ELECTROMYOGRAPHIC CHARACTERISTICS OF INTENTIONALLY SLOW, VOLITIONAL, AND MAXIMAL VELOCITY REPETITIONS OF THE BENCH PRESS EXERCISE

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Introduction

Repetition velocity is a training variable that can be modified to influence the resistance training stimulus, which may have significant influence on both acute (5) and chronic (3) performance characteristics. Previous work has demonstrated the influence velocity has on lifting kinetics and kinematics, with intentionally slow velocities yielding reduced force and power outputs (5). Recent work has demonstrated a relationship between intensity and motor unit recruitment, with lower intensity muscle actions not recruiting the same high-threshold motor units as high intensity muscle actions (4). As early adaptations are often attributed to neural aspects (1), understanding the influence velocity has on electromyographic (EMG) characteristics is warranted.

Purpose

The purpose of this study was to compare the EMG characteristics of the bench press under varying resistance training velocities.

Methods and Materials

- Recreationally trained males participated in this study (X±SD; n = 14, age = 24.0±3.9 yrs, height = 175.7±8.2 cm, mass = 89.6±13.4 kg, 1RM = 111.4±20.7 kg).
- ≥ 48 hours after 1RM testing, participants completed a bench press exercise protocol using 50% 1RM loads completed at varying velocities.
- Participants completed 3 single repetitions separated by 2 minutes rest at four different concentric velocities in a randomized order:
    - 3-second (3SEC), 1-second (1SEC), self-selected (SELF), and maximal velocity (MAXV).
- The eccentric phase was completed in 2 seconds for all repetitions.
- EMG electrodes (Delsys, Inc., Natick, MA) were attached to the pectoralis major, anterior deltoid, and triceps brachii.
- EMG amplitudes are expressed as relative percentages of the amplitude achieved during MAXV.
- A repeated-measures ANOVA analyzed differences in mean and peak EMG amplitudes of all muscles between conditions. For significant main effects and two-way interaction, partial eta squared effect sizes (η_p^2) are reported. For post-hoc comparisons, Hedges' *g* effect sizes are reported.

Table 1. Concentric mean and peak EMG data of the pectoralis major, triceps brachii, and anterior deltoid for the MAXV, SELF, 1SEC, and 3SEC conditions.

Condition	Mean Pectoralis Major	Peak Pectoralis Major	Mean Triceps Brachii	Peak Triceps Brachii	Mean Anterior Deltoid	Peak Anterior Deltoid
MAXV	1.00 ± 0.00	1.00 ± 0.00	1.00 ± 0.00	1.00 ± 0.00	1.00 ± 0.00	1.00 ± 0.00
SELF	1.03 ± 0.19	1.06 ± 0.31	0.98 ± 0.36	0.98 ± 0.36	0.93 ± 0.19	0.93 ± 0.21
1SEC^	0.77 ± 0.22	1.11 ± 0.32	0.75 ± 0.21	0.78 ± 0.20*	0.77 ± 0.17	0.83 ± 0.17*
3SEC^#	0.66 ± 0.22	0.75 ± 0.25†	0.62 ± 0.17	0.75 ± 0.17*	0.66 ± 0.20	0.73 ± 0.19*‡

Mean ± SD for mean and peak EMG data for the four experimental conditions normalized to MAXV EMG values. * indicates significant difference from MAXV for respective muscle. † indicates significant difference from MAXV and SELF conditions for respective muscle. ‡ indicates significant difference from 1SEC condition for respective muscle. ^ indicates significant main effect difference from MAXV and SELF conditions for mean EMG. # indicates significant main effect difference from 1SEC condition for mean EMG ($p < 0.05$).

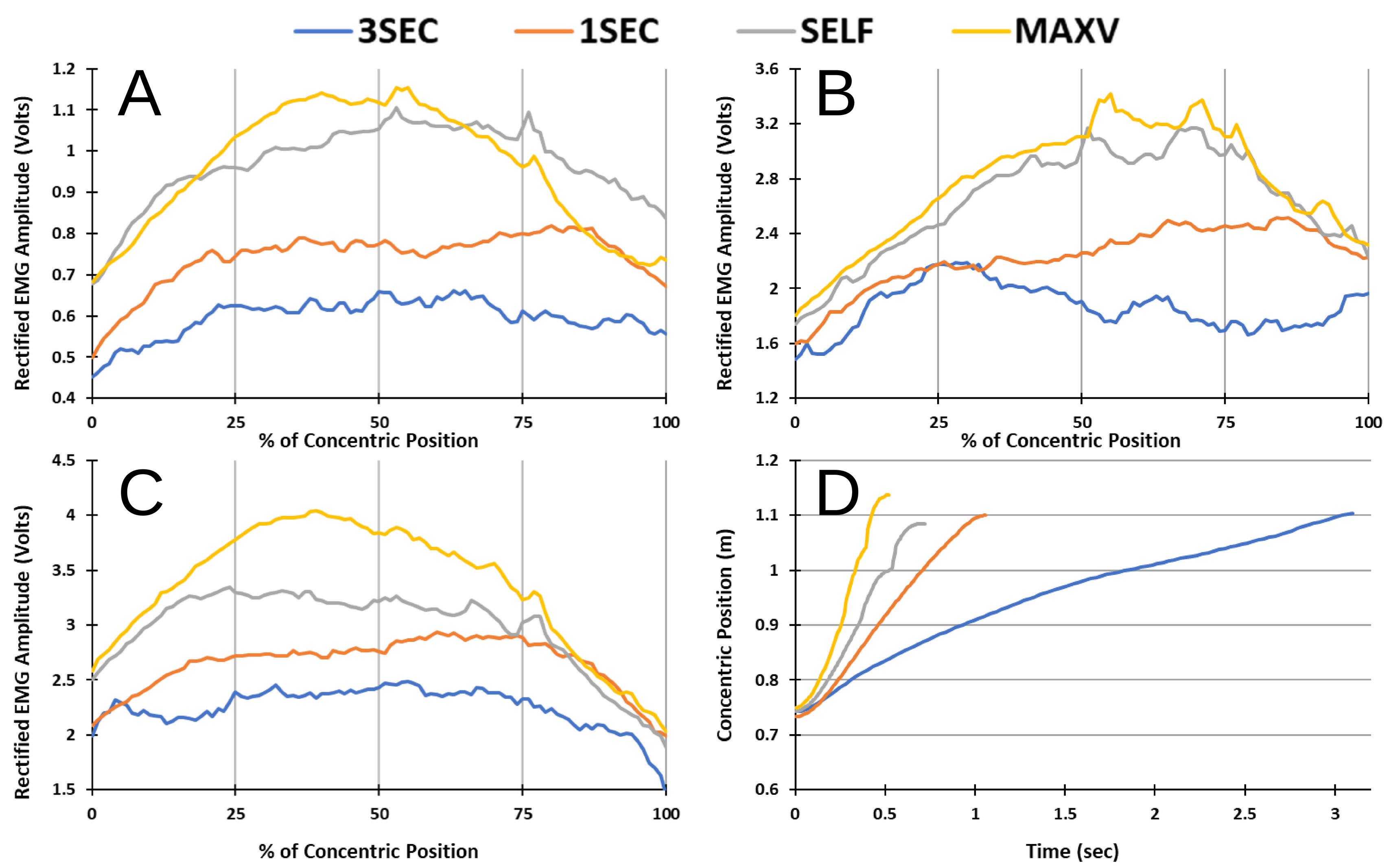

Figure 1. Rectified EMG curves across all participants for pectoralis major (A), triceps brachii (B), and anterior deltoid (C). Panel D displays concentric position-time curves for all velocity conditions, showing starting and ending positions relative to concentric time to completion.

Table 2. Mean velocity, concentric duration, and displacement for experimental conditions and 1RM.

	3 Second	1 Second	Self-Selected	Maximum Velocity	1RM
Mean Velocity (m/s)	0.12 ± 0.02^	0.35 ± 0.06*	0.56 ± 0.16*	0.81 ± 0.09*	0.15 ± 0.06^
Duration (sec)	3.12 ± 0.21^	1.05 ± 0.09*	0.71 ± 0.20*	0.52 ± 0.05*	2.82 ± 1.59^
Displacement (m)	0.36 ± 0.04	0.37 ± 0.05	0.37 ± 0.04	0.42 ± 0.05#	0.36 ± 0.06

Mean ± standard deviation ($p < 0.05$). * indicates significantly different than all other conditions. ^ indicates significantly different than 1SEC, SELF, and MAXV. # indicates significantly different than 1RM, 3SEC, and 1SEC. Table and data adapted from Hermes et al. (2).

Results

Mean EMG

- Main effect for condition ($p = <0.001$, $\eta_p^2 = 0.730$), but not muscle ($p = 0.827$, $\eta_p^2 = 0.013$)
- **MAXV and SELF greater than 1SEC ($p = <0.001-0.008$, $g = 0.998-2.698$) and 3SEC ($p = <0.001-0.001$, $g = 1.290-4.061$)**
- MAXV and SELF were not different ($p = 1.000$, $g = 0.108$)

Peak EMG

- A two-way interaction between muscle and condition was noted for peak EMG amplitude ($p = 0.002$, $\eta_p^2 = 0.217$)
- **Pectoralis Major**:
    - **3SEC lower than MAXV ($p = 0.010$, $g = 0.973$)**
    - **3SEC lower than SELF ($p = 0.008$, $g = 0.997$)**
- **Triceps Brachii**:
    - **MAXV greater than 1SEC ($p = 0.006$, $g = 1.037$)**
    - **MAXV greater than 3SEC ($p < 0.001$, $g = 1.420$)**
- **Anterior Deltoid**:
    - **MAXV greater than: 1SEC ($p = 0.011$, $g = 0.968$)**
    - **MAXV greater than 3SEC ($p = <0.001$, $g = 1.346$).**
    - **SELF greater than 3SEC ($p = 0.006$, $g = 1.036$).**

Conclusion

Despite constant load between conditions, intentionally slow velocities resulted in lower EMG amplitudes. Lower intensities (4) and velocities (6) have previously demonstrated lower motor unit recruitment, indicating different neuromuscular characteristics between faster and intentionally slow velocities. This may influence resistance training performance characteristics, with both lower acute performance (5) and lesser adaptation (3) with intentionally slow resistance training velocities.

Practical Application

As velocity appears to influence neuromuscular performance, coaches and practitioners must consider training velocity when force-velocity adaptations are desired. Intentionally slow velocities yield different recruitment strategies, impacting long-term adaptation.

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