Preoperative digital planning in adult developmental dysplasia of the hip

Clinical History:

A 64-year-old woman was investigated for surgical treatment of developmental hip dysplasia. Her complaint was bilateral hip pain and restriction in daily activities for the past two years. She had two deliveries and managed to compensate her disabilities before. The patient has short stature, hyperlordosis and equal lower limb length.

Imaging Findings:

Digital pelvic radiography (Fig. 1) revealed the Crowe type IV bilateral developmental dysplasia of the hip (DDH). [1] Radiographic imaging of the pelvis enabled virtual preoperative templating (Fig. 2), although preoperative planning needed more sophisticated imaging techniques. Multiplanar CT of the pelvis was performed to further investigate bone stock and perform morphometric measurements of bony landmarks of the pelvis and femora (Fig. 3) MDCT scan of the pelvis provided accurate position of dislocated femoral heads relative to real acetabuli (Fig. 4). Essentially, 3D-CT scan showed bilateral high unsupported posterior hip dislocation, with exact relation between deformed femoral heads, iliac wings and true acetabuli. On both iliac wings two neoacetabuli were found, indicating an evolution of hip dysplasia (Fig. 5).

Discussion:

Developmental dysplasia of the hip (DDH) may range from hardly detectable acetabular dysplasia to immensely malformed and highly dislocated hip.

The incidence of established developmental hip dislocation ranges between 1.5 and 20 per 1000 newborns. [2] Children whose parents had DDH are 10 times more prone to express DDH compared to their peers whose parents did not. [3]

Adolescent and adult DDH exists in two forms, those that were previously treated, and some that were left untreated, leading to premature hip osteoarthritis and groin pain. Almost 80% of total hip replacements (THR) performed in women and 15% in men are related to some degree to hip dysplasia. [4] Due to inefficient abductor musculature these patients limp or have a waddling (Trendelenburg) gait. [5]

Radiographic findings of DDH include shallow, mostly retroverted acetabulum and insufficient coverage of the femoral head, an increased femoral anteversion with shortened femoral neck and coxa valga. [6] Crowe classification is widely accepted in addressing THR for DDH, although frequently it is not a helpful tool for preoperative planning. [1, 7] It is based on the extent of proximal migration of the femoral head addressing the ratio between the vertical distance of interteardrop line and the femoral head-neck junction (b) and the pelvic height (a);
(type I < 50% subluxation or proximal dislocation <0.10; type II >50% and 74% subluxation or proximal dislocation 0.10 to 0.15, type III > 75% and 99% subluxation or proximal dislocation 0.16 to 0.20, type IV > 100% or complete dislocation >0.20). [1, 7] Eftekhar and Hartofilakidis proposed a radiologic classification depending on the grade of femoral head dislocation. The severity of DDH was divided into three and four stages, ranging from dysplasia to complete dislocation. [8, 9] CT studies confirmed a wide variety of deformities within the same Crowe grade. [10] MDCT provides valuable information regarding the type of deficiency and degree of acetabular dysplasia and may be used for 3D computerized preoperative planning. [11, 12] Preoperative digital planning has proven useful in joint replacement surgery allowing surgeons to choose an appropriate implant from the database [13, 14] The patient underwent one stage modular total hip arthroplasty of the right hip with subtrochanteric shortening and realignment osteotomy according to preoperative digital templating (Fig.6a, b). 

Take home message:
Digital preoperative planning in addressing total hip replacement in DDH improves the procedure's precision and its outcome, ensures the required implants are available, minimizing the costs and complications.

Differential Diagnosis List: Developmental dysplasia of the hip (luxatio coxae congenita bilateralis), none

Final Diagnosis: Developmental dysplasia of the hip (luxatio coxae congenita bilateralis)

References:
Description: Radiographic findings of Crowe IV bilateral DDH. True acetabuli are shallow and inferior to irregular, highly displaced femoral heads. In DDH B/A ratio varies from &lt; 0.10 in Crowe type I to &gt; 0.20 in Crowe type IV. [1] Origin: © "Department of Radiology, Clinical Center Kragujevac, Faculty of Medical Sciences University of Kragujevac/Serbia 2015"
Figure 2

Description: Digital radiographs of the pelvis demonstrating preoperative templating procedure and calculated transverse subtrochanteric shortening osteotomy using digital planning software. Origin: © "Department of Radiology, Clinical Center Kragujevac, Faculty of Medical Sciences University of Kragujevac/Serbia 2015"
Description: 3D reconstruction CT scan showed two shallow neoacetabuli on both iliac wings, indicating an evolution of hip dysplasia from low supported hip luxation to high unsupported hip luxation [8]. Origin: © "Department of Radiology, Clinical Center Kragujevac, Faculty of Medical Sciences University of Kragujevac/Serbia 2015"
Description: Axial CT of the pelvis demonstrated hypoplastic acetabuli with moderate increase in the right acetabular anteversion (21°) and normal acetabular anteversion (15°) of the left acetabulum. An angle &lt;15° is indicative of acetabular retroversion. [10] Origin: © “Department of Radiology, Clinical Center Kragujevac, Faculty of Medical Sciences University of Kragujevac/Serbia 2015”
Figure 5

Description: Postoperative radiographs of the pelvis, showing surgical placement of the modular total hip prosthesis with plate osteosynthesis of the subtrochanteric osteotomy. An implant position was analyzed by digital planning software. Origin: © "Department of Radiology, Clinical Center Kragujevac, Faculty of Medical Sciences University of Kragujevac/Serbia 2015"
Description: MDCT scan showed bilateral high unsupported hip dislocation with exact relation between posteriorly displaced, deformed femoral heads, iliac wings and true acetabuli. Origin: © "Department of Radiology, Clinical Center Kragujevac, Faculty of Medical Sciences University of Kragujevac/Serbia 2015"