Location of Hip impingement for Patients with Severe SCFE – 3D-CT impingement simulation

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Introduction
In situ pinning is the conventional treatment for a stable slipped capital femoral epiphysis (SCFE). However, with a severe stable SCFE the residual deformity may lead to femoroacetabular impingement (FAI) and articular cartilage damage. SCFE can result in complex 3D deformity and is the most common hip disorder in adolescent patients. But there are only few studies evaluating the exact effect and location of impingement using 3D CT scans.

Purpose/Questions The purpose of this study was to evaluate the benefits of using 3D impingement simulation for severe SCFE patients.

We asked (1) what is the hip range of motion in terms of flexion and internal rotation (2) where is the (2) acetabular and femoral impingement located in hips with severe SCFE using preoperative 3D CT scans.

Patients and Methods
A retrospective radiological study involving 3D CT scans of 20 hips of 17 patients with severe SCFE (slip angle >60°) was performed. Preoperative CT scans performed during this time period of patients with SCFE at the institution of the senior author were evaluated. Segmentation of preoperative 3D models of 20 hips with severe SCFE were performed. For each hip joint, a separate femoral and acetabular 3D model was segmented (Figure 1), resulting in 40 3D models to simulate hip ROM and location of hip impingement¹. Three patients (15%) had bilateral SCFE. The contralateral hips of the 15 patients with unilateral SCFE were used as a control group. Mean age was 13 ± 2 years and 67% were male patient. 86% of the patients had an unstable slip according to the Loder classification, 81% of the patients had a chronic slip. Specific software was used for semi-automatic 3D segmentation and for 3D impingement simulation, to calculate location of femoral and acetabular impingement. The equidistant method was used for 3D impingement simulation.

Results
(1) Range of motion in terms of flexion (26 ± 32°) was significantly (p<0.001) decreased in patients with severe SCFE compared to the contralateral side (102 ± 9°). Internal rotation in 90° of flexion (-23 ± 15°) was significantly (p<0.001) decreased in patients with severe SCFE compared to the contralateral side (18 ± 11°).

(2) Femoral Impingement in maximal flexion was located on 3 o clock in 40% of the patients with severe SCFE and did significantly differ (p<0.001) compared to the control group. In 90° of flexion (Figure 2) and maximal internal rotation, femoral impingement was located on 3 and 5 o clock in 40% of the patients with severe SCFE and did significantly differ (p=0.045) compared to the control group. Acetabular Impingement in 90° of flexion and maximal internal rotation was located on 12 o clock in 50% of the patients with severe SCFE and did significantly differ (p=0.029) compared to the control group.

Internal rotation in 90° of flexion was significantly (p<0.001) decreased compared to internal rotation in 0° of flexion for patients with severe SCFE.

Conclusion
Patient-specific 3D models for patients with severe SCFE facilitate diagnosis and surgical planning simulating the range of motion and location of impingement. Femoral impingement is mostly located anterior. This study could aid in preoperative planning and surgical decision making e.g. what kind of operation should be performed for patients with severe SCFE.

Reference