FATIGUE EFFECTS ON BAR KINEMATICS DURING THE BENCH PRESS

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INTRODUCTION

The kinematic patterns of the bar during a single lift bench press have been reported [1], however, there is no report of how bar movement changes as a subject performs multiple repetitions to failure. Multiple repetitions of an exercise are often used to train for a single exertion for example in powerlifting, or as means of training a particular muscle group. If the kinematics of the task change with increasing number of repetitions the specificity of the training must be questioned, as can its training effect on a particular muscle group. The purpose of this investigation was to examine the effects of fatigue on the movement of the bar during a free weight bench press.

METHODS

Eighteen male and female subjects were recruited after completion of a college level introductory weight training course. They had a range of maximal bench presses from 52 to 166% of body weight. All subjects were considered experienced recreational lifters. Maximal single repetition bench press load (1-RM) was determined, and then subjects were asked to perform as many repetitions as possible at 75% of 1-RM load. A Pro-Reflex motion analysis system was used to determine bar path during each trial. Subsequent processing of these data provided bar velocity, and the timings of key kinematic events. For each repetition the start of lowering was considered 0% of movement time, and the end of raising the bar 100% of movement time. Repeated measures ANOVA was used to compare across various metrics of bar path and trajectory across repetitions. Alpha was set at $p \leq 0.05$.

RESULTS AND DISCUSSION

Subjects were able to complete between 4 and 16 repetitions with 75% of their 1-RM load. All data are presented as the group mean and standard deviation for the first and last repetitions. The time to lower the bar (1.43 ± 0.54 s) and the distance the bar traveled in each lift (0.33 ± 0.04 m) remained nearly constant throughout the trials.

As the subjects progressed from their first to last repetition, several changes were observed. The time to lift the bar increased from 1.08±0.26 s to 2.38±0.66 s ($p<0.01$), which accompanied a decrease in average vertical velocity from 0.33±0.07 $m.s^{-1}$ to 0.15±0.04 $m.s^{-1}$ ($p<0.01$) and a decrease in peak vertical velocity from 0.46 ± 0.11 $m.s^{-1}$ to 0.25 ± 0.08 $m.s^{-1}$ ($p<0.01$). Most notably, the timing of the peak vertical velocity changed from occurring late in the lift phase (65 ± 15% of upward lift phase) to very early in the lift phase (18 ± 21% lift phase, $p<0.01$). This pattern change is illustrated in Figure 1.

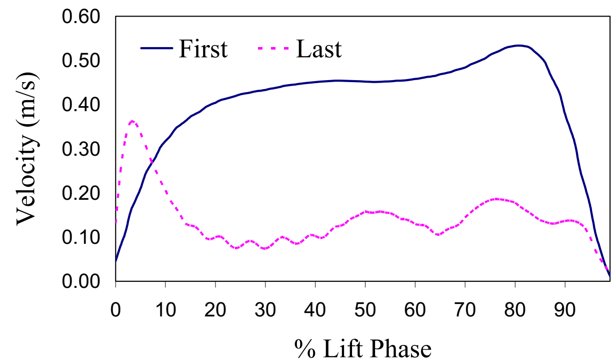

Figure 1: Bar vertical velocity for the lift phase of the first and last repetitions of a representative subject.

In the horizontal plane, subjects kept the bar more directly over the shoulder as the number of repetitions increased. The mean horizontal distance between the bar and the shoulder decreased from 0.108 ± 0.025 m to 0.073 ± 0.039 m ($p<0.01$) but change in maximal horizontal deviation of the bar from the shoulder was not found to be significant 0.142 ± 0.0027 m to 0.131 ± 0.030 m ($p=0.075$).

CONCLUSIONS

This study has demonstrated differences in bar path and trajectory over a set of free weight bench presses. These results have implications of the training effect of multiple repetitions of this exercise. The pattern of keeping the bar more directly over the shoulder during the later repetitions is believed to be a strategy to reduce the moment produced by the weight of the bar about the shoulder, as suggested by Madsen and McLaughlin [1]. Their study, however, looked at differences in single, maximal lifts between world and national caliber lifters. They found that the strongest lifters kept the bar closer to the shoulder. It is unclear why lifters would not use this strategy throughout all of the repetitions, unless the strategy used by the lifters is in some way distributing fatigue across the available muscles.

REFERENCES

1. Madsen N & Mclaughlin T. *Med Sci Sport Exer,* **16,** 376-381. 1984