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ORIGINAL ARTICLE

Eccentrically overloaded bench press training: Augmenting strength gains via a novel bench press pad

Phillip Goldman . *Airway and UC Fit Digital Health-Exercise Physiology Research Laboratory. David Geffen School of Medicine. University of California Los Angeles. Los Angeles, CA, United States of America.*
Baylor College of Medicine. Houston, TX, United States of America.
John Taylor. *Airway and UC Fit Digital Health-Exercise Physiology Research Laboratory. David Geffen School of Medicine. University of California Los Angeles. Los Angeles, CA, United States of America.*
Trent Yamamoto. *Airway and UC Fit Digital Health-Exercise Physiology Research Laboratory. David Geffen School of Medicine. University of California Los Angeles. Los Angeles, CA, United States of America.*
Chobanian and Avedisian School of Medicine. Boston University. Boston, MA, United States of America.
August E. Blatney. *Airway and UC Fit Digital Health-Exercise Physiology Research Laboratory. David Geffen School of Medicine. University of California Los Angeles. Los Angeles, CA, United States of America.*
Trinabh K. Sahni. *Airway and UC Fit Digital Health-Exercise Physiology Research Laboratory. David Geffen School of Medicine. University of California Los Angeles. Los Angeles, CA, United States of America.*
Ross J. Lechner. *Airway and UC Fit Digital Health-Exercise Physiology Research Laboratory. David Geffen School of Medicine. University of California Los Angeles. Los Angeles, CA, United States of America.*
Dominic M. Benna. *Airway and UC Fit Digital Health-Exercise Physiology Research Laboratory. David Geffen School of Medicine. University of California Los Angeles. Los Angeles, CA, United States of America.*
Matthew Bolton. *Airway and UC Fit Digital Health-Exercise Physiology Research Laboratory. David Geffen School of Medicine. University of California Los Angeles. Los Angeles, CA, United States of America.*
Vishruth Shatagopam. *Airway and UC Fit Digital Health-Exercise Physiology Research Laboratory. David Geffen School of Medicine. University of California Los Angeles. Los Angeles, CA, United States of America.*
Ethan Chen. *Airway and UC Fit Digital Health-Exercise Physiology Research Laboratory. David Geffen School of Medicine. University of California Los Angeles. Los Angeles, CA, United States of America.*
Jacob Bright. *Airway and UC Fit Digital Health-Exercise Physiology Research Laboratory. David Geffen School of Medicine. University of California Los Angeles. Los Angeles, CA, United States of America.*
Brett A. Dolezal. *Airway and UC Fit Digital Health-Exercise Physiology Research Laboratory. David Geffen School of Medicine. University of California Los Angeles. Los Angeles, CA, United States of America.*

ABSTRACT

This study examined the efficacy of a novel bench press pad (BPP) to improve 1-RM bench press strength during a 1-month eccentrically overloaded bench press regimen. Forty-two male participants with intermediate resistance training experience were randomized to novel bench press pad or traditional flat bench press (CON), with both groups making use of a novel connected adaptive resistance exercise machine to provide supramaximal eccentric overload. The groups completed identical, thrice weekly bench press training programs for one month (12 sessions). The observed increase in 1-RM between BPP and CON group was 7.3 kg ($p < .001$, g = 3.85), indicating a ~66% significantly greater increase in using the bench press pad. These results suggest that the use of a BPP on top of a conventional flat barbell bench press, as well as a CARE machine providing supramaximal eccentric overload, improve 1-RM bench press muscular strength in moderately trained, college-aged males.
Keywords: Performance analysis, Bench press, Muscular strength, 1-RM, Eccentric overload, Ergogenic aid.

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Corresponding author. *Airway and UC Fit Digital Health-Exercise Physiology Research Laboratory. David Geffen School of Medicine. University of California Los Angeles. Los Angeles, CA, United States of America*
E-mail: oldman.phil@gmail.com
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INTRODUCTION

The traditional flat bench press targets the pectoralis major, triceps brachii, biceps brachii, latissimus dorsi, deltoids, and scapula stabilizer muscles (Borges et al., 2018; Krol et al., 2010; Rodriguez-Ridao et al., 2020). This exercise is designed to enhance the stretch-shortening cycle (SSC), thus improving the potential for greater muscular pushing forces and power outputs. The resultant SSC force is manifested by the rapid cyclical transitions from eccentric-to-concentric contractions, which offer several advantages in sport performance or activities of daily living.

The active lowering of the bar to the chest during the bench press is primarily controlled by eccentric stretching and elongation of the pectoralis muscles, in addition to supporting musculature of the appendicular skeleton (Blazek et al., 2019; Coratella et al., 2020, Borges et al., 2022). At the terminal range of motion, an immediate high amplitude concentric muscular contraction of the pectoralis major and associated muscles propel the bar away from the chest (Borges et al., 2022). Here, forces are generated by a spring-like elastic stretch-shortening cycle (SSC), as well as a neurological or myotatic reflex response (Newton et al., 1997). While the elastic response is a classic result of transformed potential to kinetic energy, the myotatic reflex response results from an ascending neurological signal sent to the spinal cord as a response to the rapidly stretched pectoralis major and supporting muscles of the shoulder girdle (Newton et al., 1997). Upon reaching the spinal synapse, the neurological signal invokes a rapid descending response to the motor units of the stretched muscles, resulting in an explosive concentric contractile response from the pectoralis and supporting muscles (Newton et al., 1997; Wilcox et al., 2006).

Over the years, numerous lifting modifications have been made to the flat bench press to enhance and optimize the SSC; these include but are not limited to alternations in grip widths, bench press angle, and/or barbell design. Such changes have been reported to exclusively modify joint range of motion and muscular stretch, resulting in changes to muscle recruitment and activation patterns, (Daniels & Cook, 2017; Mausehund et al., 2022) greater acute and chronic bar velocity moments, and muscle power and strength outputs (Bloomquist et al., 2013; Kristiansen et al., 2021a; Król et al., 2010; Król & Gołaś, 2017; Pallarés et al., 2020; Schoenfeld & Grgic, 2020; Wilcox et al., 2006). Moreover, the increases in bar velocity and muscle strength/power outputs have been reported to translate into improvements in several functional sport activities (Newton et al., 1997; Wilcox et al., 2006).

Specifically, increases in elastic range-of-motion (ROM) of the pectoralis major during the descending phase (*i.e.*, eccentric) of the flat bench press has been a primary facilitator of greater movement velocity and muscular outputs of the concentric phase of the bench press(Calatayud et al., 2018; Martínez-Cava et al., 2022; Mausehund et al., 2022; Pallarés et al., 2020). However, due to the orientation of the scapula and the contour of the traditional flat bench, ROM at the scapulothoracic joint remains limited. This may restrict optimal bar displacement and limit force production. Thus, it is posited that modifications to the bench platform that alter or increase scapulothoracic joint ROM during the concentric phase of the bench press may result in greater force production and bar velocity.

Recently, the Launch Pad™ (Advanced Muscle Mechanics, Dallas, TX, USA), a specialty ergonomically designed bench press pad, has been designed to augment improvements in muscular strength and performance in standard bench press exercises. The Launch Pad ™, which rests under the thoracic spine and scapula, provides ergonomic support with the goal of correcting posture, addressing muscular imbalances, and transforming the bench press (with a barbell or dumbbells) into a more effective and safe exercise. It does so by enhancing scapular retraction and consequently increasing the range of motion of pressing movements while providing adequate lumbar and thoracic spine support. Furthermore, the addition of eccentric overload by way of a novel connected adaptive resistance exercise (CARE) machine (Vitruvian Form; Perth, Australia), which utilizes an adaptive supercharged electro-magnetic motor to overload the eccentric phase of the movement may serve as an additional stimulus for muscle growth and increased gross power output (Walker et al., 2016).

The purpose of the study was to evaluate Launch Pad ™ as an ergogenic aid for flat bench-pressing, in combination with a 1-month eccentrically overloaded workout using a CARE device, to augment improvements in 1-RM muscular strength for the bench press exercise.

METHODS

Participants

Forty-two apparently healthy male participants from southern California volunteered for this study. Inclusion criteria included individuals of 18-27 years of age with a history of resistance training 2-3 workouts/weekly over the past 12 months (*i.e.*, intermediate skill). Exclusion criteria included the presence of any significant medical diagnosis such as musculoskeletal, cardiovascular, metabolic, pulmonary, and/or other disorders that limit the ability to exercise or increase the risk of adverse cardiovascular events while exercising. Screening for the use of any performance enhancing drug known to enhance anabolic responses was also used for exclusion purposes. All exploratory participants from UCLA provided written informed consent while ethical approval was obtained from UCLA (IRB: 11-003190). Off-site participants provided written informed consent and single IRB (sIRB: BRANY, NY, USA) approval. Research practices were conducted in accordance with the ethical principles documented in the Declaration of Helsinki. Participants completed a pre-participation physical activity readiness questionnaire (PAR-Q) and an exercise history questionnaire. Sample size of n = 42 was calculated based on a priori power analysis using the 1-RM bench press reported from an unpublished exploratory study using 5 resistance-trained, collegiate-aged males of similar design in our research laboratory assuming $a = 0.05$ and $B = 0.20$.

Study design

This was a 4-week, single-blind, randomized control trial using a parallel research design. An investigator, independent of the recruitment of participants, used an online-generated random number program to randomly place participants 1:1 into one of two groups: the intervention, using a novel bench press pad (BPP) or the control, only using a traditional flat bench press (CON). Allocation was concealed with the use of consecutively numbered envelopes. The participants performed eccentric overloaded flat bench press exercises using a motorized resistance device thrice weekly for 4 weeks (i.e., for a total of 12 sessions). To prevent confounding, participants were asked to (*i*) refrain from additional resistance-type or high-intensity anaerobic training for the duration of the study and (*ii*) dietary intake and macronutrient portions were not controlled apart from not using a dietary supplement. All assessments and training sessions were monitored at an off-site training facility that employed one researcher consulted under the guidance of the lab director at UC Fit Digital Health - Exercise Physiology Research Laboratory at UCLA.

Flat Bench Press: Bench Press Pad (BPP) vs Traditional Bench (CON)

Both groups used a standard flat utility bench (Flat Utility Bench 2.0, Rogue Fitness, Columbus, OH, USA) weighing 49lbs, with a 2x3” 11-gauge steel construction, polyurethane foam pad, and a pair of angled, wide-set legs for maximized stability.

The bench press pad (BPP), Launch Pad™, is made of durable, rigid, high density polyurethane foam with black anodized aluminium construction (30" L x 12.5" W x 3" H, weight 22 kg) with an adjustable lumbar that straps to the top of most Olympic and competition benches as well as OEM standalone benches (stationary and adjustable). Per company website, it provides a stable, ergonomically-sound base that optimizes movement mechanics, supports proper posture and reduces the impact on joints.

For the chest press exercise, a connected adaptive resistance exercise (CARE) machine (Vitruvian Form Trainer+, Perth, Australia) that employs the use of a supercharged electro-magnetic motor along with a cable-drawn mechanism allowing for both concentric and eccentric movements, was laid beneath the bench (Figure 1). During the exercise, participants exert force against the cables, loaded between 0-100 kg per cable in real time at 50 Hz, as the winches retract them. The machine-learning device utilizes neural networks and other classification algorithms to constantly adjust the resistance based on velocity, force, and displacement during the movement and can make minor adjustments to the load, ensuring the user is performing at their maximal load (Nuzzo et al., 2023; Yamamoto et al., 2023).Furthermore, the device was able to accentuate eccentric loading up to 150% of concentric loading while maintaining concentric loading.

Figure 1. CARE machine assembly with flat utility bench and bench press pad (Launch Pad™) ensemble.

Supervised, periodized, training with and without a bench press pad

The 4-week training provided to all randomized participants integrated portions of an evidenced-based program effective for increasing muscular strength in the chest muscles (Yamamoto et al., 2023). Table 1 describes the progressive overload workouts performed – which took approximately 20 min, three times weekly on non-consecutive days for 4 weeks (12 sessions).

Positioning on the flat utility bench using the bench press pad was normalized by following the company's user manual. All trials were performed with a standardized hand position on the bar of ~150% of the participants bi-acromial distance (Krzysztofik et al., 2020). For both groups, emphasis was enforced for a stable, supine position on the bench with the hips, gluteal complex and feet maintaining continuous contact with the bench and floor, respectfully, throughout the full range-of-motion of the exercise.

The CARE bar was lowered until contacting the chest. Then, without bouncing, an immediate press upwards toward full elbow extension was performed. All the while a consistent tempo of approximately two seconds for the eccentric phase and one second maximum speed for the concentric phase was maintained. The CARE machine was set so that every repetition performed had accentuated eccentric loads at 1:1.5 (or 150%) of the pre-set concentric load. For example, if a participant was asked to perform a 100 lb. bench press - the concentric phase during pressing from the top of the chest would be 100 lb. with the CARE machine automatically increasing the eccentric phase load to 150 lb. once the bar stopped at the top of full elbow extension. After the weight was lowered back to the top of the chest, the machine would automatically de-load the resistance to 100 lb. again. This was repeated for all repetitions.

A trained research associate supervised each workout, spotted and monitored the lift sequence to ensure safety, verbally assisted the participant with maintaining a controlled bar speed (Krzysztofik et al., 2020), and recorded workout data and training compliance. Per-cable resistance was initially set to 70% of the participants' calculated 1RM. Each session consisted of a systematized warm-up before performance of flat bench press movement. Per-cable resistance was increased by 5-10 lbs. per week to incorporate standard progressive overload principles (Table 1).

Table 1. 4-week bench press volume-load regimen.

Warm-Up:	**Details:**
• 5 mins light jog on treadmill. • Personalized upper body stretching with resistance band.	• Treadmill: 3 mph, 0% incline. • Resistance band exercises targeting pectoralis major, deltoids, rotator cuffs.
Bench Press:	**Details:**
• Wk #1, sessions 1-3: 5 sets x failure @ **70%+ 1RM.** • Wk #2-4, sessions 4-12: 5 sets x failure **@ 70%+ 1RM** plus 10 lb. each week.	• CARE mode: Accentuated eccentric loads at 1:1.5 (or 150%) of the pre-set concentric load. • Each set performed to volitional failure **(reps per set recorded).** • Mandatory 3-5 mins rest allowed between sets.

Testing procedures

All participants were measured for anthropometrics and 1-RM muscular strength of flat bench press at baseline and post-4-week training. Participants completed a familiarization session during which bench press protocols were practiced until participants were confident. To ensure accuracy, reliability and consistency in test administration, all pre-and post-testing occurred in the same location and time of the day (*i.e.*, early evening to optimize diurnal effect on strength) by the same investigator:

Anthropometric measures

Body mass and Height

Body mass and Height: Body mass was measured on a calibrated medical scale (accuracy ±0.1 kg), and height was determined using a precision stadiometer (Seca, Hanover, MD, United States; accuracy ±0.01 m). In a fasted state and after voiding their bladder, participants were instructed to remove unnecessary clothing and accessories prior to being weighed, as well as remove their shoes prior to taking height measurements.

Body composition

Body fat percentage was measured using a validated octipolar, multi-frequency, multi-segmental bioelectrical impedance analyser (BIA) (InBody Co., Seoul, Korea Republic) (Dolezal et al., 2013). To ensure accuracy, participants adhered to standard pre-measurement BIA guidelines recommended by the American Society of Exercise Physiologists (Heyward, 2001). Briefly, the test was performed after at least 3 hours of fasting and voiding, with participants instructed to remain hydrated and not exercise 2 hours before testing. After investigators explained the procedure, the participant stood upright with their feet on two metallic footpads while holding a handgrip with both hands. The instrument measured resistance and reactance using proprietary algorithms.

Primary outcome measure

1-RM Bench press muscular strength

Upper-body isotonic muscle strength was measured by determining 1-repetition maximum (1-RM) of a free-weight flat bench press using standardized procedure (Grgic et al., 2020). The 1-RM is defined as the highest weight lifted through one full range of motion after reaching volitional or momentary failure. Briefly, subjects performed a light warm-up including whole body exercise on a treadmill or cycle ergometer, followed by light stretching. Participants were allowed several practice trials of bench press with minimum resistance to ensure good form, full range of motion, and adequate breathing technique. The resistance was progressively increased by trained researchers following standard procedure, leading to an attempt to complete 1–2 repetitions at a load estimated to be near maximum. Subsequently, the participant rested for 2 minutes and then attempted to achieve the 1-RM. For each 1-RM trial, participants attempted 2 repetitions. If participants were able to complete 2 repetitions, they were given a 2-minute rest, and the load was increased. If participants failed the 1-RM attempt at the given weight, 2-minute rest was provided, and the load was decreased to the midpoint between the last successful lift and the failed lift.

Statistical analysis

Statistical analysis was performed in SPSS v27.0 (IBM, NY, USA). Descriptive statistics are presented as mean ± standard deviation (SD). Statistical significance was determined based on $\alpha = .05$ and all tests were two-tailed. Continuous variables were first assessed for normality via Shapiro-Wilk tests. Within-group comparisons at baseline and after 4 weeks for the primary outcome measure, 1-RM bench press muscular strength, were made by paired *t*-tests and Wilcoxon signed-rank tests for normally and non-normally distributed variables respectively. Changes between groups after one month of training were made by Welch's *t*-tests if data were normally distributed and Wilcoxon rank-sum tests if data deviated significantly from normality. A Holm-Bonferroni correction to control the familywise error rate was applied. Effect sizes were measured by Hedges' *g*.

RESULTS

All forty-two male participants successfully completed the 4-week training program with no missed sessions. No significant differences in age, height, body mass and body fat percentage were detected between groups at baseline and within groups from baseline to one-month post-training. Both groups demonstrated significant increases in 1-RM after 4 weeks (both $p < .001$), with the BPP group showing a significantly greater increase compared to the CON group ($p < .001$, $g = 3.85$) (Table 2).

Table 2. Anthropometrics and 1-RM muscular strength at baseline and after 4 weeks training for all participants.

	CON (control; n = 21)			
	Baseline	4 Weeks	Δ	*p*-within†
Age (yr)	23.5 ± 1.4	-	-	-
Height (cm)	179.2 ± 5.7	-	-	-
Body mass (kg)	84.5 ± 5.7	84.0 ± 3.4	-0.5 ± 2.9	.833
Body fat (%)	11.7 ± 4.1	11.8 ± 4.6	-0.1 ± 2.9	.889
1-RM bench (kg)	98.1 ± 4.5	109.2 ± 6.7	11.1± 2.4	<.001
	BPP (intervention; n = 21)			
	Baseline	4 Weeks	Δ	*p*-within†
Age (yr)	24.2 ± 1.8	-	-	-
Height (cm)	180.4 ± 6.4	-	-	-
Body mass (kg)	83.1 ± 6.5	83.3 ± 5.0	0.2 ± 3.1	.922
Body fat (%)	12.2 ± 5.0	12.1 ± 4.2	-0.1 ± 2.5	.917
1-RM bench (kg)	97.4 ± 6.1	115.8 ± 5.0	18.4 ± 4.3	<.001
	***p*-between†**	**Hedges *g***		
Age (yr)	-	-		
Height (cm)	-	-		
Body mass (kg)	1.000	-		
Body fat (%)	1.000	-		
1-RM bench (kg)	<.001	3.85		

Note. Values are mean ± SD. No significant differences were observed at baseline between groups. 1-RM = one repetition maximum; †after correcting for multiple comparisons.

DISCUSSION

The present study is the first to examine the efficacy of a novel bench press pad applied in conjunction with a motorized, eccentrically overloaded resistance platform in augmenting bench press muscular strength over one month of training. The observed increase in 1-RM between the BPP and CON group was 7.3 kg (*p* <.001), indicating a ~66% significantly greater increase in BPP. While the exact mechanism by which the intervention improves performance is unclear, we propose improvements may be attributed to enhanced glenohumeral and sternoclavicular stability conferred by the BPP. By increasing the pressing range of motion via scapular retraction, while reinforcing the axis through greater lumbar support, greater muscular stimulation and utilization may be achieved. Important to note, however, is that the addition of eccentric overload through the CARE machine serves as an additional stimulus aimed to maximize gross strength improvement throughout the study duration. Therefore, these findings may also suggest a synergistic effect between the BPP and the CARE machine training protocol.

While the effects of scapular hyper retraction applied to the flat barbell bench press have not been elucidated, there is notable data regarding load alleviation on the rotator cuff and glenohumeral joint. Specifically, retracted scapulae significantly decrease the total glenohumeral reaction force, resulting in lower glenohumeral compression and glenohumeral posterior shear force components, decreasing the total acromioclavicular reaction force (Noteboom et al., 2024). Placing the scapula in a retracted position decreases load on the rotator cuff, a key functional purpose of the BPP, making the flat barbell bench press a safer movement.

The present study's results are also consistent with the overarching body of literature on eccentrically overloaded training methodology. Kristiansen et al., found supramaximal eccentric overload delivered significant performance improvements as well as greater strength gains in the flat barbell bench press. Notably, accentuated eccentric overload have also been linked to greater eccentric muscle activation, improved concentric velocity, and more rapid muscle fatigue (Taber et al., 2021). The novel BPP may provide a framework for anatomically optimal bench-pressing technique characterized by improved stability, joint centration, lumbar support, and scapular hyperflexion. Consequently, pectoral utilization becomes more achievable and further augmented by an eccentrically overloaded resistance pathway.

It is important to note that there is a conflicting body of evidence regarding the efficacy of a partial versus full range of motion (ROM) in stimulating muscle growth and increasing strength performance - those of which are a key function of the BPP under examination. Through scapular hyper retraction, increased lumbar support, and active postural correction, the BPP enables a greater pressing ROM by reducing stress on the glenohumeral and acromioclavicular joints, increasing overall safety of pressing movements. A study conducted by Martinez-Cava et al., supports this functionality, finding that a full ROM bench press is the most effective training variation for neuromuscular adaptations in recreational and well-trained men. Alternatively, Massey et al., 2004[11] not observe any significant differences in the one-rep max of the full, partial, and combined ROM groups over a 10-week program, suggesting that ROM was not a significant factor in driving strength gains and hypertrophy.

The limitations of the present study include a small, homogenous sample size and a relatively short training duration, which may limit the generalizability of the findings and the ability to assess long-term effects or variations across a broader, more diverse population. A key strength of the study was its use of a randomized controlled trial design, which minimized bias and established stronger casual inferences of the BPP by randomly assigning participants to intervention and control groups. Further examination of the hypertrophic effect of performing flat pressing movements with the Launch Pad may be examined through pectoral and deltoid EMG data. Furthermore, the effects of the Launch Pad on eccentric and concentric bar velocity, power output, and post-activation potentiation enhancement are metrics worth examining. Finally, while there is strong theoretical backing to support the idea that the BPP enhances safety through glenohumeral stability and range of motion through scapular retraction, these were not directly measured in the present study. Thus, conclusive claims in these regards are not able to be made.

CONCLUSION

The present study is the first to demonstrate the efficacy of the BPP (Launch Pad™) as an ergogenic aid, showing its ability to enhance the rate of strength improvement in flat bench-pressing movements. The BPP functions to increase the range of motion (as well as the functional safety of deeper ranges of motion) of the flat barbell bench, as well as decreasing stress on the shoulder girdle by way of scapular retraction. For those looking to maximize training results, the novel bench press pad is a useful tool to safely optimize muscular strength outcomes on the flat barbell bench press.

AUTHOR CONTRIBUTIONS

The study was conceived and designed by B.A.D., whereas T.Y, A.E.B., T.K.S., R.J.L, and V.S. performed data collection. P.G., T.Y., E.V.N., D.M.B., and B.A.D. completed data analysis. P.G., T.Y. and B.A.D. interpreted data and composed the manuscript while A.E.B., T.K.S., E.C., J.B., and V.S., made crucial edits. All authors have read and agreed to the published version of the manuscript.

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DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

ETHICS COMMITTEE APPROVAL

This study was performed in accordance with the ethical standards of the Helsinki Declaration and was approved by the UCLA Institutional Review Board (#11-003190). All participants provided written informed consent.

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