

1. ANALYSIS OF WRIST AND FINGERS POSITIONS DURING WRITING IN PRESCHOOL CHILDREN

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Background: Learning to write legibly is a complex task of childhood and therefore it is not uncommon for problems to arise during this learning process. As a result, child may take a longer time to complete writing tasks or avoid handwriting tasks because it requires so much effort to produce text.

Purpose: The purposes of this study are to analyze the wrist extension angle and the metacarpophalangeal joint angle during writing in preschool children and to find a solution of improper writing way by designing a tool that helps child to write properly.

Methods: Fifty-eight preschool children were included in this study with a mean age of 5.8 (1.3) years. They were photographed using still camera and video camera while they were asked to perform a simple writing task. For the purpose of allowing each child to assume the usual writing posture, the analysis was done at each child's school and in the same classroom environment. The task required from each child was to draw shapes (circle, triangle, square). Two writing postures were performed and compared. The first one was writing using the usual posture assumed by the child (which was referred as incorrect grip). The second task was to write while using the correct penhold (referred as correct grip). The correct penhold grip (tripod grip) suggests that the index finger (not the thumb) should lead the writing process. The images of the two writing posture were analyzed and two angles were measured; the wrist extension (WE) angle and the metacarpophalangeal joint (MCP) angle. The WE angle was measured between two lines (1) dorsum of the radius and (2) dorsum of second MCP bone. The MCP angle two lines were (1) dorsum of second MCP bone and (2) first phalanx of the index finger.

Results: The results revealed that 53.4% of children assumed a significant ($p < 0.000$) more extended wrist angle 155.06° (10.98) while writing with corrected grip compared to incorrect grip (140.8° (13.03)). About 46.5% wrote with correct penhold with a

significant less ($p < 0.000$) WE angle (147.81° (10.82)) than the incorrect penhold (171.55° (17.56)). The majority of children (62%) wrote with less MCP angle (132.47° (21.35)) when holding the pen correctly. Holding the pen incorrectly produced a significant ($p < 0.000$) more MCP flexion than correct penhold. About 38% of children assumed the opposite compared to the majority 62% i.e. when they wrote with incorrect penhold, they assumed more MCP flexion angle than the correct penhold (143.6° and 127.18° respectively).

Conclusion(s): The majority of children in preschool period wrote with a more extended wrist joint and a less flexed MCP joint than writing with incorrect pen grip. The proper writing penhold angles were concluded to be $147\text{--}155^\circ$ WE and $127\text{--}132^\circ$ MCP flexion.

Implications: Identifying the proper wrist and metacarpophalangeal joint angles, help achieve ideal writing style. Industrial (interaction) designer should consider this interaction relation between hand and pencil by designing a suitable interaction tool or way to improve writing style.

Keywords: Preschool writing; Interaction design; Hand angles

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