MASSIVE PELVIC BONE DEFECT RECONSTRUCTION WITH A 3D-PRINTED PATIENT-SPECIFIC ENDOPROSTHESIS (A CASE REPORT)

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INTRODUCTION

Periacetabular osteolysis caused by total hip replacement (THR) failure can lead to massive bone defects (MBD) that pose major challenges for reconstruction.

Several approaches have been developed to solve this condition. Among them are allogeneic bone bank implantation and patient-specific custom-made endoprosthesis.

The aim of the present paper is to present a patient with a MBD caused by agressive osteolysis (pseudo-tumoral) secondary to THR, solved by a 3D-Printed Patient-Specific Implant designed with engineering-on-anatomy computer assisted design software.

MATERIALS AND METHODS

A 75-year-old female patient had a cemented THR eight years ago (2007). Five years after (2012) she returned again with progressive pain and limp until she became completely abasic with a Harris Score of 26.

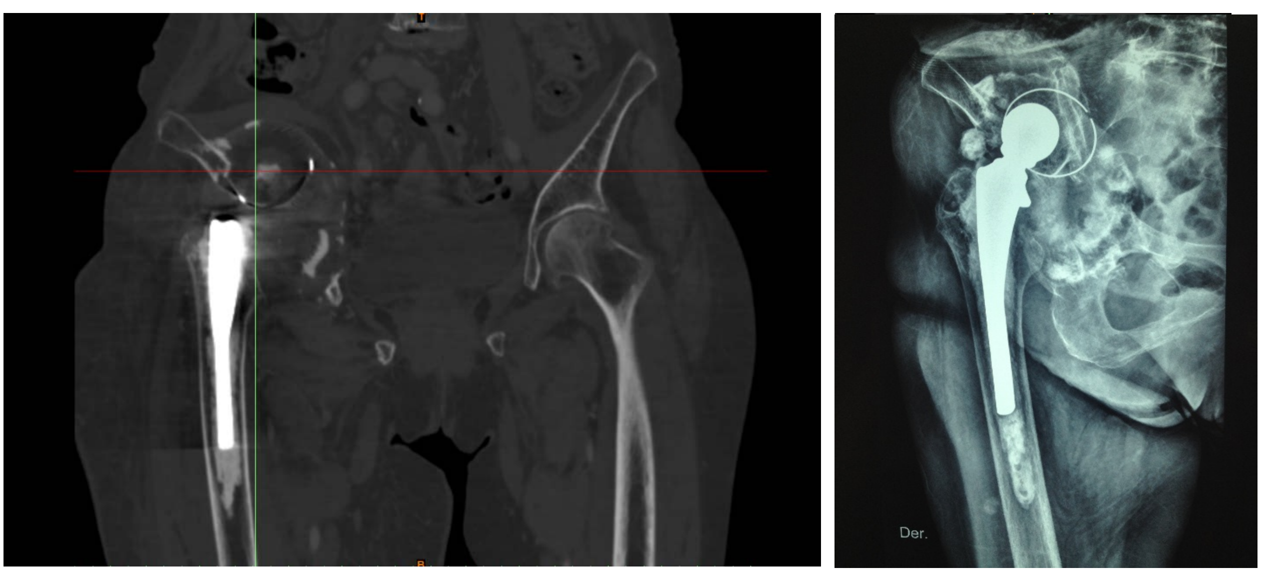


Fig. 1

The CT scan (Fig. 1) shows an all poly (UHMWPE) acetabular cup that has migrated to the interior of the pelvis, a severe periacetabular osteolysis and with a poor quality bone (egg shell) in the proximal femur.

A 3D digital model of the patient´s anatomy and of the prosthesis were generated by advanced processing of the medical images. At this point, a preliminary design of the patient-specific implant was also created. For these purposes, the Mimics Innovation Suite (Materialise NV) was used. These models were then 3D-printed and a workshop was performed in order to simulate the surgery and gather valuable feedback for the design.

The final implant was designed and 3D-printed by Raomed SA and manufactured in Ti 6Al 4V using an EBM (Electron Beam Melting) system. It consists of a four-flange, solid-core, external structure aimed to achieve primary fixation by means of screws attached to the bone areas that exhibit higher quality (as determined by analysis of the CT images), and an inner, trabecular structure whose purpose is to fill the gap left by osteolysis and allow osseointegration, that is to say, biological fixation.

An extended iliofemoral approach was used for implantation. The original cup was extracted by exopelvic channel and the soft tissue was debrided in order to expose the bone defect that matched exactly with the 3D-models built from CT.

The original device was implanted, exhibiting full coincidence with the planning regarding morphology as well as matching of the surfaces of the trabecular structure, aimed to achieve biological fixation. A UHMWPE (ultra-high-molecular-weight-polyethilene) constrained cup was cemented inside the acetabular cup of the prosthesis; and a proximal-1/4-resection modular megaprosthesis was implanted on the femur.

## RESULTS

The patient had a single dislocation event 30 days after the procedure that has not been repeated until the last control.

14 months after the surgery the Harris Score of the patient is 83 .  She walks with the assistance of a cane and the x-rays show stability of the implant, without any sign of loosening or migration.

## DISCUSSION

Masive pelvic bone defects caused by failed THR pose a major challenge for stable, lasting, reconstructions.

Massive allografts are a reasonable choise, being their main advantages the morphologic similarity and the possibility  of osteointegration to the host bone. On the other side, they exhibit drawbacks as the need to have bone bank technology available, as well as a good stock so as to be able to choose a piece that matches optimally with the receptor anatomy. Furthermore, a greater infection-related complications incidence has been reported.

Patient-specific, metallic mega-implants have shown to be an effective alternative, with consistent and durable results in time .

One of the main problems is the implant-host interface, and the possibility of migration and mechanical failure of the assembly. The availability of physical 3D models prior to and during the surgery makes possible to design the final implant with solid-core and biology-mimicking trabecular structures in the optimal locations for primary as well as mid-term biological fixation.

The present case showed an exact correspondence, and the fixation was made on good quality bone stock. The follow-up time is relatively short, but the preliminary results are encouraging, posing a promising alternative for solving extremely complex reconstruction cases.

CONCLUSIONS

The Patient-Specific Implant designed by computer-assisted 3D methods, with the aid of 3D-printed biomodels and manufactured by additive-manufacturing techniques is a reasonable alternative for solving massive pelvic bone defects caused by pseudo-tumoral osteolysis following catastrophic failed, migrated implants.


The availability of 3D models and computer-assisted planning and design makes possible manufacturing implants with complex-optimally designed mixed solid-core and porous structures in the optimal fixation locations.