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Prevalence of femoral Retroversion of pediatric patients with Slipped capital femoral epiphysis using preoperative MRI with rapid 3D T1 VIBE Dixon

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Disclosures and Biography Till Lerch

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- > Medical School 2008-2014, Medical Doctor 2014
- MD PhD 2015-2017, physician-scientist, project title: Torsional deformities of the hip as a new entity of Femoroacetabular Impingement and Hip Osteoarthritis – from virtual simulation to improved patient outcome
- > Residency:
- > 2 years general surgery and orthopedics, 2 years radiology
- > Research fellowship Boston Childrens Hospital 2022
- Funding for this study: Swiss National Science Foundation

Related scientific Publications

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- > Automatic bone segmentation to generate MRI-based 3D models for impingement simulation
- Posterior Impingement simulation for patients with increased femoral version
- > Anterior Impingement simulation for patients with femoral retroversion

Increased FV and Femoral Retroversion



Normal femoral version:
 10 – 25°
 Tönnis et al, JBJS Am, 1999

- Increased femoral version:
 - Posterior Impingement
 - Extraarticular

> Femoral Retroversion:

- Anterior Impingement
- Extraarticular

Femoral Retroversion FV<0°





Lerch et al, American Journal of Sports Medicine, 2019

Increased FV and Femoral Retroversion

Increased femoral Version

Femoral Retroversion

Extraarticular Impingement



Impingement posterior ischiofemoral Impingement anterior subspine

Lerch et al, American Journal of Sports Medicine, 2019

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Femoral Retroversion



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- Impingement sim Anterior Test with 20° Adduction
- Anterior Impinger internal rotation a
- > Extraarticular sut



Lerch et al, American Journal of Sports Medicine, 2019

Anterior FAI with normal FV

FAI with decreased FV < 5°

Introduction

- SCFE is a long-known pre-arthritic hip deformity
- Severe SCFE show inferior and posterior displacement of the capital epiphysis.
- High risk for avascular necrosis of the femoral head (AVN)
- These deformities likely lead to Femoro-acetabular impingement (FAI) and premature osteoarthritis (OA).





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14-year old male patient with 10-year followup after modified Dunn procedure

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Femoroacetabular Impingement

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CLINICAL ORTHOPAEDICS AND RELATED RESEARCH Number 417, pp. 112–120 © 2003 Lippincott Williams & Wilkins, Inc.

Femoroacetabular Impingement

A Cause for Osteoarthritis of the Hip

Reinhold Ganz, MD*; Javad Parvizi, MD**; Martin Beck, MD*; Michael Leunig, MD*; Hubert Nötzli, MD*; and Klaus A. Siebenrock, MD*

Ganz et al, CORR, 2003 Dec;(417):112-20

Fig. 1A–D AP radiographs of (A) a normal hip and three forms of abnormalities associated with mild slipped capital femoral epiphyses called (B) "flattening," (C) the "bump," and (D) the "hook." Reproduced with permission from Harris WH. Etiology of osteoarthritis of the hip. *Clin Orthop Relat Res.* 1986;213:22.



Introduction: Cam - Impingement

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We investigated

- > mean femoral neck version,
- > mean femoral version
- > and prevalence of femoral retroversion
- > in patients with SCFE

Patients

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- > Design: Retrospective, controlled comparative study of 38 hips
- Inclusion criteria: bilateral pelvis MRI including the distal femoral condyles
- > 2 groups:
- Control group (18 hips) of contralateral hips
- SCFE group (20 hips)
- Patients 10-16 years of age without previous surgeries were evaluated.

Tannast et al, J Orthop Res. **2007** ;25(1):122-31. Steppacher et al, Clin Orthop Rel Res; **2015**, 473(4):1404-16

Patients



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- FV was measured using the Murphy method on rapid bilateral T1 VIBE Dixon MRI (01/2017-12/2021) Water-based images of the pelvis and knee.
- > FV was compared to the contralateral side.
- > All SCFE patients were treated surgically.
- Fifteen SCFE hips presented with moderate or severe slips and were treated with open surgery

Methods



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- Acquisition time less than 1 minute for 192 images of entire pelvis (45 seconds)
- > Slice thickness 1mm
- > TR/TE1/TE2, 3.94/1.27/2.5ms,
- > flip angle 9°
- > FOV of 312 x 400mm,
- > a matrix size of 175 x 320mm,
- > anisotropic voxel size of 1.2 x 1.2 x 1mm for 192 slices
- > Same parameters for knee images

Measurement of femoral version

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> T1 VIBE Dixon





$24-19 = 5^{\circ}$ of femoral version



Statistical analysis

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- > Test for normal distribution
- Independent T-test for mean femoral version
- > Chi square-test for frequency of femoral retroversion

Results



- Mean FV of SCFE patients (1±17°) was significantly (p<0.001) lower compared to contralateral side (17±14°).</p>
- FV of SCFE patients had a wider range from -42 to 35° (range of 77°) compared to contralateral side (-3 to 44°).
- Mean femoral neck version of SCFE patients (6±15°) was lower compared to contralateral side (11±12°).
- Ten SCFE patients (40%) had absolute femoral neck retroversion (femoral neck version<0°).</p>

Results

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- Eight SCFE patients (40%) had femoral retroversion (FV<0°), five of them had severe slips and two had mild slips.
- One patient (6%) of the contralateral side had femoral retroversion (FV<0°).
- Side-to-side difference of FV was high for SCFE patients (18±15°).

Limitations

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- > Small sample size
- Control group of unaffected hip of patients with unilateral SCFE
- Selective patient group from universitary center
 Limited generalizability

Summary



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- Preoperative MRI for SCFE patients showed femoral retroversion in more than one third of the patients and showed asymmetrically lower FV compared to contralateral side.
- > FV angles ranged widely and SCFE does not necessarily lead to femoral retroversion.
- Femoral retroversion was mainly prevalent in severe SCFE but also in mild SCFE.

Conclusion



Adding FV to the diagnostic workup of children with SCFE could help for diagnosis of femoral retroversion. Patientspecific analysis of FV may better inform surgeons to decide when to use isolated offset correction or to perform an additional femoral osteotomy for SCFE correction.

- > Outlook:
- Patient-specific bony MRI 3D models could be generated and used for collision detection software that may facilitate diagnosis of FAI and surgical planning for SCFE patients.



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MR-based 3D-models for SCFE patients for 3D Printing and patient-specific preoperative planning of hip preservation surgery

Bilateral Bone Segmentation

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Bilateral Bone Segmentation



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Poster @ ESPR 2022: MRI-based 3D Model

MR-based 3D-models for SCFE patients for 3D Printing and patient-specific preoperative planning of hip preservation surgery

Poster exhibition

Thank you for your attention

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