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Stabilizing of a Metastatic Pelvis Fracture Using a Photodynamic POLYMER Stabilizing System (ILLUMINOSS™). Anatomical Study and First Case Report

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Introduction

The occurrence of skeletal metastases in an urothel cancer because of a hematogenic dissemination of cancer cells is a prognostic disadvantageous incidence [1-7]. Beside specific, treatment options in relation to the primary tumor and local or systemic measures to reduce the disseminated tumor mass the surgical treatment of the affected bone aims in pain release in the first place but also in retaining or regaining skeleton stability. The latter serves to avoid or delay immobility and the ensuing severe deterioration of quality in the remaining period of life. In men, it occurs 3 times more frequent than in woman. 65% of the metastases are located in the pelvic girdle [7]. Osteolytic metastases in this area with a subsequent fracture are followed by severe pain and the disability to walk forcing the patient to be bed-ridden.

Surgical means are unsatisfactory or completely absent to regain enough stability in pathological pelvic fractures.

Material and Methods

A new photodynamic polymer stabilizing technique (IlluminOss™) was examined in the anatomic laboratory to identify it´s potential use in pelvic stabilization. A thin walled PET (Dacron) balloon is infused with a low viscosity photodynamic monomer, quickly cured in vivo with a visible light source; which forms a stabilizing implant between the outer and inner cortex of the hemipelvis.

Five human hemipelves were harvested from the student's anatomical course and freed from all adherent soft tissues. Posteriorly two well-spaced entry portals were identified according to **Figure 1(a-d)**, the first one being located at the posterior superior spine the second one approximately two fingers cranially. The thin cortical layer was perforated with a pointed awl and a straight hole was created in direction to the anterior inferior spine little above the greater sciatic notch starting at the caudal entry portal. The hole was subsequently widened with reamers to a diameter of 13 mm. The second cranially located entry portal was prepared similarly with the created canals converging anteriorly towards each other (**Figure 1 c,d**). Image intensification was used to define radiological landmarks and angles for the instrumentation of the pelvis.

Hereafter a balloon (diameter 13 mm) was filled within the canal and fully inflated with a radiopaque fluid (containing barium sufate). The expansion of the balloons was observed under image intensification to both visualize the conformance of the balloon to the shape and size of the intramedullary canal and to ensure the full inflation of the balloons (**Figure 2 a,b**).

Results

The drill entering the posterior pelvis at the above described entry portal was led between the inner and outer table of the hemipelvis towards the anterior inferior spine in all of the specimens (**Figure 1**). It could be demonstrated that the canal between the posterior superior spine and the anterior inferior spine has an entirely straight geometry. The posterior anterior direction of the canal was 30° externally rotated (**Figure 4c**). With the x-ray beam in line with the created canal the lateral border of the acetabulum became prominent displaying a typical overlay of radiological landmarks (**Figure 3**).

In all of the specimen the inflated balloons were spreading

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between the cortical layers of the pelvic wing in all possible directions thus filling the entire created space from the posterior to the anterior side (**Figure 2**).

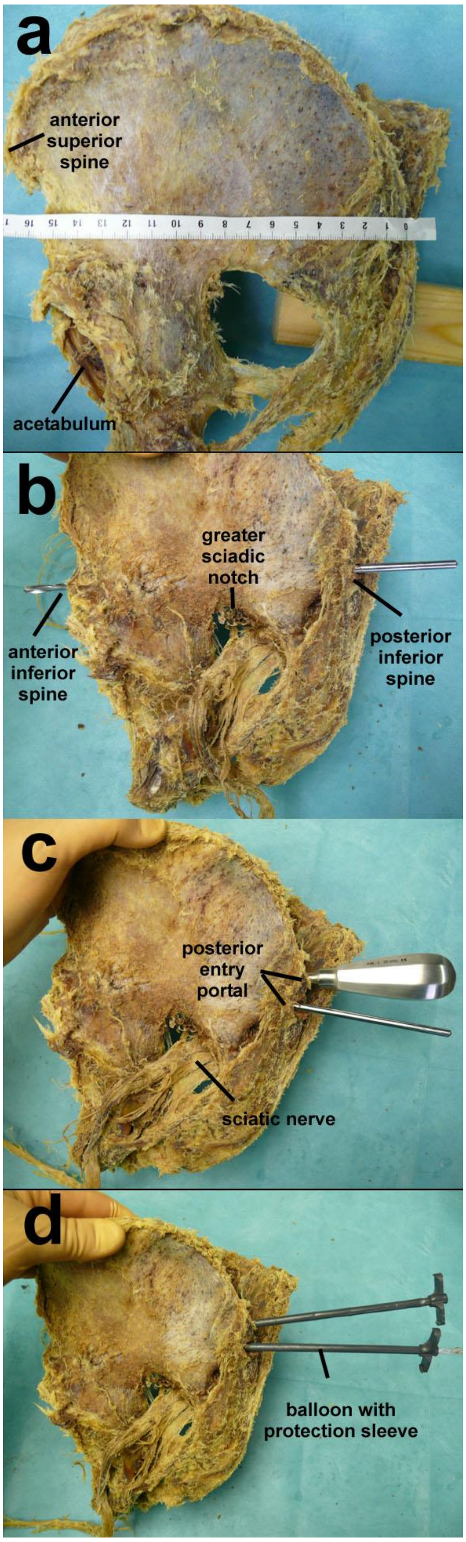

Figure 1: Lateral view of the hemipelvis **(a)** The sagittal diameter of the iliac wing cranial to the sciatic notch measures approximately 14 cm **(b)** The canal between the posterior superior spine and the anterior inferior spine has a straight geometry, indicated by the drill that enters the pelvis posteriorly and pierces the spine anteriorly **(c)** The possible posterior entry portals are demonstrated. The cranial hole is prepared by a pointed awl **(d)** The balloon are fully inserted with the protective sheath in place.

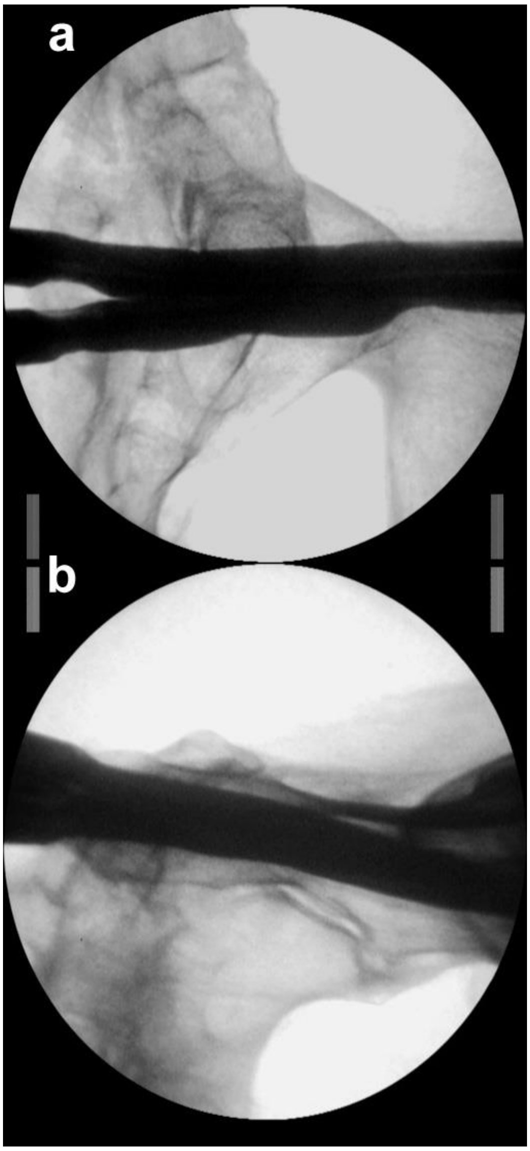

Figure 2: Hemipelvis (anatomical specimen) **(a)** Lateral view with two fully inflated balloons. Filled with a radiopaque fluid the expansion of the balloons can be demonstrated. Notably different from that of conventional metal implants, the balloons conform to the shape of the intramedullary canal and employ the total available space between inner and outer table of the iliac wing **(b)** Cranial aspect of the same specimen showing the position of the balloon and it´s relation to the sacro-iliac joint space.

Case Report

A 69-year-old male patient was brought to the hospital with widely disseminated metastases originating from a urothel carcinoma. At the time of his first presentation in the hospital, the patient was able to walk but reported about increasing pain in his left side pelvis during gait. To complete the clinical records a szintigraphy of the skeleton was conducted as well as a CT scan of the pelvis (**Figure 4 a,b**).

Figure 3: Hemipelvis with prepared canal. Axial radiological view at the canal with a drill projection as a dot proving its straight geometry. In this projection, the lateral wall of the acetabulum appears prominent and can be used as a landmark for intraoperative orientation.

The szintigraphy showed multiple metastases in the whole skeleton but the osteolysis in the left iliosacral region was most severe and responsible for the increasing pain.

One day before the planned surgery a sudden acute pain occurred at his left pelvis that made walking impossible and thus forcing the patient to be completely bed-ridden from that moment on.

The operation was performed the next day with the patient in a prone position on the operating table. A one cm skin incision was made after identifying the posterior entry portal according to the anatomical study. After opening the cortical layer with a pointed awl the two adequately sized canals (13 mm) towards the anterior inferior spine were carefully prepared gently passing the sacroiliacal located tumor mass (**Figure 5 a-c**). The two balloons (160 mm long / 13 mm diameter) were inserted controlling their position with the image intensifier and afterwards simultaneously inflated with monomer using standard infusion syringes. After curing the dorsally protruding part of the balloons were cut with a gigli saw plain with the bone surface. The patient recovered quickly being able to sit and walk short distance from the first postoperative day on with limited or no pain. He was discharged the second day after surgery. The wound healed uneventfully but showed initially a minor seroma that was treated by conservative means.

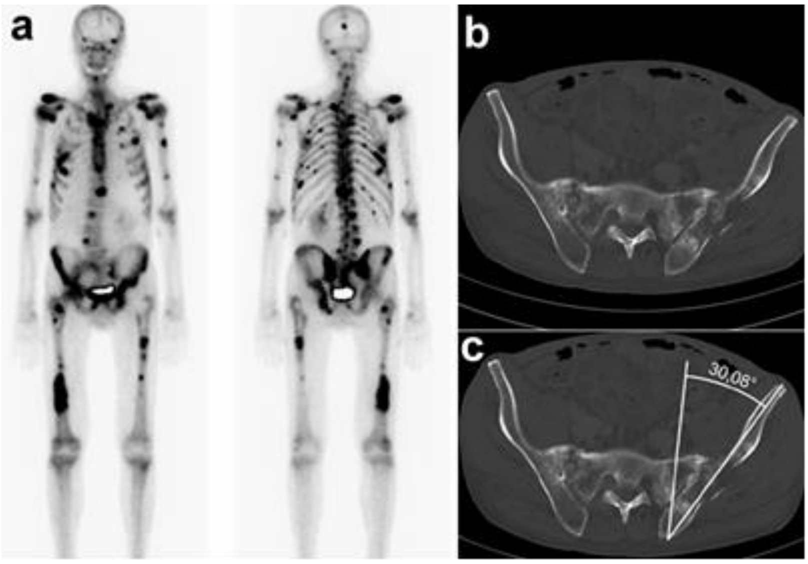

Figure 4: **(a)** Szintigraphy of a patient with disseminated metastases **(b)** Clinically the left side pelvis osteolysis appeared with severe pain and instability **(c)** According to the anatomical investigation (see above) the pelvic wing is orientated 30° externally rotated.

Discussion

Bone osteolysis and subsequent fractures due to disseminated carcinoma in the spine, pelvis and lower extremity are a common cause for early immobility in tumor patients. Whereas in long bone lesions intramedullary stabilization proved to be a reasonable surgical technique to maintain stability, there are no standard concepts to treat unstable tumor lesion in the pelvic girdle, nor to achieve intramedullary stabilization.

Augmentation techniques with bone cement are minimally invasive but emerged to be of use only in narrow boundaries and are likely fail in the presence of unstable fractures with extensive osteolysis. The use of plates and screws as a stabilizing technique proved to be a complex and therefore endangering surgical procedure that needs of major

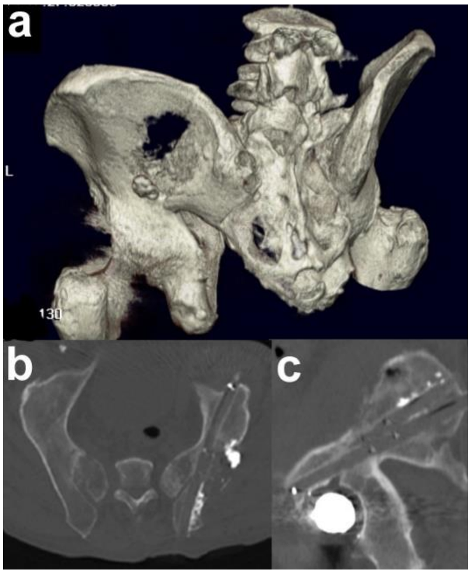

Figure 5: Postoperative CT scan of the pelvis **(a)** 3-dimensional reconstruction. Posteriorly the two entry portals are clearly visible **(b)** Axial section showing the position of the caudal IlluminOss rod. To enhance stability bone cement was injected percutaneously but failed **(c)** Sagittal view to visualize the converging arrangement of the IlluminOss rods.

extensive exposure and dissection of soft tissues with the risk blood loss and wound healing problems followed by prolonged hospitalization time and slow recovery. The above described techniques allows the surgeon to implant stable "rods" at the base of the iliac wing through a minimal invasive approach, providing sufficient stability to compensate for tumor related instability. The advantage of these implants is that they can be formed in situ according to the individual patients anatomy providing customized implant shapes and sizes The technique seems to be a renewing and promising approach to complicated lesions in areas where conventional metal implants fail. Further biomechanical studies on stabilization concepts in the pelvis are required to increase the evidence of the potential benefits of photodynamic bone stabilization systems for this specific indication.

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