

## The Effects of Modern Climbing Holds on the Finger Forces

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With the inclusion of Sport Climbing to the 2020 Olympics, understanding how competitive rock climbing affects the body is critical. Much of the biomechanical climbing research of the hand while hanging has involved simulated holds and postures, little research has looked at the effects of competition grade climbing holds. **PURPOSE:** To determine if changing the type of climbing hold affects the forces on individual fingers by looking at maximum normal and average normal forces on each individual finger, as well as the distance between the middle finger (MF) and ring finger (RF) center of force locations. **METHODS:** 19 subjects (9 climbers, 10 upper body trained) completed 2 second isometric hangs on 7 different climbing holds. Hold 1 and 2 (H1, H2) were slopers, 90° and 110°. Hold 3 and 4 (H3, H4) were pinches, one thin and one thick. Hold 5,6,7 (H5, H6, H7) were edges 60°, 75°, and 90°. Attached to each hold was a pressure sensing film that recorded both normal forces and center of force locations between the fingers at 67 Hz. Means and standard deviation were calculated for each of the four fingers (thumb excluded) and 2 two-way and 5 one-way repeated measures ANOVAs were run to compare fingers and climbing holds ( $\alpha = 0.05$ ). **RESULTS:** The MF had the greatest force across all 7 climbing holds, 103.64 N  $\pm$  1.58; then the pointer finger (PF), 125.98 N  $\pm$  2.15; then the RF, 96.26 N  $\pm$  1.30; and the pinky, 62.28 N  $\pm$  0.94. H1 had less maximum force than most other holds, with a difference in means (DIM) ranging from 15 - 24 N (p-value 0.000 - 0.038). H5 had a greater average force than H6, H7, and H4 with a DIM ranging from 11-13 N (p-value 0.028 - 0.080). For RF specifically, H5 had greater force than H1 and H7 with a DIM of 11 N and 22 N respectively (p-value 0.00 and 0.04). The COF distance between the MF and RF was less on H7 than H5 and H6 with a DIM of 0.58 cm and 0.68 cm (p-value 0.001 and 0.002). **CONCLUSION:** The findings of the study suggest that overall the climbing hold itself does not largely change the forces on the fingers; however, H5 did have a greater force than most other holds for both average and maximum forces. With the COF differences of the external forces for H7, the internal forces of the fingers may be affected by hold which could have clinical applications; this is an area needing further research.

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