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The motor control of landing in young children: A pilot study

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1. Introduction

During childhood, children learn to build the complex voluntary responses necessary to land on the ground in a safe and stable way. In this pilot study, we aim to highlight child-specific motor adjustments related to height when landing from a jump. We hypothesized that the motor development of landing follows a cephalo-caudal direction, as observed in walking [1].

2. Research question

How does motor strategy evolve with age when landing from different heights?

3. Methods

Three children (aged 3, 7 and 9 yo) were instructed to jump and land from different heights (20, 30, 40 and 50cm). The vertical component of the ground reaction force (F_v) was recorded using force plates (Arsalis, 1000 Hz), and the maximal value of F_v ($F_{v\text{-peak}}$), the vertical displacement of the center of mass (S_v) and the lowest vertical position ($S_{v\text{-min}}$) of the center of mass of the body (CoM) were computed. In parallel, the joint angles (hip, knee, ankle) were recorded using a motion capture system (Qualisys, 250 Hz), and the range of motion (RoM) between ground contact and the maximal angular position was computed for each joint.

4. Results

The 3 children were able to land from 20 to 50cm without falling. $F_{v\text{-peak}}$ and $S_{v\text{-min}}$ increased with height. Greater $F_{v\text{-peak}}$ and $S_{v\text{-min}}$ were observed for the youngest child, compared to 7 and 9 yo. These age-related changes were concomitant with an augmented hip RoM and a diminished ankle RoM, whatever the height of the jump.

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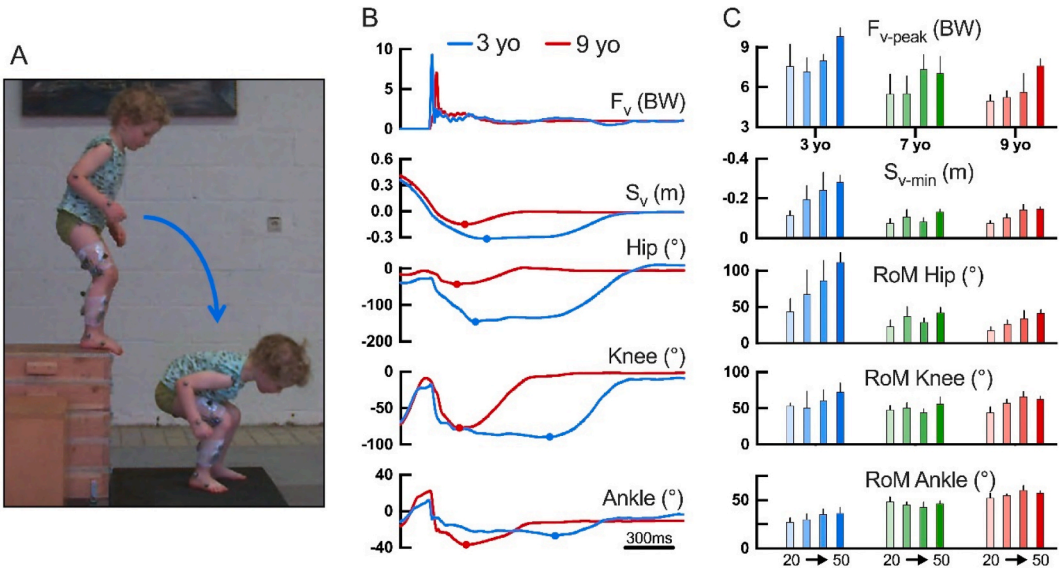

Fig. 1. A: 3 yo child landing from 50 cm; B: 3 & 9 yo typical traces (50cm); C: results (mean ± sd) as a function of age and height (3 yo: n = 3, 5, 5, 5; 7 yo: n = 5, 5, 5, 5; 9 yo: n = 5, 5, 5, 5).

5. Discussion

When landing from a jump, a safe strategy is commonly associated with a large CoM displacement (large triple flexion of the lower limb joints). This strategy is "expensive" as a large amount of muscular work must be performed. In contrast, a stiff strategy (limited triple flexion) is more economic but at the expense of other costs, such as pain or risk of injury [2,3]. Here we observed a specific behavior: the youngest child (3 yo) performing both large CoM displacement and ground impact. So, in comparison to older child (7–9 yo), his landing strategy is uneconomical and unsafe. This behavior could be related to the cephalo-caudal redistribution of movement control during childhood: augmented use of the ankle and diminished use of the hip with age. In the future, we plan to study this cephalo-caudal pattern redistribution in a large sample of children to describe more precisely their specific motor control of landing, in relationship with other skills such as balance.

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