EFFECT OF THE FINGER POSITION ON MAXIMAL FINGERTIP FORCE AND FATIGUE OF THE EXTRINSIC MUSCLES OF THE HAND DURING A SIMULATED ROCK CLIMBING GRIPPING EXERCISE

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INTRODUCTION

Actual rock climbing requires extreme forces on digital extremities. A fall occurs when the climber is unable to maintain the set of required fingertip force to hang on the holds. This is often associated to finger flexors fatigue. Rock climbers' grip techniques result from a variety of finger joint positions. The most common are the 'crimp' (CRI) and the 'slope' (SLO) positions (Schweizer 2001). This author shows that the maximum force at the middle fingertip is not significantly different for the 'slope' position in comparison with the 'crimp' position (82 N versus 78 N). However, this author did not monitor the forces applied by all the fingers concomitantly involved in the grip. Moreover, no fatigue experiments have been performed to assess fatigue associated to different rock climbing grip techniques. The aim of this experiment was to measure the effect of the finger joint position on the maximal fingertip force and fatigue rates of the extrinsic muscles of the hand in a simulated rock climbing gripping exercise.

METHODS

A total of 6 right hand-preferred male subjects took part in this study (age: 22 ± 1.4; height: 177.4 ± 4.5 cm; body mass: 65.6 ± 2 kg). They were elite rock climbers (French 8a or 5.13a Y.D.S on sight). Subject were sat on a chair. The wrist was fixed thanks to a mitten at 40° of extension in front of the hold. The hold consisted of a steel plate (100×20×3mm) fastened to the force sensor (*Slumberger, model CD-750, France*). The fingers gripped the hold on a one centimeter deep surface. The tests were conducted in the 'crimp' and 'slope' positions described by Schweizer (2001). Surface EMG activity of the hand extrinsic flexors (i.e. flexor digitorum superficialis and profundis, FDS and FDP) and extensor (i.e. extensor digitorum communis, EDC) was recorded.

The subjects performed three maximal isometric finger flexion contractions for 5s separated by a 5-min resting period. The highest peak force was adopted as maximal voluntary contraction force (MVC). After ten minutes rest, the subjects carried out twenty finger flexion contractions at 80% MVC during 5s followed by 5s of rest (Pitcher and Miles 1997). This protocol mimics the standard of actual difficult routes.

RESULTS

The comparison of the maximal fingertip forces indicated that the values did not present significant difference between the 'crimp' and the 'slope' position (P > 0.05). The maximum force amounted to 407 N (SD 26) in the 'crimp' position, whereas it equaled 434 N (SD 46) in the 'slope' position. After twenty contractions, the mean force amounted to 270 N (SD 43) in the 'crimp' position and 279 N (SD 61) in the 'slope position. No significant difference was noted between these values (P > 0.05).

Figure 1 illustrates the drop of f_{med} and the slopes of the line of best fit were indicated for each position. Negative mean f_{med} slopes were exhibited in each position, respectively –0.76 (SD 0.38) in CRI and –0.84 (SD 0.62) in SLO. The statistical comparison of these values did not indicate significant difference (P > 0.05).

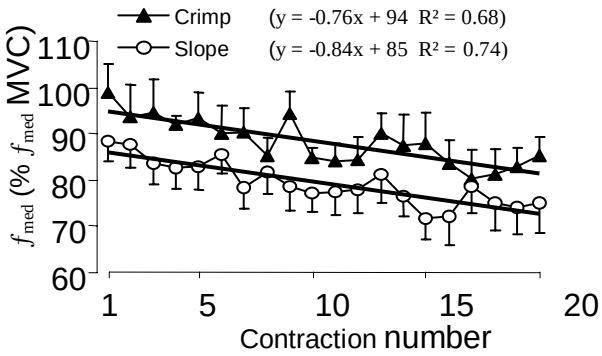

Figure 1: Mean time-related behavior of f_{med} across all subjects (n = 6) for the 'crimp' and 'slope' position. Regression linear lines are superimposed for each position.

DISCUSSION

Our results corroborate Schweizer (2001) findings since the resultant four-fingertip force does not change with rock climbers' grip techniques despite the subsequent biomechanical modifications. The practical consequence is that the use of the 'crimp' or the 'slope' position during climbing does not seem to depend on the intensity of the required external force, but rather on the characteristics of the hold (i.e. size and shape). The 'slope' grip is used when grasping wide or large handholds, whereas the 'crimp' grip refers to the use of small edges, regardless of the grip force amount.

The results concerning the muscular fatigue in the extrinsic flexors of the hand agree with several previous works (Petrofsky 1981; Blackwell et al. 1999). They indicate that repetitive intense contractions induce a decrease in the fingertip force. Additionally, they show that the finger position does not affect the fatigue rate. The similarity of the f_{med} slopes and the 20th force value for different finger positions illustrate this fact.

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