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POSTURAL CONTROL STRATEGIES IN ADULTS WITH ACHONDROPLASIA: NATURAL GROWTH VERSUS LIMB LENGTHENING

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1 INTRODUCTION

Achondroplasia is a rare genetic skeletal condition characterized by disproportionate short stature. Mature motor skills and healthy states are associated with an optimal amount of movement variability. Abnormal motor development or unhealthy states are less adaptable systems to perturbations [1]. Traditional biomechanical models of postural stability do not fully characterize the nonlinear properties of postural control [2]. This study investigated sway variability during quiet standing in adults with achondroplasia, comparing those with natural growth (NG) to those who underwent lower limb lengthening (LL).

2 METHODS

Sixteen adults with achondroplasia, mean age 37.2±13.6 years, among which 11 had normal growth (NG), while 5 undergone limb lengthening surgery (LL), performed bilateral standing tasks with eyes closed (CE) and eyes opened (OE) and in unilateral OE, with right foot (RF) and left foot (LF) support. Centre of pressure (CoP) data were collected using a Bertec® force plate. CoP sway linear measures as Amplitude (Amp), and Ellipse Area (Area) and nonlinear measures as Sample Entropy (SaEn) and Correlation Dimension (CoDim) were analysed in the anteroposterior (AP) and mediolateral (ML) directions. Between groups descriptive mean comparison and Mann-Whitney U test were applied for group differences analysis, presented by effect size (r_{rb}) Significance level was set at $p<0.05$.

3 RESULTS

Comparing with NG, the LL group exhibited amplified linear sway, indicating larger postural deviations and inferior Sample entropy and Correlation dimension, suggesting more rigid and repeated corrections. In the bilateral tasks, the mean Area_CE traversed by the LL group was 34.13 cm higher while Amp_ML was 1.99 cm and Amp_AP was 1.54 cm higher than those of the NG. In the unipedal tasks, LL presented even greater displacements and compared to NG, a higher difference of 13.11cm for transversed Area, 6.19 for Amp_ML and 4.36 for Amp_AP. Significant differences ($p<0.05$) between groups were found in six measures, mostly for the right

foot (dominant in 14 out of 16 participants): ToTex_AP_RF (r_{rb}=0.673), Amp_ML_CE (r_{rb} 0.745), Amp_AP_RF (r_{rb}=0.745), Area_OE (r_{rb}=0.782), SaEn_AP_CE (r_{rb}=0.673) and CoDim_ML_RF (r_{rb}=0.709).

4 DISCUSSION

Adults with achondroplasia who underwent limb lengthening demonstrated amplified yet more rigid sway patterns, suggesting overcorrections in alignment and proprioception that may hinder dynamic equilibrium reactions. In contrast, those with natural growth demonstrated more unpredictable and variability in movement corrections, characteristic of systems that retain some capacity to adapt [3].

5 CONCLUSIONS

These findings provide novel insights into the effects of limb lengthening on postural control in adults with achondroplasia, highlighting the need for targeted sensorimotor rehabilitation strategies and tailored training programs to address potential deficits in balance and adaptability in this specific subgroup of adults with achondroplasia. Initiating these rehabilitation programs after surgery the early as possible is most likely the best option, yet this needs to be investigated.

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