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Original Research

Muscle Activation, Barbell Velocity, and One-Repetition Maximum Comparisons Between the Traditional and Swiss Barbell During the Bench Press

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Abstract

International Journal of Exercise Science 19(4): 4006, 2026. ***https://doi.org/10.70252/IJES2026406*** The purpose of this study was to compare electromyographical activation, barbell velocity differences at submaximal loads, and strength differences between the traditional (TB) and Swiss barbells (SB). Eleven college-aged males (age = 21.27 ± 0.65 yrs; stature = 178.41 ± 5.56 cm; body mass = 87.45 ± 13.41 kg) were recruited for this investigation. The first two sessions consisted of one-repetition maximum (1RM) testing with the TB or SB. The final session consisted of two sets (65% and 85% of 1RM) of three repetitions with each barbell. Surface electromyography (sEMG) and mean barbell velocity (MBV) were examined. A repeated-measures design was used to compare the effects of bench pressing with the two barbells on sEMG, MBV, and 1RM. A 2X2 repeated measures analysis of variance was used to examine differences in MBV and sEMG. Paired sample *t-tests* and Pearson correlations were used to examine the differences and relationships between 1RM for each barbell, respectively. A main effect was found for barbell type for sEMG of the lateral head of the triceps brachii ($\eta_p^2 = 0.66$, $p < 0.01$). Main effects for intensity were also found for all observed muscles ($\eta_p^2 \geq 0.51$, $p \leq 0.03$), apart from the latissimus dorsi. Further, a significant interaction between barbell type and intensity was observed for MBV ($\eta_p^2 = 0.54$, $p = 0.01$), with larger decrements in MBV observed in the SB across intensities. There were significant differences in the 1RM outcomes, with the TB having a higher 1RM compared to the SB ($p < 0.001$, $g = 1.26$). However, there was a strong positive relationship ($r = 0.96$, $p < 0.001$) between barbell 1RM values. Practitioners may consider using the SB to mimic sport-specific movements, decrease injury risk, and elicit similar muscle activation at lower absolute loads.

Keywords: Electromyography, barbell kinematics, strength, exercise selection

Introduction

The bench press is a common exercise prescribed by strength and conditioning practitioners and exercise specialists to develop strength, power, muscle hypertrophy, and muscular endurance.[1,2] This exercise is often performed using a traditional barbell (TB) with a pronated grip. Previous studies have identified associations between the bench press and other performance measures (e.g., total playing time and throwing velocity),[3–5] resulting in various professional athletic organizations using the exercise to assess upper-extremity muscle function (i.e., strength and

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endurance).[6,7] Although the TB is the most common barbell used for the free-weight bench press exercise, alternative barbells provide strength and conditioning professionals with the ability to vary how the bench press is performed to meet specific training aims.

The Swiss barbell (SB), which is composed of several handles at varied widths and grip angles, surrounded by a rectangular frame, is an alternative to the TB. The SB is unique in that it allows the lifter to perform the bench press using a neutral, or near-neutral, grip at varied widths. Further, the combination of neutral grip and rectangular frame reduce stability, which may contribute to changes in muscle activation, movement characteristics, and strength.[8] Thus, the SB presents as an option for strength and conditioning practitioners who wish to prescribe variants of the bench press; however, questions remain regarding how the SB may influence muscle activation, load-velocity relationships, and maximal strength compared to traditional training implements such as the TB.

It is known that factors such as grip orientation and width, and barbell stability influence muscular activity during pressing movements. For instance, a neutral grip has been demonstrated to influence muscle activation of the pectoralis major (PM) during the chest press exercise compared to a pronated grip.[9] Similarly, grip width in the bench press has also been shown to alter muscular activation, particularly in the triceps brachii, biceps brachii, and anterior deltoid (AD).[10–12] Further, grip orientation and the rectangular frame of the SB may contribute to greater instability than the TB, which could influence the activation of the musculature involved in stabilization (e.g., AD and latissimus dorsi [LD]).[13] Similarly, barbell velocity and strength may be influenced by the same factors. Indeed, maximal barbell velocity increases with a narrower grip, although maximal strength is reduced as grip narrows.[10,14,15] However, less is known on how a neutral grip, such as that which is used for the SB, may affect barbell velocity. Finally, barbell instability tends to decrease maximal velocity and strength during the bench press exercise.[8,16] These factors are inherent to the use of the SB in the bench press and therefore, the SB may elicit changes in muscular activity, barbell velocity, and maximal strength; however, it is unknown to what degree these performance variables differ compared to the TB.

Given that physiological adaptations are specific to the demands placed on the system, the ability to prescribe movements that more closely mimic athletic tasks stands as a useful tool for strength and conditioning practitioners to maximize performance. The SB may be a suitable bench press variation that better mimics sport-specific tasks. For example, pressing movements with the SB may more closely mimic athletic pressing movements where a neutral grip is functionally preferred such as the blocking techniques for American football linemen. Thus, it is necessary for those prescribing exercise with the SB to be aware of potential differences in muscular activity, barbell velocity, and strength. Therefore, the purpose of this study was to compare muscle activation and barbell velocity at submaximal loads and maximal strength differences between the TB and SB.

Methods

Participants

Eleven college-aged males were recruited and enrolled in this study. All participants were free of any musculoskeletal or cardiovascular impairment that could be exacerbated by physical testing. They were required to have ≥1 year of resistance training experience and be able to bench press

≥75% of their body mass with a TB. This research was carried out fully in accordance with the ethical standards of the International Journal of Exercise Science[17] and in accordance with the 1964 Helsinki declaration and its later amendments. All procedures were approved by the university institutional review board.

Protocol

The current study employed a repeated-measures design in which participants reported to the biomechanics laboratory on three occasions, separated by a minimum of 48 hours (all sessions were completed within ≤ 10 days). In the initial session, participant body mass and stature were assessed with a calibrated scale (Detecto® DR 400, Cardinal/Detecto®, Webb City, MO, USA) and stadiometer (SECA 213, Seca Ltd. Hamburg, Germany), and each participant completed a 24-hour dietary recall questionnaire. The first two sessions were counterbalanced and included a one-repetition maximum (1RM) test for either the TB or SB. Before the 1RM assessment, participants walked on a treadmill at a self-selected pace for 5-minutes and performed 10 repetitions of the following exercises: push-ups, band pull-a-parts, scapular pull-ups, and dumbbell front/lateral raises. The 1RM procedure followed NSCA guidelines[1] and all participants reached a successful 1RM within four attempts. In the final session, participants completed two sets of three repetitions with each barbell in the same counterbalanced order. The intensity for the first and second sets were 65% and 85% of the previous 1RM for each barbell, respectively.

During session three, surface electrodes were placed over the PM, AD, LD, and triceps brachii medial (TBM) and lateral (TBL) heads per *Surface EMG for Non-invasive Assessment of Muscles* (SENIAM) guidelines.[18] Before electrode placement, the skin was shaved, abraded, and cleaned with alcohol wipes. A Noraxon Ultium (Noraxon, Scottsdale, Arizona, USA) wireless system was used for surface electromyography (sEMG) data collection. Before performing the two sets of three repetitions, participants performed a maximal voluntary isometric contraction (MVIC) for sEMG normalization, with the TB fixed 3 inches above the chest, which is around the approximate sticking region of the bench press.[19] This position was selected to standardize testing across participants; however, the elbow angle at this position was not assessed, which may influence force output and sEMG amplitude.

During the third session, a linear position transducer (LPT; TENDO Sports Machines, Trencin, Slovak Republic) was attached to the barbell allowing for mean barbell velocity (MBV) assessment during the two sets for each respective barbell. Researchers instructed the participants to concentrically press the barbell as fast as possible while maintaining proper form. The intra-set average MBV (average MBV across three repetitions within each set) was used for analysis.

Raw sEMG signals were collected at 2 kHz and filtered through a fourth-order, zero-phase shift Butterworth filter with a 10-500 Hz bandpass.[20,21] The signals were rectified and smoothed (by root mean squared algorithm with a 100ms sliding window) and normalized to the MVIC.[22] The normalized peak sEMG amplitude was taken from all three repetitions and averaged for further analysis. All sEMG analyses were conducted through Noraxon Myomuscle software (Noraxon, Scottsdale, Arizona, USA). Due to technical issues, we were unable to analyze sEMG for one participant and sEMG for the PM of a second participant. Therefore, sEMG was analyzed in the muscles of interest for 10 participants except for PM (n=9). MBV was analyzed for 11 participants.

Statistical Analysis

To determine the minimum number of participants needed for this study, an a priori power analysis was performed using the G*Power (v3.1.9.7) software with a statistical power of 0.80, $\alpha = 0.05$, and a moderate effect size Cohen's f of 0.3 calculated from a previous study.[8] The power analysis revealed that eight participants would be needed to achieve statistical power. The current study included a sample size of 10 and 11 for sEMG and MBV, respectively. A 2 (barbell: TB and SB) by 2 (intensity: 65 and 85% of 1RM) repeated-measures analysis of variance (RM-ANOVA) was used to examine differences in MBV across both barbells. An additional 2 (barbell: TB and SB) by 2 (intensity: 65 and 85% of 1RM) RM-ANOVA was used to analyze the normalized sEMG for each muscle (PM, AD, LD, TBM, TBL). Bonferroni-corrected *post-hoc* analyses were used in the event of a significant omnibus effect. Partial eta squared (η_p^2) values were used to quantify the magnitude of the main effect, where values of 0.01, 0.06, and 0.14 were used to denote small, medium, and large effects, respectively. Effect sizes for pairwise comparisons were estimated using *Hedge's g (g),* where values of 0.15, 0.40, and 0.75 were used to denote small, medium, and large effects, respectively. Paired sample t-tests and Pearson correlations were used to examine relationships between 1RM for each barbell. Statistical significance was established a priori at $\alpha \leq 0.05$. All data were analyzed in SPSS (IBM Corp., v. 28.0.0.0, Armonk, NY, USA).

Results

Participant demographics and performance variables are summarized in Table 1. For sEMG, there was a statistically significant main effect for barbell type, albeit in the TBM alone (mean difference [MD] = 17.9; 95%CI=7.3, 28.5; $g = -0.39$), with the TB eliciting greater peak activation. Furthermore, significant main effects for intensity were observed for all muscles measured, except for LD. For the TB, higher peak activation occurred in the PM (MD = -20.5; 95%CI = -38.4, -2.6; $g = -0.87$), AD (MD = -15.9; 95%CI = -27.4, -4.4; $g = -0.81$), TBM (MD = -21.5; 95%CI = -36.0, -7.0; $g = -0.47$), and TBL (MD = -17.1; 95%CI = -25.3, -9.0; $g = -0.93$), when moving from 65 to 85% of 1RM. No statistically significant interactions between bar type and intensity were observed for any muscle. Model statistics for sEMG are summarized in Table 2.

Regarding barbell velocity, a significant interaction was observed for MBV where the decrease in velocity going from set 1 (65% 1RM) to set 2 (85% 1RM) was greater in the SB (MD = 0.29; 95%CI = 0.24, 0.34; $g = 3.62$) compared to the TB (MD = 0.23; 95%CI = 0.19, 0.26; $g = 4.16$). There were significant differences in the 1RM values between bars with the TB having a higher 1RM, compared to the SB (mean difference = 8.66 kg, $p < 0.001$). Despite the differences, there was a significant strong, positive relationship between the TB and SB 1RM values ($r = 0.961$, $p < 0.001$).

Table 1. Demographic and performance variables.

	Mean ± SD
Age (yrs)	21.27 ± 0.65
Stature (cm)	178.41 ± 5.56
Body Mass (kg)	87.45 ± 13.41
BMI (kg/m²)	27.15 ± 3.18
Traditional Barbell 1RM (kg)	109.07 ± 21.41*
Swiss Barbell 1RM (kg)	100.41 ± 21.18*

BMI – body mass index; 1RM – one-repetition maximum; TB – traditional barbell; MBV – mean barbell velocity; SB – Swiss barbell.
* Denotes significant difference in one-repetition maximum between barbells ($p<0.05$).

Table 2. MVIC Normalized Mean peak electromyography amplitude at 65% and 85% of one-repetition maximum for each barbell.

	Traditional Barbell		Swiss Barbell	
	65%	85%	65%	85%
Pectoralis Major	90.01 ± 22.23	109.62 ± 24.86	92.35 ± 22.54	117.27 ± 31.47
Anterior Deltoid	75.77 ± 20.42	91 ± 20.45	81.71 ± 14.44	98.3 ± 22.7
Triceps Brachii-Medial Head	99 ± 44.66	130.26 ± 52.63	90.89 ± 41.05	102.57 ± 42.95
Triceps Brachii-Lateral Head	88.12 ± 14.03	107.47 ± 25.95	87.3 ± 11.55	102.22 ± 18.69
Latissimus Dorsi	83.5 ± 28.92	97.66 ± 35.29	90.47 ± 35.71	96.14 ± 34.87

Data is presented as mean ± standard deviation. Mean data represents the average of 3 repetitions for each barbell at each intensity.

Table 3. Repeated measures analysis of variance for electromyography and mean barbell velocity.

Variable		Bar			Intensity			Bar*Intensity		
	n	*F*	*p*	η_p^2	*F*	*p*	η_p^2	*F*	*p*	η_p^2
Pectoralis Major	9	0.57	0.48	0.08	7.31	0.03	0.51	0.01	0.97	0.01
Anterior Deltoid	10	2.44	0.16	0.23	10.12	0.01	0.56	0.18	0.69	0.02
Triceps Brachii Medial Head	10	15.17	<0.01	0.66	11.66	<0.01	0.59	3.12	0.12	0.28
Triceps Brachii Lateral Head	10	0.25	0.63	0.03	23.64	<0.01	0.75	0.57	0.47	0.07
Latissimus Dorsi	10	0.25	0.63	0.03	3.46	0.10	0.30	1.53	0.25	0.16
Mean Barbell Velocity	11	0.01	0.99	<0.01	237.74	<0.001	0.96	11.88	0.01	0.54

η^2_p, Partial eta squared effect size (small effect = 0.01, medium effect = 0.06, large effect = 0.14).

Discussion

This investigation examined the electromyographical activation, barbell velocity, and strength differences between the TB and SB. There was a significant main effect in sEMG amplitude between barbells in the TBM alone. Unsurprisingly, there were significant increases in sEMG amplitude when moving from 65% to 85% of 1RM across both barbells for PM, AD, TBM, and TBL. Regarding barbell velocity, the MBV between the TB and SB were similar at the same relative intensities (i.e., 65% TB vs 65% SB and 85% TB vs 85% SB), and MBV for each barbell decreased similarly when intensity increased. Lastly, participants were significantly stronger (higher 1RM) using the TB, compared to the SB. However, there was an evident strong, positive relationship between the 1RM values when comparing both barbells.

The finding that muscle activation (sEMG amplitude) increases with external load for upper-extremity resistance exercise is in agreement with previous research.[23,24] For example, Schick et al,[24] found that the PM and AD sEMG amplitude was higher at 90% compared to 70% of 1RM for both the free weight and Smith machine bench press. An important consideration is the Smith machine and free-weight bench press have participants perform the exercise with a pronated grip, which is different than the neutral grip used with the SB and could alter muscle activation.[23] This is evident from research by Muyor et al,[23] who found differences in sEMG activity between a seated chest press machine with a neutral grip and a flat bench press with a pronated grip when performing 8-repetitions at 60% of 1RM. An important consideration of the previous study is the comparison between machine and free-weight exercises which could also influence sEMG activity. The SB and TB utilized in the current investigation allow for a comparison of a neutral and pronated grip on sEMG activity, barbell velocity, and strength in a free-weight bench press.

The increase in intensity from 65% to 85% of 1RM was associated with a significant decrement in MBV for both the TB (65%: 0.62 m/s versus 85%: 0.39 m/s) and SB (65%: 0.65 m/s versus 85%: 0.36

m/s) (Figure 1). This finding was similar to previous investigations examining the influence of external load on MBV during upper-extremity resistance exercise.[25,26] For example, Orange et al,[26] found that MBV decreased from .79 m/s to .39 m/s when moving from 60% to 90% of 1RM during the free weight bench press. In the current study, although there were no significant differences in MBV between barbells at 65% or 85% of 1RM, the decrement in MBV between intensities was greater with the SB. While the decrease in MBV was statistically greater for the SB as intensity increased, the difference may not be meaningful within the scope of strength and conditioning practice, as the MBV values at each intensity did not differ between bars. However, practitioners using specific velocity zones in their programming should be cautious when prescribing loads using the SB, as the decrement in MBV could be greater when performing multiple sets and repetitions (fatigue-inducing), as velocity could decrease and diminish program effectiveness. Additionally, practitioners should consider how familiar individuals are with using a SB when conducting 1RM tests to prescribe intensities and prescribing MBV values for training.

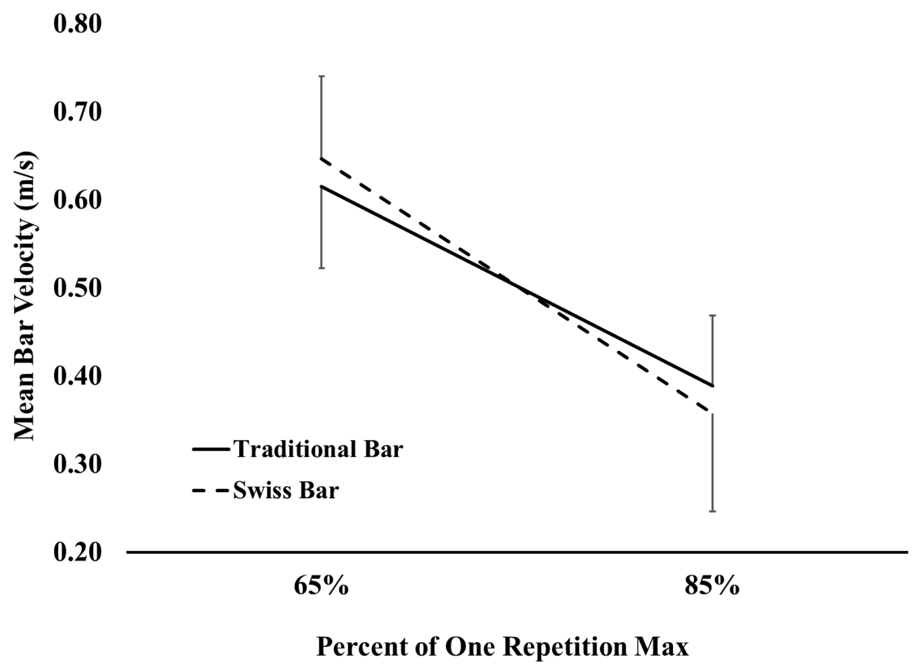

Figure 1. Mean barbell velocity for the traditional and Swiss barbells at 65% and 85% of one-repetition maximum.

The strong, positive relationship between 1RM values and significant differences in 1RM strength between barbells are in line with a similar investigation.[27] The authors examined differences in upper body strength between a traditional grip and close grip flat bench press in resistance-trained males.[27] They found significant positive relationships between traditional grip and close grip bench press 1RM strength (r = 0.982) with significantly higher loads being lifted with the traditional grip, compared to the close grip (mean difference = 5.84 kg, P<0.001).[27] Similarly, despite the strong positive relationship between TB and SB strength, participants in the current study were on average 8.66 kg stronger with the TB. Although reduced training experience with the SB may have contributed, it is unlikely to fully explain the lower SB 1RM, as previous investigations suggest maximal strength testing is generally consistent across training experience and familiarization status.[28] Thus, the lower SB 1RM likely reflects, at least in part, differences in mechanical demands between the two barbells. Additionally, our protocol implemented strength testing guidelines set by the National Strength and Conditioning Association.[1]

Although participants were significantly stronger (greater 1RM) with the TB compared to the SB (mean difference = 8.66 kg), there were no differences in sEMG at 65% and 85% between barbells suggesting similar muscle activation with lower external resistance for the SB, compared to the TB. This finding has a direct impact for practitioners wishing to elicit similar levels of muscle activation to the working musculature as it can be done with a reduced load, compared to the TB. Nevertheless, it is important to note that, unlike the TB, the SB has fixed handles and doesn't allow a customized grip width, which could have differing effects based on individual anthropometrics (e.g., biacromial width) and may also influence muscle activation.[23]

The SB elicited similar levels of muscle activation and barbell kinematics at relative intensities as the TB in recreationally trained males. However, participants were stronger with the TB compared to the SB, indicating that absolute load should be altered when transitioning between barbells to elicit desired training adaptations. Although there was a greater decrement in MBV when moving from 65% to 85% of 1RM, the decrement may not be meaningful in the scope of strength and conditioning practice. Future research should examine longitudinal changes in sEMG amplitude, MBV, and strength with the SB. Additionally, investigators should examine the differences between these barbells across other pressing variations (e.g., incline and military press).

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