondral bone, and superior acetabular rim and inferior soft tissues resected to permit trial insertion of the GAP II cage (Stryker, Newbury, UK UK), sized 3mm less than the final reamer, ensuring appropriate reconstruction in terms of acetabular inclination and anteversion.

Cementoplasty (Refobacin, Zimmer Biomet, Bridgend, UK) was performed to the remaining acetabular defects, and the GAP II cage inserted. Screws were inserted through the superior and inferior cup holes and subsequently within the proximal flanges on the outer table. If a pathological acetabular fracture was present, the GAP II cage could be used to reduce the fracture prior to replacing the hip. In more complex fracture morphology, supplementary internal fixation would be utilised. Depending on the final cage size an X3 polyethylene liner (Stryker, Newbury, UK), in as large a diameter as possible (32mm, 36mm or 40mm, n=49) to fit the cage was selected. In later cases when cage size was >52mm an ADM dual-mobility cup (Stryker, UK, n=7) was selected. The cups were cemented (Refobacin, Zimmer, UK) in to the GAP II cage after cement pressurisation.

The femur was then prepared depending on implant choice. A cemented Exeter stem (n=14, Stryker, Newbury, UK) was used where no femoral metastasis were present or felt likely within the patient's lifetime, and uncemented Plasma Restoration (n=42, Stryker, Newbury, UK) stems were used where metastatic disease was present within the femur or considered likely within the patient's lifetime. Extensive soft tissue components to the tumour would be either curetted of excised, anatomy permitting. Post-operatively all patients were mobilised full weight-bearing and underwent routine post-operative rehabilitation as per standard total hip replacement protocol.

Results

Fifty-six patients met the eligibility criteria. Patient demographics and pre-operative diagnoses are presented in Table 1. Mean follow-up was 20 months (range 1 – 143 months). Thirty-three patients died during the study period at a mean of 15 months post-operatively (range 1 – 63 months). Pre-operative radiotherapy was given to 59% of patients and post-operative radiotherapy to 36%. Further systemic and local therapy was decided through MDT approach and facilitated by the oncology team. Mean operative time was 134 minutes (range 90 – 180). Mean post-operative blood transfusion requirement was 1.2 units (range 0 – 7). Median length of hospital stay was 7 days (range 2 – 188).

Complications are presented in Table 2. There were no cases of implant loosening or movement. Three patients (5.4%) underwent a further surgical intervention, of which two (3.6%) were revisions. This included one closed reduction for dislocation, one revision of the femoral component for dislocation and one washout for prosthetic joint infection. Specifically there were no revisions of the acetabular component. No dislocations occurred in the patients with dual mobility cups.

Using death as a competing risk, at 50 months the probability of revision was 0.036 while the probability of death was 0.71. At 100 months, the probability of revision was unchanged and the risk of death was 0.84 (Figure 1). Case examples are presented in Figures 2 and 3.

Table 1. Patient demographics and primary malignancy.

Mean age (range)	65 years (33 – 83)
Mean BMI (range)	27 (17 – 42.7)
Median ASA	3
Primary malignancy (%)	
Breast	19 (34%)
Prostate	13 (23%)
Multiple myeloma	7 (12%)
Renal	7 (12%)
Lung	6 (11%)
Colorectal	2 (4%)
Bladder	2 (4%)

Table 2. Medical and surgical complications.

Complication	**n (%)**
Urinary tract infection	3 (5.4%)
Dislocation	2 (3.6%)
Lower respiratory tract infection	2 (3.6%)
Prosthetic joint infection	1 (1.8%)
Pulmonary embolism	1 (1.8%)
GI bleed	1 (1.8%)
Acute kidney injury	1 (1.8%)

Discussion

The management of BMHM around the acetabulum remains a challenging clinical scenario. Whilst some lesions can be managed non-operatively,[14 - 15] larger, lytic and symptomatic deposits that affect the structural integrity of the acetabulum merit surgical intervention to alleviate pain, prevent fracture and permit immediate weight-bearing.

Due to the heterogeneous nature of the patients, tumours and acetabular involvement, a variety of implants have been described to manage acetabular defects.[2, 8 - 10] The classically described technique by Harrington[6] and subsequent modifications provide reasonable early outcomes. However, a failure rate of 9% has been reported, particularly in patients with a prognosis beyond 5 years.[2, 7] Given the improving prognosis and longevity of these patients a more robust construct may be required.

The APC construct, where a cage is fixed with screws to the pelvis and a cup cemented within the cage, has been proved successful in the context of non-malignant acetabular bone loss.[12 - 13] At present, there is limited evidence within the literature examining the results of this technique for periacetabular BMHM. Of the available literature Tsagozis et al[16] describe curettage, APC and multiple retrograde screws with a cemented cup. The commonest complication experienced was dislocation, with a rate of 19%. The authors attribute this to the extensive exposure required, poor tissues due to malignancy and chemoradiotherapy and lack of anatomical landmarks. Rowell et al describe the use of a stainless steel APC in 47 hips, demonstrating good outcomes, with only one case of radiological loosening. They noted an 8% reoperation rate at 2 years, the majority of which were for instability.[8]

The aim of this study was to assess the survivorship of a specific titanium APC implant (Restoration GAP II cage, Stryker, Newbury, UK) which has thus far not been reported in this context. With death as a competing risk, the probability of all-cause revision at 8 years was 3.6%, and the probability of acetabular revision was 0%. No APC implants showed evidence of loosening or failure radiologically. This compares favourably to Harrington type reconstruction which shows a higher failure rate beyond 5 years.[7]

The dislocation rate was 3.6%. Whilst higher than would be expected for a standard primary THA,[17] this compares favourably to other studies utilising modified Harrington procedures,[8] and is lower than other reported APC constructs.[8, 16] We would attribute the lower dislocation rate to minimising soft tissue disruption at the time of surgery and utilising as large a femoral head diameter as possible, including dual mobility constructs where possible. None of the patients with dual mobility implant suffered dislocation, however, these were low numbers and thus no firm conclusions can be drawn. We would note the available literature supports their use in BMHM to lower dislocation rates without increasing other post-operative complications [18 – 20].

It is important to note that despite these promising results, the use of the Restoration GAP II cage will not be appropriate in all cases of metastatic disease. In particular, cases of extensive acetabular bone loss are difficult to reconstruct with an APC and with an intact ilioischial bar and posterior pelvis we would favour use of an ice-cream cone type prosthesis.[16, 21 - 22] We noted no cases of APC loosening or failure radiologically and would stress the importance of tumour curettage to permit cement interdigitation into more normal cancellous bony architecture and reduce localised tumour progression.

There are limitations to this study. Whilst this is the largest reported cohort using an APC in this context, the sample size remains small and heterogeneous in keeping with the nature of patients with BMHM. Mean follow-up was 20 months which, although short compared to standard THA survivorship data, reflects the nature of the BMHM patients and the high mortality rate. Outcome scores were available for some patients but the data was not considered to be robust enough to merit publication. Assessment of patient reported outcome measures and post-operative function would be of benefit to ensure these high risk procedures do improve patient quality of life.

BMHM around the acetabulum represents a significant surgical challenge in a high risk patient population. Using a specific titanium APC, we demonstrated excellent short-term survivorship, with no cases of component revision, and comparatively low complication rates. We would recommend the use of an APC in appropriate patients presenting with BMHM.

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