

Discussion

While children with DCD and those with CP share postural control impairments, their underlying neuromuscular patterns differ, suggesting distinct internal modeling deficits. The non-specific hip co-contraction in children with CP likely reflects a compensatory mechanism for reduced selectivity or spasticity. Conversely, the task-specific variability in children with DCD suggests a "noisy" internal model struggling to select and execute consistent motor plans. These findings warrant individualized, task-specific rehabilitation strategies tailored to these distinct neuromuscular profiles.

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Derotation osteotomies in adolescent femoral retroversion improve gait efficiency but do not reduce joint loads: A clinical case study

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Introduction to clinical case

Femoral retroversion is considered a potential risk factor for altered joint loading and the subsequent development of osteoarthritis [1-4]. Derotation osteotomies aim to restore transverse-plane alignment, normalize gait, improve hip range-of-motion, increase gait efficiency, and decrease joint loads [5-7]. However, evidence supporting the latter two aspects is limited [8].

We report longitudinal data of a female obese patient assessed at ages 13, 16, and 19 years across three data collection sessions, including computed tomography (CT) imaging, 3D gait analysis, and clinical assessments. The patient was initially referred due to a knee valgus deformity. Based on CT-confirmed femoral retroversion and tibial rotational deformity, altered gait kinematics, limited internal hip rotation during clinical assessment, and worsening between sessions 1 and 2, the medical team decided to perform a femoral (20° internal) and tibial (16° internal) derotation osteotomy. The aim was to improve bony alignment, gait kinematics, and reduce joint loads to prevent long-term secondary impairments such as osteoarthritis.

Methods

Overground, barefoot gait kinematic (Vicon, UK), electromyography (Cometa, Italy) and force plate data (AMTI, USA) were collected during three sessions (baseline, preoperative, postoperative). Clinical assessments included passive hip internal/external range-of-motion, as well as sparse CT imaging of the hip, knee, and ankle joints to quantify femoral and tibial torsion.

A novel workflow combining segmentation of sparse medical imaging, statistical shape modelling [9], and OpenSim Creator [10] was used to generate subject-specific musculoskeletal models (Fig. 1A) for each session. Dynamic electromyography-informed simulations [11] based on these models and the 3D gait data were performed to estimate muscle forces, joint loads, and metabolic cost of transport (COT, Bhargava model [12-13]).

Results

Body-mass-index increased from 29 kg/m² to 32 kg/m² and 38 kg/m² over the three data collection sessions. Dimensionless gait velocity, normalized to leg length [14], changed from 0.49 to 0.37 and 0.42, remaining below the healthy control (0.51).

Between the baseline and preoperative assessments, the patient's foot-progression-angle and hip external rotation increased and passive hip rotation worsened. Joint loads decreased, likely due to slower walking velocity. After derotation osteotomy, femoral alignment, passive hip range-of-motion, foot-progression-angle (mean -18° vs. -3° during stance phase), hip external rotation (-35° vs. -5°) and gait efficiency improved (Fig. 1B/1 C). However, hip joint loads changed little and medial knee loads increased. The medial-to-lateral condyle load ratio approached normal values (pre=1.27, post=1.43, healthy=1.41).

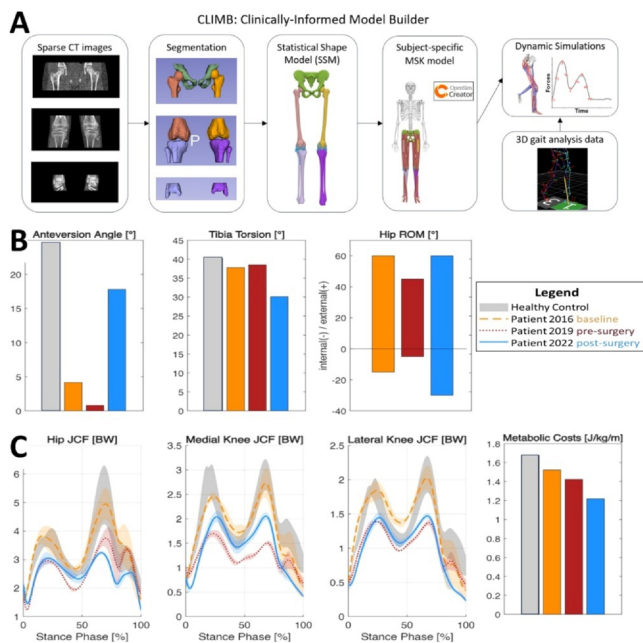


Fig. 1. A: Modelling workflow. **B:** Clinical measures. **C:** Simulation results. Data from the three session of the patient (colored bars and waveforms) as well as from a healthy sex-, age-, and height-matched control participant (grey bars/waveforms) are shown. MSK=musculoskeletal; JCF=Joint Contact Forces; ROM=Range-of-Motion.

Conclusion and clinical relevance

Derotation osteotomy improved gait kinematics and efficiency, but hip joint loads remained largely unchanged, questioning the link between femoral retroversion and increased loading. Knee load distribution normalized without reducing overall loads. Body weight-normalized joint loads were comparable or lower than in the healthy control, partly due to slower walking. The novel modeling framework demonstrates the value of integrating imaging, motion analysis, and musculoskeletal modeling to assess clinical outcomes.

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Effect of surgery on hip contact and muscle forces during daily activities and high-impact tasks in femoroacetabular impingement patients.

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