MUSCULAR INVOLVEMENT DURING THE BENCH PRESS USING THE ISOBAR® LITE AND STANDARD OLYMPIC BAR

A THESIS

Submitted to the Faculty of the School of Graduate Studies
and
Research
of
California University of Pennsylvania in partial
fulfillment
of the requirements for the degree of

Master of Science

by
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California, Pennsylvania
2009

CALIFORNIA UNIVERSITY of PENNSYLVANIA
CALIFORNIA, PA

THESIS APPROVAL

Graduate Athletic Training Education

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ACKNOWLEDGEMENTS

I would like to take this opportunity to thank all the people that have helped me reach this point.

First, I would like to thank the staff and professors at California University of Pennsylvania. And I would especially like to thank my thesis committee: Jeff Hatton, Dr. Thomas F. West and Dr. Marc Federico. The amount of work that took place this year could not have happened without your encouragement and persistence. The enthusiasm that this staff has for the progression of research is intoxicating and has made the process of writing this thesis enjoyable.

I would like to thank my undergraduate professors and staff athletic trainers at West Virginia University. Your dedication to the development of quality athletic trainers and quality people has prepared me for the challenges that I face daily. Without your commitment and compassion, I would not be the athletic trainer I would be today.

I would also like to thank Mike and Mark Lesako; you are amazing mentors, excellent athletic trainers and spectacular people. Your dedication to the athletes and your families is truly inspiring. Thank you for all the opportunities and for the confidence you had in me. I am truly grateful for the opportunity to work with you this year. I would do this year over again just for the opportunity to work with you guys another time.

I would also like to thank the staff and athletes of Washington and Jefferson College for always being able to make me laugh no matter how stressed I was with class work. You are truly a unique group of people and it was an honor meeting and working with you.

I would like to thank all my friends, old and new. Whenever I needed a laugh to loosen up a little bit you were there. I wish everyone great luck in the future with every endeavor you undertake.

I would like to thank my family; through everything you have been here to support me. Thank you for always lending me an ear to listen, your mind for an inquisitive thought and a shoulder to cry upon. Thank you for providing for me so that I could have every opportunity that was possible. I will always be just a phone call away to help in any way possible and to come to bat for you. I hope that I can help you reach your dreams as you have supported me in attaining mine. I will be forever grateful for everything you have done for me and all the sacrifices made. Thank you for teaching me never to settle and to take the risks that may not be the safest option but will lead me to what I truly want. Thank you to my entire family for helping with everything in and out of school work. I hope that I can always make you proud, and “heal” you in your old age.

Finally, I would like to thank Thomas. Without you I would not have made it through this year. Thank you for your support and reassurance to reach for my dreams, without you I would have never continued to pursue everything I truly wanted. I am so proud of everything you do and I hope that I make you proud as I continue on. I am here whenever you need someone.

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INTRODUCTION

Strength training is a crucial element in athletics today. The bench press is one component of the essential weight lifting program, which increases strength in the upper body. Although the bench press is part of many strength and conditioning programs, there is no evidence it is the most effective way to activate the musculature a person is trying to strengthen. There have been many studies on different ways to manipulate repetitions, load, volume and body positioning to identify the most effective method for increasing strength. Furthermore, recent research has investigated manipulating the bar type by changing the grip width or type of hand positioning.

The inclusion of a multiplanar or decreased stability component to the bar has not been investigated. Truform's Isobar® Lite [Santa Barbara, CA] was developed with mobile hand grips to allow multiplanar movement during the bench press.[1] In this study the researcher will be testing the efficacy of the Isobar® Lite in activating specific musculature of the upper body during the bench press as compared to the Olympic bar.

The shoulder is known as the most mobile joint in the body, but with the increased amount of mobility comes a decreased amount of stability. The muscles in the upper extremity work together to provide a range of movements that complete functional tasks. The muscles can be grouped into categories according to their origins and insertions, in the shoulder these groups are the scapulohumeral and scapulothoracic.[2] The scapulohumeral group is responsible for motions at the glenohumeral joint that include internal and external rotation, extension, adduction, abduction and flexion. In the scapulothoracic group the muscles originate on the trunk and attach to the upper extremity.[3] Scapular motions completed by this group are elevation, depression, protraction, retraction, upward and downward rotation.

The shoulder complex is the most multifaceted articulation in the body using three different joints to produce multiplanar motion. The wide variety of muscular attachments allows complex motion to occur, especially at the scapulothoracic and glenohumeral joints. The motions that occur at the scapulothoracic joint are adduction, abduction, upward rotation, downward rotation, anterior tilt, elevation and depression.[4] Upward and downward rotation of the scapula are important to allow greater range of motion of the shoulder complex. Other benefits of scapular rotation include the movement of the glenoid fossa thus providing the humeral head a firm but mobile articulation. This biomechanical property is known as a force couple. A force couple is created at the scapula when several muscles contract simultaneously and pull the scapula in opposite directions. Without the force couple, scapular rotation would not be possible and would result in limited shoulder range of motion. The uniqueness of these joints allows for many different types of motions, consequently needing an extensive strengthening program in an attempt to minimize the likelihood of injury. Different exercises are completed in multiple planes to strengthen the muscles involved in the motions at the shoulder. If exercises are only completed in one plane not all muscles will be strengthened optimally because they function normally in a different plane.

While strengthening the upper body there are different factors which may affect the efficiency of the exercise. If these factors interfere, the muscular activation will be altered and the exercise will fail to produce the desired results. One of these factors is fatigue. The function of the upper extremity can be affected by fatigue of the muscles involved in the exercise. During the horizontal bench press the upward velocity is greatest early in the set. As the lift progresses to the final repetition the amount of time to lift the bar will double in duration.[5] Another way fatigue will affect upper extremity function is changing the amount of time to complete the bench press. With each repetition the lift duration becomes more similar to the one repetition maximum duration. As with the other factors, the bar path becomes more similar to the path of the one repetition maximum when a set is done to fatigue.[5] This study detailed above by Duffey, et al illustrates that when proper mechanics of the bench press are not followed the maximum effects will not be achieved.

There are variations that will affect the amount of muscles and the type of contraction. During the bench press the bar can have a different width or grip; this will affect type of strengthening which will occur. The width of the bar will affect different muscles.[6] In multiple studies a wide grip or narrow grip was found to increase neuromuscular activation and maximal voluntary contraction (MVC) of specific muscles.[6,7,8,9] When doing the bench press changing the positioning of the hands can also be more effective for certain muscles. Another variation was to supinate or pronate the hands while performing the bench press. Standard hand positioning during the bench press is usually pronation which evidence shows is more effective in strengthening particular muscles.[6] Sometimes changing hand or grip positioning did not affect muscle activation or MVC.[6,9,10] Mobile parts on the bar may also have an influence on which muscles are activated effectively, but more research is necessary in this area. In a strength training program it will be necessary to utilize variations to activate multiple muscle groups.

For years the bench press has been used in all types of strength training programs. There have been many studies which have manipulated the body positioning, grip or type of work out. When using the bench press some muscles could be missed in the complex network that is the shoulder. These studies have provided evidence that improvements can be made to the standard bench press exercise. This has lead companies to new developments and variations to the Olympic bar. The Isobar® Lite is one of these variations that have claimed to be superior to the standard Olympic bar. The purpose of this study was to examine the effects of the Isobar® Lite on muscle activation as compared to the Olympic bar in active college students aged 18-27.

METHODS

The purpose of this study was to investigate the difference in muscle activation during the bench press when using a standard Olympic bar and the Isobar® Lite. EMG activity was measured to evaluate the activation of specific muscles during the exercise. This section will include research design, subjects, instruments, procedures, hypothesis and data analysis.

Research Design

This research was a quasi-experimental, within subjects, repeated measures design. The independent variables were bar type, contraction type and muscles used. The different bars used were the Isobar® Lite and a standard Olympic bar. Results were measured during concentric and eccentric muscle contraction to allow comparison of muscle activity during these motions. The muscles tested in this study were the pectoralis major, infraspinatus, biceps brachii and triceps brachii. The dependent variables were peak muscle activation and average muscle activation as measured by surface EMG.

Subjects

The subjects used for this study were 26 male and female volunteers from California University of Pennsylvania. The ages of the subjects ranged from 18-27. All the subjects were active individuals and possessed the basic knowledge of weight lifting, including the bench press exercise. This active individual is defined as someone who engages in some sort of heart rate raising physical activity at least three times a week. A person with a basic knowledge of weight lifting is defined as someone who has participated in a formalized weight training program in the past. The subject must currently lift weights or previously lifted weights and not reported injury to the upper extremity or chest within the past six months that resulted in medical attention or have any current condition that may affect their performance.

It was required that each subject participate in a preliminary meeting where a one-repetition maximum (1 RM) on the Olympic bar was obtained. Subjects then returned to participate in one 1-hour testing session one week later. Each participant’s identity remained confidential and will not be included in the study. The study was be approved by the Institutional Review Board (Appendix C1) at California University of PA. All subjects in the study signed an Informed Consent Form (Appendix C2) and completed a Demographic Information Sheet (Appendix C3) prior to participation in the study.

Preliminary Research

A pilot study was completed prior to completing this research project. Subjects who met the selection criterion were used to test the protocol. The researcher looked for the ability of the subjects to follow instructions, complete the activity and warm up, the amount of time it would take to complete each task, and if the protocol was accurate. The data was collected and placed in the data collection sheet (Appendix C4).

Instruments

The researcher used a demographic sheet (Appendix C3) to accept or eliminate individuals. The study used the following equipment: bench, bar rack, two different bars, Biopac MP150[Goleta, CA], metronome and two one-pound cuff weights. The first bar was the standard 45-pound Olympic bar and the second bar was the Isobar® Lite which weighed 23 pounds. The Isobar® Lite had freely mobile hand grips which slide along the bar linked together so that balance, symmetry and control were maintained (Appendix C5).[11] The cuff weights were added to the ends of the Isobar® Lite so it would have the ability to equal the same total weight as the Olympic bar during the experiment. The metronome was used while performing the bench press so to complete the exercise in a controlled and uniform manner.

In collecting the EMG data, the researcher used six channels from a Biopac MP150® electromyography machine. Four channels were designated for the muscles tested and the other two channels were connected to an electronic biaxial goniometer. The Biopac MP150 was connected to a Microsoft Windows based personal computer with the Biopac’s AcqKnowledge® program [Goleta, CA] to collect analyze the data. The study utilized pre-gelled disposable Ag-AgCl surface electrodes with a diameter of one centimeter.[12,13] The electrodes were placed on the subject’s dominate arm over the motor points of each muscle belly with a center-to-center spacing of 2.5 centimeters.[13] This goniometer was applied to the subject’s arm at the elbow to measure the angle of the arm when a peak muscular contraction occurred. The raw EMG signal was band pass filtered at 10 and 1000

Hertz (Hz).[6,14,15] The researcher utilized a sampling rate of 2000 Hz using the AcqKnowledge software.[16,17] The signals were rectified and normalized before the data analysis was completed.

Procedures

Once informed consent and a demographic sheet were obtained from all potential subjects, there was an explanatory session to inform the participants of the process. The Institutional Review Board at California University of Pennsylvania approved all testing protocol prior to experimentation. Participants were chosen by searching the campus of California University of Pennsylvania to acquire volunteers. To collect the volunteers the researcher visited various classes on the California University of Pennsylvania campus by introducing and explaining the study. Volunteers were disqualified from the study if there was a self-reported recent significant injury to the upper extremity or chest, any other condition that may affect performance, or if they did not meet the demographic standards.

The subjects participated in a pre-experimental lift where the participant completed a one-repetition maximum (1

RM) with the standard Olympic bar. The volunteers were asked to estimate what their 1RM was based upon their prior experience and this value was considered their perceived maximum. Prior to the maximum lift, the subjects peddled the Upper Body Ergometer (UBE) for five minutes at a moderate workload speed of 60 revolutions per minute (rpm). The subjects peddled forward for two minutes and backwards for three minutes on the UBE to warm up the muscles used in the 1 RM. The warm up continued after a one-minute rest with a set of five bench press repetitions at 50% of the perceived maximum. During the period of rest, the subjects were permitted to perform light self-stretching of their choosing to the upper extremity.

To determine the volunteers 1 RM using the Olympic bar their perceived maximum weight was placed on the bar for the first lift. The subjects were then asked to lift the bar. If the subject was only able to lift the bar for one repetition, then ten pounds was added to the bar and they were asked to lift the bar again. If they were unable lift the bar then the earlier weight was determined to be their 1 RM. This procedure was repeated until the 1 RM was determined. It was expected that several attempts of the bench press exercise would be needed to be performed to determine 1 RM. The goal was to find the volunteer’s 1RM within 3-5 tries with a ten pound increment of weight added after each successful lift until a lift attempt fails.[18] During every 1RM attempt there were two spotters closely observing to assist the lifter with bar replacement. The spotters were positioned at either end of the bar and followed the bar's path with their hands keeping the bar within reach. The 1 RM for each subject was recorded on a sheet with their corresponding subject number. While waiting to complete their 1 RM the subjects had an opportunity to practice a lift with the Isobar® Lite.

After a minimum of seven days following the 1 RM testing, the subjects returned at a time designated by the researcher. Prior to beginning activity, the subjects completed a Visual Analogue Scale (VAS) to identify the level of soreness they were experiencing as a result of the 1 RM test. There were numbers listed from 0-10 where zero equaled no pain and ten was the most pain they have ever experienced. If the subjects stated their discomfort was a value over four the athlete was unable to begin the second day until it subsided. After filling out the VAS the subjects completed a warm-up session utilizing the UBE and one warm up set on each of the two bars.[5] The UBE portion of the warm up was a five minutes session as performed in the 1 RM testing. The bench press warm up exercises consisted of lifting either 50% of their 1 RM or 45 pounds (the weight of the bar alone), whichever was greater. The subjects completed two sets of ten repetitions with one set using each bar.

The subjects were randomly assigned to two groups, one completed the Olympic bar lift first and the second completed the Isobar® Lite lift first. The sites for electrode placement were shaved, cleaned and prepared to decrease impedance with a high grit sand paper before electrode placement occurred.[13,15,19,20] The electrodes were placed over the motor points in each muscle belly.[12] The muscles tested in this study were the pectoralis major, biceps brachii, triceps brachii and infraspinatus. After the electrodes were in place, the goniometer was applied at the elbow with one attachment distal to the deltoid insertion and the other under the wrist extensor muscle group.

The BIOPAC MP150 was then turned on and connected to the laptop computer to begin the activity. For each muscle tested, the participants completed three maximal voluntary isometric contractions (MVIC). These three isometric contractions lasted six seconds each with a three second rest period between contractions.[20] The greatest value from the three attempts was recorded as the value for the MVIC.[20]

The MVIC is the value which was used to normalize the EMG data. The subjects were also measured going through the bench press motion with a light wooden rod in order to obtain the zeros of the goniometer.

To complete the MVIC testing the arm needed to be placed in specific positions optimal for initiating contraction with the tested muscles. Each muscle completes at least one major motion and may contribute to others. For this study, the major action of each muscle was tested and used for the MVIC. The subject was positioned on the bench with the non-dominant arm placed on the bar for stabilization during the pectoralis major, biceps brachii and triceps brachii MVIC tests. For the infraspinatus MVIC test the non-dominant arm was placed on the post of the bar rack. For the pectoralis major’s MVIC the dominant arm was placed at 90 degrees of flexion and then resisted as the subject moves into horizontal adduction while lying on the bench. The subject sat with their dominant arm in terminal external rotation and was resisted while they continued to push into external rotation for the MVIC of the infraspinatus. The beginning positioning for the biceps brachii and the triceps brachii was identical. The subject laid on the bench with their shoulder in a neutral position, elbow completely extended and their hand in full supination. The biceps brachii MVIC was completed by the researcher resisting as the subject contracts into elbow flexion from the beginning position. For the triceps brachii MVIC the subject extended the elbow from the beginning position while the researcher attempted to push the elbow into flexion.

The procedures were repeated identically for both bars. The subjects lie on a horizontal bench ensuring they were not rubbing the infraspinatus electrodes on the bench. The subjects grabbed the Olympic bar outside the knurl and the Isobar® Lite against the inner bumper of the handle with the handle at least two inches from the collar of the bar. The subjects then lifted the bar off the rack and held the bar for 1 second with their elbows extended.[5] The bar was lowered until it gently touched the subject's chest, paused for one second, and then lifted back up to the beginning position. The bench motion was completed in a slow and controlled manner, which took three seconds on the descent and two seconds to ascend.[13,21] To keep the movements uniform, there was a metronome to keep a beat. There were two spotters to maintain the lifter's safety positioned in the same location as they were during the 1 RM testing.

The participants completed three repetitions at 65% of their maximal contraction as determined by their 1 RM. The 65% of the subjects’ 1 RM were rounded down to the nearest five pounds to increase the ease of adding plates to the bar. The hand placement on the mobile parts of the bar was the only difference between the experiments with the two bars. The natural movement was used with the Isobar® Lite, this allowed the hands to follow the natural path they would normally take through the range of motion during the bench press.[1] The subjects were instructed not to purposely move their hands along the length of the Isobar® Lite, but to keep their hands in a comfortable distance apart like they would using the Olympic bar (Appendix C6). There was a minimum of a three-minute rest between the tests.[8, 22]

As the participant was lifting, EMG data was recorded as waves on the computer through the Biopac’s Acqknowlege® software system. After the data was collected the data for each subject it was rectified and smoothed. The data was then selected starting with the first flexion of the elbows through the final (third) extension. The maximum (peak) and the mean (average) were calculated by the software and then recorded in Microsoft Excel.

Hypotheses

The following null hypotheses were based previous research and the researcher’s intuition based on a review of the literature.

1. There will not be a significant difference in peak muscle activation for each muscle during eccentric or concentric contractions with the different bar types.
2. There will not be a significant difference in average muscle activation during eccentric or concentric contractions with the different bar types.

Data Analysis

The research hypotheses were analyzed using a multivariate repeated measures 2x2x4 analysis of variance. All data was analyzed by SPSS version 16.0 for Windows at an alpha level of 0.05. All EMG scores were reported as percentage of maximal voluntary contraction.[13]

RESULTS

The purpose of this study was to investigate the difference in muscle activation during the bench press when using a standard Olympic bar and the Isobar® Lite. The following section contains the data collected through this study and is divided into the following three subsections: Demographic Information, Hypotheses Testing, and Additional Findings.

Demographic Information

There were 26 physically active, healthy subjects who participated in this study. The age range was 18-27 years and the mean age was 21.4 years and is demonstrated in Figure 1. Eleven (42.3%) of the subjects were male, leaving the remaining fifteen (57.7%) female. Sixty-one and one half percent of the population participates in physical activity 3-4 times a week where 38.5% participate in some type of physical activity 5-7 times a week.

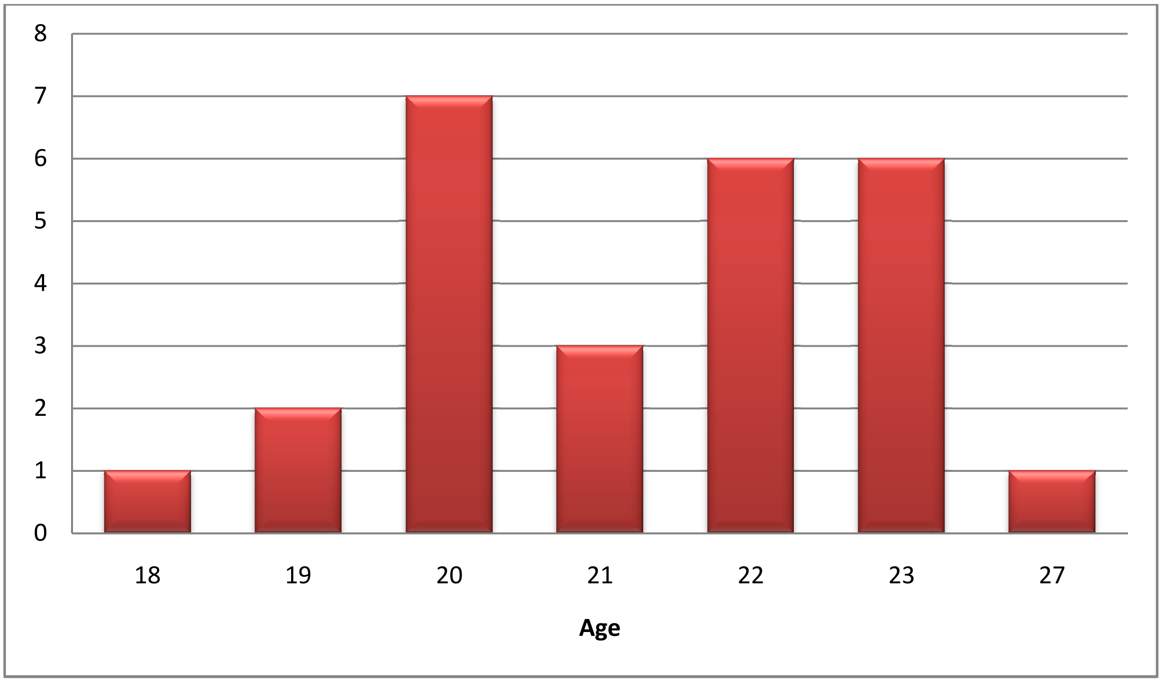

Figure 1. Distribution of Subject Age

All 26 subjects participated in a variety of different activities as demonstrated in Table 1; many subjects participate in more than one.

Table 1. Subject Physical Activity Participation

Type of Activity	Frequency	Percent
Cardiovascular	21	42.9
Weight Lifting	20	40.8
Aerobics	1	5.0
Sports	4	8.2
Other	3	6.1

Hypothesis Testing

The following hypotheses were tested during this study. All of the hypotheses were tested with a level of significance set at $\alpha \leq 0.05$. A multivariate, repeated measures 2x2x4 analysis of variance was calculated to find the effect of the bar differences on the tested muscles.

Null Hypothesis 1: There will not be a significant difference in peak muscle activation for each muscle during eccentric or concentric contractions with the different bar types.

Conclusion: Mean scores for each muscle’s peak activation were calculated during eccentric and concentric contractions. The mean scores for each bar during eccentric and concentric contraction are listed in Table 2. For the peak muscle activation, there was no significant difference found between different bars. The individual significances are listed in Table 3. There was also no significant difference found between any combinations of the three variables together. The null hypothesis is therefore accepted.

Table 2. Mean Peak Muscle Activation Scores of Sample

Bar	**Pectoralis Major(% MVIC)**		**Infraspinatus (% MVIC)**	
	Con.	Ecc.	Con.	Ecc.
Olympic	173 (±220)	160 (±211)	277 (±230)	265 (±173)
Isobar	187 (±253)	164 (±216)	251 (±185)	281 (±200)
Bar	**Triceps (% MVIC)**		**Biceps (% MVIC)**	
	Con.	Ecc.	Con.	Ecc.
Olympic	80 (±41)	66 (±31)	91 (±108)	901 (±105)
Isobar	94 (±49)	76 (±35)	102 (±103)	100 (±106)

Table 3. Peak Muscle Activation Within- Subject Effects

Source	**df**	**F**	**Sig.**
Bar	25	0.548	0.466
Muscle	25	17.453	<0.001
Contraction	25	0.997	0.328
bar*muscle	25	0.456	0.714
bar*contraction	25	0.817	0.375
Muscle*contraction	25	2.271	0.087
bar*muscle* contraction	25	2.39	0.075

In the peak testing, the only significant difference ($\alpha \leq 0.05$) was the comparison between the individual muscles, see Table 3. The significance for the muscle variable was <0.001. The values for each individual muscle as compared to each muscle can be seen in Table 4. Not every muscle was significantly different from one another. The only muscles that were not significantly different were the triceps brachii and biceps brachii.

Table 4. Peak Muscle Activation Pairwise Comparisons

Muscle (I)	Muscle (J)	Mean Diff. (I-J)	Stand. Error	Sig.
Pectoralis	Infraspinatus*	-97.6	28.2	0.002
	Triceps*	91.9	39.3	0.028
	Biceps*	74.7	26.9	0.01
Infraspinatus	Pectoralis*	97.6	28.2	0.002
	Triceps*	189.4	33.8	<0.001
	Biceps*	172.3	25.6	<0.001
Triceps	Pectoralis*	-91.9	39.3	0.028
	Infraspinatus*	-189.4	33.8	<0.001
	Biceps	-17.1	16.3	0.304
Biceps	Pectoralis*	-74.7	26.9	0.01
	Infraspinatus*	-172.3	25.6	<0.001
	Triceps	17.1	16.3	0.304

*The mean difference is significant at the .05 level

Null Hypothesis 2: There will not be a significant difference in average muscle activation during eccentric or concentric contractions with the different bar types.

Conclusion: The comparison of the mean scores for the average muscle activation resulted in the findings that the difference between bars was not statistically different. The means for the average muscle activation with for each muscle and contraction type can be found in Table 5.

Table 5. Mean Average Muscle Activation Scores of Sample

Bar	**Pectoralis Major (% MVIC)**		**Infraspinatus(% MVIC)**	
	Con.	Ecc.	Con.	Ecc.
Olympic	75 (±62)	64 (±80)	86 (±54)	989 (±58)
Isobar	98 (±125)	74 (±89)	89 (±61)	112 (±76)
Bar	**Triceps (% MVIC)**		**Biceps (% MVIC)**	
	Con.	Ecc.	Con.	Ecc.
Olympic	37(±17)	32 (±18)	67 (±110)	67 (±108)
Isobar	43 (±18)	31 (±14)	70 (±107)	69 (±108)

In the average muscle activation comparison between the different bars there was not a significant difference found, this data is found in Table 6. This table shows that the bar significance was 0.134 and was greater than the specified significance level. The null hypothesis is therefore accepted.

Table 6. Average Muscle Activation Within-Subject Effects

Source	**df**	**F**	**Sig.**
Bar	25	2.401	0.134
Muscle	25	5.295	0.002
Contraction	25	1.503	0.232
bar*muscle	25	0.745	0.529
bar*contraction	25	0.473	0.498
Muscle*contraction	25	14.093	<0.001
bar*muscle* contraction	25	1.024	0.387

The average muscle activation had similar result for the bar as did the peak muscle activation. There were two variables that had significant difference in the average muscle activation statistics; see Table 6. The muscles compared to one another had a significance of 0.002. This variable had two muscle comparisons that were significantly different from one another. The triceps brachii average muscle activation was significantly different than both the pectoralis major and infraspinatus muscles as seen in Table 7.

Table 7. Average Muscle Activation Pairwise Comparisons

Muscle (I)	**Muscle (J)**	**Mean Diff. (I-J)**	**Stand. Error**	**Sig.**
Pectoralis	Infraspinatus	-18.8	14.6	0.209
	Triceps*	41.9	15.5	0.012
	Biceps	9.3	12.9	0.476
Infraspinatus	Pectoralis	18.8	14.6	0.209
	Triceps*	60.7	10.6	<0.001
	Biceps	28.1	17.7	0.125
Triceps	Pectoralis*	-41.2	15.5	0.012
	Infraspinatus*	-60.7	10.6	<0.001
	Biceps	-32.6	20.3	0.122
Biceps	Pectoralis	-9.3	12.9	0.476
	Infraspinatus	-28.1	17.7	0.125
	Triceps	32.6	20.3	0.122

*The mean difference is significant at the .05 level

The other average muscle activation that was significantly different was the difference between the contractions of each muscle. As shown in Figure 2, the concentric and eccentric muscle contractions of the pectoralis major and infraspinatus were significantly different. The triceps brachii did have a difference between contraction types, but it was not significant. There was not a significant difference between the contraction types of the biceps brachii.

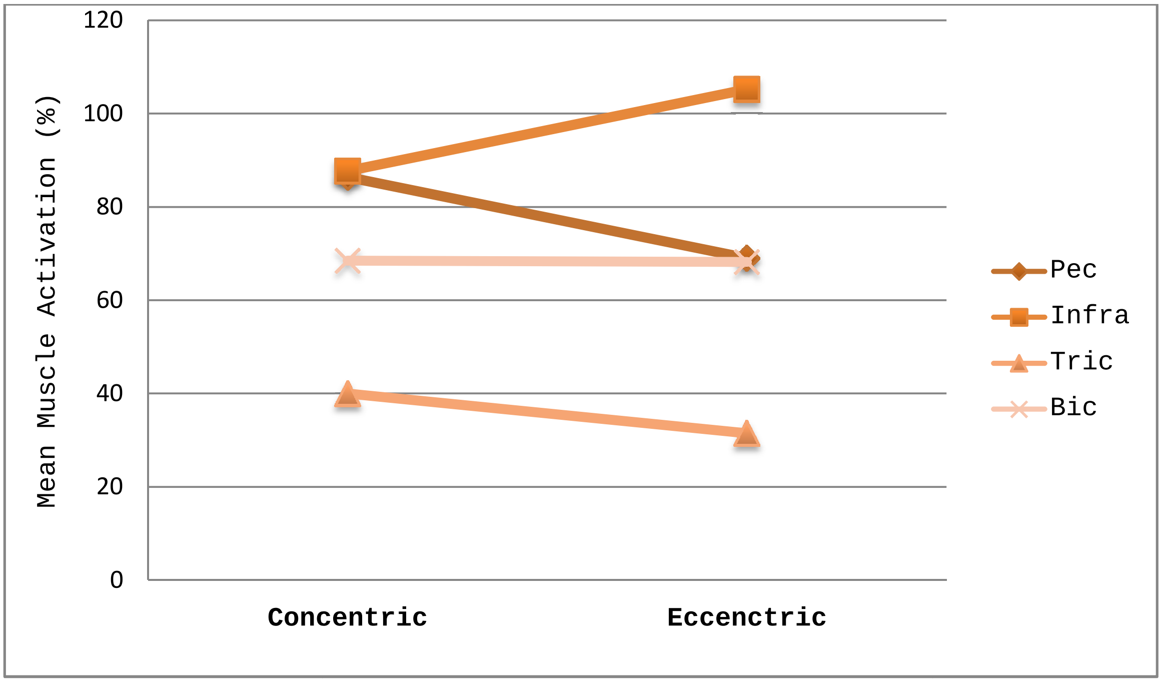

Figure 2 Effect of Contraction Type on Muscles for Average Muscle Activation

Additional Findings

In addition to the hypothesis testing completed, another 2x2 repeated measures analysis of variance was computed to find a significant difference in the overall peak and average muscle activation. The mean scores of overall peak and average muscle activation for each bar are defined in Tables 8 and 9 respectively.

Table 8. Overall Peak Muscle Activation Mean Scores of Sample

Bar	**Muscle (% MVIC)**			
	Pectoralis Major	nfraspinatus	Triceps	Biceps
Olympic	187 (±227)	298 (±223)	82 (±36)	96 (±105)
Isobar	208 (±290)	304 (±210)	97 (±46)	114 (±101)

Table 9. Overall Average Muscle Activation Mean Scores of Sample

Bar	**Muscle (% MVIC)**			
	Pectoralis Major	Infraspinatus	Triceps	Biceps
Olympic	81 (±115)	92 (±54)	32 (±13)	67 (±110)
Isobar	86 (±125)	101 (±70)	37 (±15)	72 (±107)

There was not a significant difference found between bars discovered through the results of the overall peak muscle activation testing. These results can be seen in Table 10. The significance level for the muscle interactions was <0.001. There was a significant difference found between all the muscles except between the biceps brachii and triceps brachii muscles and is demonstrated in Table 11.

Table 10. Overall Peak Test of Within-Subject Effects

Source	F	Sig
bar	1.816	0.19
muscle	17.101	<0.001
bar*muscle	0.136	0.938

Table 11. Overall Peak Muscle Activation Pairwise Comparisons

Muscle (I)	Muscle (J)	Mean Diff. (I-J)	Stand. Error	Sig.
Pectoralis	Infraspinatus*	-103.5	31.6	0.003
	Triceps*	107.8	45.4	0.026
	Biceps*	92.6	35	0.014
Infraspinatus	Pectoralis*	103.5	31.6	0.003
	Triceps*	211.3	36.3	<0.001
	Biceps*	196.1	28.9	<0.001
Triceps	Pectoralis*	-107.8	45.4	0.026
	Infraspinatus*	-211.3	36.3	<0.001
	Biceps	-15.2	15.4	0.333
Biceps	Pectoralis*	-92.6	35	0.014
	Infraspinatus*	-196.2	28.9	<0.001
	Triceps	15.2	15.4	0.333

*The mean difference is significant at the .05 level

The results of the overall average muscle activation found that there was not a significant difference between the Olympic bar and the Isobar® Lite. In Table 12 it is demonstrated that there was a significant difference found between the individual muscles. The significant difference was found between the triceps brachii and both the infraspinatus and pectoralis muscle. These significant differences are demonstrated in Table 13.

Table 12. Overall Average Test of Within-Subjects Effects

Source	**F**	**Sig**
bar	2.609	0.119
muscle	4.53	0.006
bar*muscle	0.189	0.904

Table 13. Overall Average Muscle Activation Pairwise Comparisons

Muscle (I)	Muscle (J)	Mean Diff. (I-J)	Stand. Error	Sig.
Pectoralis	Infraspinatus	-13.3	20.2	0.518
	Triceps*	49.1	22.7	0.04
	Biceps	13.8	11.2	0.228
Infraspinatus	Pectoralis	13.2	20.2	0.518
	Triceps*	62.4	10.9	<0.001
	Biceps	27.1	18.1	0.147
Triceps	Pectoralis*	-49.1	22.7	0.04
	Infraspinatus*	-62.4	10.9	<0.001
	Biceps	-35.3	20.4	0.095
Biceps	Pectoralis	-13.8	11.2	0.228
	Infraspinatus	-27.1	18.1	0.147
	Triceps	35.3	20.4	0.095

* The mean difference is significant at the .05 level

DISCUSSION

The purpose of this research was to investigate the claims of companies that variations of the standard Olympic bar are better for training. The Isobar® Lite is a variation of the standard bar and includes mobile hand grips. The purpose of this study was to see if a significant difference exists with muscular activation between this bar and the Olympic bar. The following section is divided into three subsections: Discussion of Results, Conclusions, and Recommendations.

Discussion of Results

Upon completion of this study, it was found that the Isobar® Lite did not produce a significantly different amount of peak or average muscle activation as compared to the Olympic bar. A significant difference of both peak and average muscle activation was found between muscles. There was no difference found between the contraction types for the peak muscle activation but there was a significant difference found with average muscle activation. The results supported the null hypotheses that stated there is not a significant difference between the Olympic bar and the Isobar® Lite.

Recent literature has focused on variations that can be applied to weight training. There have been multiple studies which focused on the bench press specifically altering hand positioning, grip width and body positioning.[8, 16, 23] After an extensive literature review of the variations of weight lifting techniques, no prior studies had investigated the effects of mobile parts on the bar.

Many of the prior studies found mixed results where the increase or decrease of muscle activation was dependent upon which muscle was tested. The researchers found that there were specific muscles that were affected differently dependent upon the different type of variation applied to the exercise. In two studies that tested the effect of grip width found that the pectoralis major, biceps brachii and latissimus dorsi had increased muscle activation with a wide grip but the anterior deltoid and triceps brachii muscles were activated more efficiently with a narrow grip.[16,23] In another study completed by Grant, et al found that a smaller bar diameter had the lowest overall neuromuscular activation.[8] Switching the positioning of the hand from pronation to supination can also effect the activation of the muscles. The muscles that had a greater activation with supination are the biceps brachii and the clavicular portion of the pectoralis major.[16]

The results of this study demonstrated that there was not a significant difference between the Olympic bar and the Isobar® Lite for peak or average muscle activation. The common thought would be that introducing mobile parts would increase muscle activation, however, this study proved otherwise under the test circumstances.

During the testing the general comment from the subjects was, that although the amount of weight was the same on each bar, using the Isobar® Lite was more difficult to complete the lift. This subjective information would imply that the subjects placed more effort into the lift with the Isobar® Lite. Many of the subjects did not like the Isobar® Lite due to the increased perceived difficulty. The researcher observed that many of the subjects had trouble keeping the mobile hand grips steady. Towards the end of the lift was when many of the subjects had the most instability and movement along the Isobar® Lite occurred.

The increased movement was more prominent on the Isobar® Lite due to the mobile parts and could be a result of fatigue in the upper extremity. Even though the subjects felt it was more difficult, the subjectivity was not reflected in the data. This could be due to the fact that a larger percent of the subjects did not begin to reach fatigue. If the protocol had included more repetitions, fatigue could have been more prominent and a significant difference might have been found between bars.

The analyzed statistics of peak muscle activation found that there was a significant difference between the activation levels of the different muscles. All the muscles were significantly different from one another except for the triceps brachii and the biceps brachii. With the exception of the triceps brachii and the biceps brachii, when comparing the muscles to one another, each muscles function is significantly different from one another. This difference between muscle function could be the reason for the significant difference in peak muscle activation. Because these muscles have different functions in the upper extremity during the range of motion of the bench press the muscles initiate the change of motion causing peak activation for each muscle.

During the bench press, the biceps brachii and the triceps brachii act as reciprocal inhibitors to one another. This could be the reason for these muscles being the only muscles that were not significantly different than one another. The function of these muscles is opposite from one another and with them exerting force against the same amount of weight their average means should not be significantly different.

The average muscle activation results also showed a significant difference between muscle contractions. The muscles that were significantly different from one another were the triceps brachii and pectoralis major. These muscles are the main muscles that are strengthened during the bench press, which could be a reason for the results in this study. The triceps brachii was also significantly different from the infraspinatus muscle which could be due to their different actions.

Another significant difference that was found in the average muscle activation results was the contraction types in each of the muscles. The concentric and eccentric contractions were significantly different for the pectoralis major and the infraspinatus. The pectoralis major had a higher concentric than eccentric muscle activation. This is to be expected in the bench press exercise because the pectoralis major muscle is the main muscle recruited initially to raise the bar off the chest. This will cause the average concentric muscle activation to be much greater than the average eccentric. During the bar lowering process, the pectoralis major is basically stabilizing and controlling the bar which recruits less muscle than concentrically.

The contractions of the infraspinatus had the opposite effect than the pectoralis major with the eccentric contraction being significantly greater than the concentric contraction. The infraspinatus is one muscle in the group of muscles labeled the rotator cuff. The main function of the rotator cuff muscle is to provide stability to the shoulder complex. The function of the infraspinatus coincides with the study's result because during the eccentric phase the muscle was mainly providing stability to the upper extremity. The opposing movement caused the concentric muscle activity where the muscle was contracting to cause the motion of the bar.

There was a difference between the muscle contraction for the triceps brachii but it was not as significant as the prior two muscles. The concentric contraction was greater than eccentric contraction. The triceps brachii had a similar result to the pectoralis major. The triceps brachii concentric contraction was the contraction that lifted the bar off the chest therefore recruiting more muscle fibers over the range than during the eccentric contraction when it was just stabilizing the bar during descent. It was not as significant as the pectoralis major because the triceps brachii is not the prime mover the bench press exercise.

The biceps brachii had very little change between the concentric and eccentric contraction. This muscle was similar in the fact that the eccentric contraction had slightly higher average eccentric muscle activation than concentric muscle activation. This muscle had the least difference between the contraction types because the biceps brachii is the muscle that is least involved in the bench press functionally. During the biceps brachii concentric contraction, which is elbow flexion, the bar is descending to the chest not requiring much muscle activation. This low level of average muscle activation during the muscle’s concentric phase was due to the bench press’ specific range of motion.

The overall peak muscle activation did not have a significant difference between the Olympic bar and the Isobar® Lite. It also only had a significance between the different muscle types. The muscles that were not significantly different were the triceps brachii and the biceps brachii. This similarity of results to the peak contractions is because there was not a significant difference found between bars in relation to the separate contraction types.

The overall average muscle activation also had similar results to the average muscle activation. Both did not find a significant difference between bar type but did find a difference between the separate muscles. The triceps was significantly different than both the pectoralis major and infraspinatus in the overall average muscle activation statistics. This similarity is also due to the fact that there was not a significant difference found between muscle contractions or bars during the average muscle activation analysis.

Discovering the optimal techniques for strengthening the upper extremity will improve the quality of current and future athletes. In prior research, specific variations have proven more efficient for targeting specific muscles. This was the intent of this study, to determine if this Isobar® Lite was more efficient in activating the muscles tested. The findings implicate that the Olympic bar was not different from the Isobar® Lite in peak and average muscle activation. According to the results, the Isobar® Lite is a tool that can be utilized in the weight room to include variation to a work out, but it will not increase the effectiveness of muscle activation during the bench press.

These results are only valid for physically active college aged students that have no recent history of injury to the upper extremity. These subjects did not have much experience with the Isobar® Lite, which could have had a small effect on the study. For a wider population with more experience the Isobar® Lite may have a different effect on muscle activation. These results are not the determining factor on the effects of mobile parts on the bar during the bench press, but a block on the base of knowledge being formed about the effect of the variations on the bench press. To the knowledge of the researcher, this is the only study investigating the effects of mobile parts on the bar during the bench press.

Conclusions

This study resulted in no difference found between the Isobar® Lite and the Olympic bar in muscle activation in active college aged adults. The area of bar manipulations research is one that will advance the training process for athletes and recreational weight lifters. Determining specific variations that target muscles more efficiently than the standard bench press can lead to improved rehabilitation and general strength training. As more products and techniques are developed for weight training their efficiency should be validated through research. These variations in training are necessary for all active individuals for advancement towards their optimal performance.

Recommendations

The researcher's recommendation for future research is to test different muscles involved in the bench press, test different types of lifts or manipulate the variables (sets/repetitions) that were used in this experiment concentrating on the Isobar® Light. Other research that could be investigated is other variables as compared to the standard Olympic bar during the bench press.

Even thought the Isobar® Lite did not have a significant difference in this study, it could have a different effect on different muscles not tested in this study and there could be a significant difference between bars. The muscles tested in this study were chosen by the researcher based on the most effected muscles during the bench press. Testing the other rotator cuff muscles or even the abdominal muscles to discover their activity during the bench press would be relevant to current research in this area.

The Isobar® Lite could be tested in different types of lifts beside just the bench press. This bar could be more effective in activating greater percentages of muscle during different types of lifts. The Isobar® Owner's manual suggests the military press, rows, biceps curls, triceps extensions, pull-overs and pushups as exercises that can be done more effectively with the Isobar®.[1] There are different types of movements that can be used with the mobile parts of the Isobar®. In this study the "natural" movement was tested, but there are exaggerated, novel, varying, and mid-exercise grip adjustment options that can be tested in the future.[1]

As with any strength training program, one group of variables that can be altered to differentiate the effects of the training are sets, repetitions and timing. These variables chosen to be used in this research were optimal for strength training.[21] The Isobar® Light may be more effective in muscle activation using different variables that are found to be optimal for different types of training. Examples can include hypertrophy, endurance, stabilization strength, or power.[21] Specifically, the sets can be varied for different effects including supersets, pyramid system, and multiple set systems.[21] The visual analogue scale was used to measure pain in this study, but in future studies it could be used to subjectively measure the perceived difficulty of the subjects while using two separate bars.

The percentage of the 1 RM used in this study was chosen based upon the ability of the pilot subjects to lift the weight with the Isobar® Lite. The original value intended to be tested was greater than the percentage used in the study. During the pilot testing the subjects were unable to complete the entire lift with the higher percentage of the 1 RM which caused the researcher to decrease the percentage to 65%. It would be interesting to research further the effect of a higher percentage of the 1 RM to see if fatigue has a greater effect on the difference between the Isobar® Lite and the Olympic bar. Another variable to manipulate would be to have the subjects lift until they reach a fatigued state. Using the two bars, a future study could measure the amount of repetitions it would take the subjects to reach muscle failure and then comparing the potential difference. This variation could also measure the difference in muscle activation.

Another possible area to test is a long term protocol using the Isobar® Lite. This study focused on the immediate differences between the Isobar® Lite and the Olympic bar. The Isobar® Lite may have a greater affect on the body if it is used as a part of a weekly strength training program. Future researchers could develop a protocol based on standard guidelines for weight lifting and compare subjects who used the Isobar® Lite and the Olympic bar over the entire study.

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APPENDICES

APPENDIX A

Review of Literature

REVIEW OF LITERATURE

Athletes are always striving for ways to achieve the greatest physical advantage over their opponent. Many athletic programs use weight training to strengthen their athletes and reach optimum performance. Weight lifting is useful in strengthening large muscle groups[1], but what is not known is the connection between the strength training and the muscles used in the more skilled areas of a sport.[2] The bench press is often used to strengthen and measure an athlete's ability to generate power in the upper extremity.

Further investigation is needed to determine if the Olympic bar bench press is an optimal strengthening practice for upper extremity athletes who need more strength to excel in their sport. The Isobar® Lite, a multiplanar weight lifting bar, has been introduced into the marketplace and will be tested in this study to determine if it is more effective than the standard Olympic bar in activating chief muscles in the upper extremity during the bench press.[3] This literature review will explore 1) anatomy of the shoulder, 2) muscles activated during a bench press exercise, 3) motion analysis of the upper extremity, 4) the electromyography (EMG) process, 5) the proper training and mechanics of a bench press, 6) the effects of the different bar types and grip positions.

Shoulder Anatomy

The shoulder is known as the most mobile joint in the body, but with the increased amount of mobility comes a decreased amount of stability. The bones involved in the upper extremity include the superior 8 ribs, sternum, clavicle, scapula and humerus.[4] The upper limb is connected to the trunk via the clavicle where the only direct attachment is at the sternoclavicular joint.[4,5] On the lateral end of the clavicle the attachment to the scapula is at the coracoclavicular and acromioclavicular joints. The final joints of the shoulder involve the scapula articulating with the ribs and the humerus to form the scapulothoracic and glenohumeral joints respectively. The scapulothoracic joint is not a true joint due to the fact that the scapula only articulates with the thorax and there is no bone on bone contact. The scapula is approximately located between the second and seventh ribs and the medial border is 2.5 inches from the spine.[6]

The muscles in the upper extremity work together to provide a entire range of movements to complete functional motion. The muscles of this region can be grouped into categories according to their origins and insertions, in the shoulder these groups are the scapulohumeral and scapulothoracic.[4,5] In the scapulohumeral group the muscles include the deltoid, teres major, supraspinatus, infraspinatus, teres minor and the subscapularis.[5] The deltoid is divided into the anterior, middle and posterior parts and each has separate motions for which they are responsible. The anterior and posterior portions are responsible for opposite motions. The anterior initiates flexion and internal rotation; conversely glenohumeral extension and external rotation is achieved by the posterior deltoid activity. The middle deltoid works in conjunction with the supraspinatus to abduct the humerus. The infraspinatus and teres minor are responsible for externally rotating the upper extremity where the subscapularis internally rotates the arm. The teres major is responsible for adduction and internally rotating the upper arm.

In the scapulothoracic group the muscles originate on the trunk and attach to the upper extremity.[5] The muscles in this group include serratus anterior, trapezius (upper, middle, and lower), pectoralis major, latissimus dorsi and the rhomboid major and minor. Elevation of the scapula occurs when the superior trapezius and levator scapulae contract. The combination of the pectoralis major, latissimus dorsi, inferior trapezius and serratus anterior depress the scapula. The pectoralis major and serratus anterior perform scapular protraction. Retraction occurs when the middle trapezius and rhomboids contract together. The upper and lower trapezius and inferior part of the serratus anterior work together to upwardly rotate the scapula. Downward rotation is a motion which occurs when the rhomboids, latissimus dorsi and pectoralis major contract. The scapula is primarily stabilized by the serratus anterior and secondarily the trapezius.[7] The humerus is extended by the latissimus dorsi, long head of the triceps brachii and posterior deltoid where it is flexed by the pectoralis major, long head of the biceps brachii and anterior deltoid.

The muscles surrounding the shoulder provide dynamic stability, but there are other non-contractile structures which provide static stabilization. The shallow glenoid fossa is deepened by the glenoid labrum. Additionally there is the joint capsule that loosely surrounds the glenohumeral joint and the anterior portion of the capsule thickens and attaches to the glenoid cavity and the anatomical neck of the humerus thus providing increased stability anteriorly. Also providing stability are the three ligaments of the glenohumeral joint which are the coracohumeral, transverse humeral and the coracoacromial.[5]

The dynamic and static structures of the shoulder are its greatest achievement and downfall. Its uniqueness provides the most range of motion of any joint in the body and at the same time placing it at the most risk of injury. In order to get a movement to occur at any joint, the muscle must receive a signal from the primary motor cortex. When movement is initiated a single muscle or a series of muscles must be activated in specific coordinated combinations to complete the action.

Muscle Activation

A muscle is activated through the efferent motor pathway. Somatic muscle fibers transmit a signal away from the brain to the skeletal muscle controlling it to contract either voluntarily or reflexively.[5] A signal for muscle contraction begins in the primary motor cortex and travels along the descending or pyramidal tract which terminates at the ventral horn of the spinal cord. The ventral horn will communicate with the efferent neurons which will transmit the signal to the muscle.[8] Once the signal is at the neuromuscular junction in the muscle, acetylcholine is released depolarizing the muscle. The acetylcholine will travel to the t-tubules in the muscle, which will activate the sarcoplasmic reticulum to release calcium.[1] Traveling to the muscle fiber, calcium binds to troponin causing tropomyosin to pull away from actin. Myosin is now able to bind with the exposed sites on the actin. Adenosine diphosphate (ADP) and an inorganic phosphate bind causing the actin to stroke and move along the myosin causing the muscle contraction.[1]

When feedback needs to be sent to the brain it travels along the ascending track starting at the axons of afferent fibers.[9] When the signal reaches the spinal cord, it travels up its dorsal column into the thalamus and cerebral cortex.[8] The dorsal column axons travel to the causal medulla to synapse with the dorsal column nuclei cells.[9] Inside the thalamus, the dorsal column pathway will run ipsilaterally but will cross to the contralateral side.[8,9] The location where the dorsal track passes to the opposite side is labeled the medial lemniscus.[9] This crossing is responsible for tactile sensation and limb proprioceptive input from the right side of the body being transmitted to the left side of the brain.[8,9] The dorsal column-medial lemniscus is responsible for sensation and proprioception to the arm, but the dorsal part of the lateral column accepts information transmitted from the lower extremity. The structure that transmits pain and temperature change is the anterolateral system. These signals ascend along the anterolateral portion of the lateral column after being sent to the contralateral side of the body. These signals travel to one of three parts of the brain, which include the reticular formation of the pons and medulla, the midbrain and the thalamus. Another function of the anterolateral column is to relay a small amount of tactile information, for this reason if there is a lesion on the dorsal column a person still retains crude tactile sensation.[9]

Muscle activation can be altered by altering different variables. Changing the positioning of the trunk is one way to alter the amount of muscle activation in the bench press. While performing the bench press there are four different positions for the trunk including incline, decline, horizontal and the military press position. The incline bench press is where the head is above the rest of the body. The muscles that had a higher activation when the body was at the incline are the clavicular portion of the pectoralis major and the triceps brachii. The decline positioning is when the head is lower than the rest of the body and the latissimus dorsi had increased activation in this positioning. The standard positioning for the bench press is horizontal; this is when the head and body are at on the same level. The sternocostal portion of the pectoralis major has increased activation in the horizontal position.[10] The military bench press is when the person is standing and presses the bar overhead. While in this position, the muscle activation increased for the anterior deltoid.[10]

More than 20 muscles are responsible for motion in the shoulder and must work in synchronization for movement to be optimal.[4] For normal biomechanics and scapulothoracic motion these muscles must have synergistic effects and maintain an appropriate length-tension relationship.[7] Different muscles are activated in different motions and it is the complex response as a result of neural signals which allows these muscles to maintain normal biomechanics.

Motion Analysis of the Upper Extremity

The shoulder complex is the most multifaceted joint in the body using three different joints, plus the scapulothoracic, to produce a wide range of motion. The wide variety of muscular attachments allow for complex motion to occur, especially at the scapulothoracic and glenohumeral joints. The motions that occur at the scapulothoracic joint are adduction, abduction, upward rotation, downward rotation, anterior tilt, elevation and depression[11] and are a result of the collaboration between the sternoclavicular and acromioclavicular joints.[6] Upward and downward rotation at the scapula are important for increasing range of motion at the glenohumeral joint. Other benefits of scapular rotation include the movement of the glenoid fossa, which gives the humeral head a firm base, preventing inferior dislocation and impingement during full elevation. In order to obtain the rotation motion, a force couple, or muscles which pull the scapula in opposite directions to create rotation must occur. The upper trapezius, levator scapulae and rhomboids will contract to pull the superior portion of the scapula medially and into elevation while the lower trapezius and lower serratus anterior contract to pull the inferior scapula into scapular depression and laterally. The result of this force coupling motion is upward rotation of the scapula.

The glenohumeral joint has a high range of motion due to its positioning and its three degrees of freedom.[6] The motions that occur at this joint are humeral flexion, extension, internal and external rotation, abduction, adduction and horizontal abduction and adduction. When the upper extremity is at rest the scapula's positioning against the thorax is one that has the glenoid fossa at approximately 35 degrees anterior to the frontal plane, also known as the scapular plane. When abduction occurs in this plane, as opposed to in the pure frontal plane, it will be greater because the apex of the greater tubercle fits into the coracoacromial arch. In order to reach this full range of abduction the convex head of the humerus and the concave glenoid fossa form a ball-and-socket joint which rolls and slides.[6]

In the shoulder, there must be proper scapulohumeral rhythm for total, pain-free motion to occur. If there were only one joint involved in the shoulder the range of motion would be greatly compromised and the amount of accompanied stability would increase. The normal ratio of abduction scapulohumeral rhythm is 2:1. This ratio is the combination of glenohumeral and scapulothoracic joint movements. There will be two degrees of glenohumeral movement and one degree of scapulothoracic movement for every three degrees of shoulder abduction.[6] To maintain this motion equilibrium at the shoulder the forces of the prime movers, gravity, compression, friction and joint reactive forces must be equivalent. The rotator cuff and deltoid muscles are two of the prime movers and they must work together for appropriate motion to occur in the upper extremity. The deltoid muscle acts to elevate the humerus which counteracts the force of gravity. The infraspinatus, supraspinatus, teres minor and subscapularis work together to pull the humeral head to center in the glenoid fossa and allow for pivoting during glenohumeral flexion and/or abduction. When the coupling effect of the deltoid and rotator cuff muscles occur, the humeral head will be depressed and stabilized, allowing abduction without superior or inferior subluxation. These muscles will also provide dynamic stability to the glenohumeral joint when the head of the humerus is compressed in the glenoid fossa.[6,12]

A problem could occur at the scapulothoracic joint if the movement is uncoordinated or if one of the muscles involved in the force couple are weak or underactive. The muscles that cause elevation and medial rotation, especially the upper trapezius, must move excessively to compensate for the weakness in the muscles that depress and laterally rotate the scapula.[7] There are also issues that can occur at the glenohumeral joint to cause dyskinesia. If the deltoid were to contract without the muscles of the rotator cuff the humerus would translate superiorly and potentially result in shoulder impingement. The overactive deltoid causes the sliding of the larger humeral head on the smaller fossa, which results in the impingement of the suprapinatus muscle, tendon and bursa. This occurs after only 22 degrees of abduction if the rotator cuff muscles do not activate.[6] If the opposite happens and rotator cuff muscles contracted without the deltoid, then the humeral head would sublux inferiorly.

The function of the upper extremity can be affected by fatigue of the muscles involved in the exercise. During the horizontal bench press, the upward velocity is greatest early in the set and as it progresses to the last repetition the amount of time to lift the bar doubled. In addition, as a lift approaches the last repetition, each repetition lift time becomes more similar to the one repetition maximum.[13] A sticking region is the time where failure to complete a lift is most likely to occur. This region can explain the attempts to increase lift velocity by the athlete trying to complete the lift by pushing through the difficult region faster.[13] The path of the bar will also change due to fatigue as a lift reaches the last repetition. As the lift progressed to the end, the bar had a tendency to move more over the shoulders than at the beginning.[13] In the study conducted by Duffey the bar path varied more from a straight line towards the end of the lift. As with the lift velocity, the bar path becomes more similar to the path of the one repetition maximum when a set is done to fatigue.[13]

With each motion that occurs in the body, there are muscles that work together and against each other to achieve a desired movement and stability. If these muscles' strength is disproportional to one another it will place the shoulder in a position for greater susceptibility to injury. There must be a way to measure the amount of movement in the body. The EMG machine is used to assist in identifying the muscles involved in the motion.

Electromyography

There are two ways to objectify and quantify the muscles activated during movement.[14] Electromyography (EMG) uses a needle electrode which is placed into the muscle belly to detect the size of contraction. The second option is the surface EMG (sEMG), which is used to noninvasively measure muscle activity and the muscular demand during exercise.[7,15] The sEMG machine uses electrode pads which are placed near excitable membranes on the belly of the muscle being tested where the machine can distinguish isometric, concentric and eccentric muscle actions.[15] The raw data is normalized into useful, comparable data that measures muscle activation.[16,17] Change in muscle contraction speed, the muscle length at the start and the type of contraction can influence or alter the output signal.

There are recommendations that should be followed when preparing the subject to be tested by the sEMG. The site of electrode attachment should be shaved, abraded and cleaned with alcohol.[7,18,19,20] To abrade the skin it is suggested to use the lowest grit available so the skin is not broken.[18,19] These steps will reduces impedance from the skin and to guarantee proper fixation.[7,20] Another way to decrease the amount of impedance and obtain stable recordings and low electrode noise level is to use a gel on the electrode pad. There are electrodes that already have gel on the pad, which makes it easier to apply and remove. Electrode size can vary between 1 mm^2 and a few cm^2, but it has been tested that the electrodes should not exceed 10 mm^2 to receive the best signals. Extra precautions to take include taping the wires and electrodes to avoid pulling artifact if the experiment requires fast dynamic contractions.[21]

The positioning of the electrodes is critical when using the sEMG because many muscles overlap one another.

Stegeman, et al recommends placing the electrodes halfway between the most distal motor endplate and distal tendon. There are conflicting reports on the orientation of electrodes and the muscle fibers. Different studies report aligning the electrodes parallel or perpendicular to the muscle fibers, so further research is needed in this area. To confirm the proper position of the electrodes on the muscle palpation[18] and manual muscle testing[7] must be completed. Examples of proper positioning include placement on the upper trapezius, lower trapezius, serratus anterior and middle deltoid. Placement of the electrodes on the upper trapezius muscle is on a line midway between the acromion and the seventh cervical vertebrae and for the lower trapezius is on a line between the intersection of the spine and the vertebral border of the scapula. Under the axilla region, between the pectoralis major muscle and latissimus dorsi muscle is the appropriate location for electrodes on the serratus anterior. For the middle deltoid muscle, the electrodes should be placed halfway between the deltoid tuberosity and the acromion process. [7, 20]

By placing the EMG on the muscles used in a movement one can test the amount of electricity generated. Thus, indirectly, the EMG machine will be effective in testing the muscles involved in the bench press. It will also be helpful in showing if there are any muscular deficiencies and if another muscle is compensating.

Techniques and Mechanics of the Bench Press

The one rep max bench press test is the gold standard in the weight room for dynamic strengthening the upper extremity.[22] There is evidence that large muscle group exercises are more effective in strengthening than small muscle group exercises. Short-term gains in strength, from 2-6 weeks after the start of a program, are caused by neural drive. Neural drive to a muscle is the muscle fiber recruitment and the rate of firing and is affected by multiple factors. These factors include increased motor unit synchronization, increased agonist activation, decreased antagonist activation, protective mechanism inhibition, reciprocal inhibition, motor unit coordination and the muscles involved in the movement. If one continues a strength-training program for longer than 10 weeks the cause of increased strength will switch from neural drive effects to muscle hypertrophy. Muscle hypertrophy is the result of a combination of increased protein synthesis and protein degradation decrease.[1] Muscle hyperplasia, or the increase in number of muscle cells, has little effect on strength increasing.

The primary goal in strength training is to find the optimal program and condition to enhance the individual athletes' performance.[23] Load, volume, rest interval and proper mechanics are main principles of the bench press. In weight lifting the load is the resistance or amount of weight lifted with one exercise, like one repetition of the bench press.[1] Every load is a percentage of the individual's one repetition maximum; the most commonly used for strength training is exercising above 50 percent of the one rep maximum. The load an individual is able to lift is dependent upon exercise order, muscle action and the length of the rest interval. The type of load will determine the amount of muscle fibers, which will be recruited within the muscle group.[1] A higher amount of weight placed on the bar the more muscle fibers the body will need to recruit to assist in lifting it. Another effect of a greater load is the greater the amount of strength gain or hypertrophy of the muscle cells. If a lighter load is used at a lower intensity local muscular endurance will increase.[1] Load and repetitions have an inverse relationship with one another. As the load increases, the amount of repetitions the individual will be able to complete will decrease. Muscle shape can also be affected it by varying the type of strength training programs.[24] Altering a work out can cause many different physiological changes to the muscle.

Two other variables which can be manipulated are the volume of the lift and the rest period between sets. The volume in which a person can lift can be represented by the sets multiplied by the repetitions and the resistance. It can be altered by changing the number of exercises, sets or repetitions.[1] The amount of rest between sets is under constant scrutiny due to the effects it can have upon the body. The study completed by Kraemer, et al stated that short rest intervals increased the amount of lactate and growth hormone concentrations. Also stated in the study by Kraemer was the fact that a long rest period had little to no change.

Proper mechanics in the bench press are necessary to obtain an optimal result. After lifting the bar off the rack the individual must begin the bench press with their elbows extended and hold that position for 2-3 seconds. The bar should then be lowered until it gently touches the chest, pause in this position and then raise the bar back to the starting position.[13] To get the best muscle activation the bench press should be moved in a slow and controlled manner directly over the shoulders.[11] For the lifter's safety two spotters can stand on either end of the bar lightly holding it so the bar can be caught if the load is unable to be lifted.[13]

The bench press will be an effective way of strengthening the upper extremity if correct mechanics are used. The bench press is not just one single motion in which only load, exercises or repetitions. There can also be different variations of the bar which affects muscles differently during the bench press.

Bar Manipulations

During the bench press the bar can have a different width or grip; this will affect type of strengthening which will occur. The width of the bar will affect different muscles.[16] A wide grip will increase activation of both portions of the pectoralis major, the biceps brachii and latissimus dorsi. The anterior deltoid, triceps brachii and the clavicular portion of the pectoralis major are more strengthened more effectively with a bar with a narrow diameter.[10,16] When doing the bench press changing the positioning of the hands can also be more effective for certain muscles. In the study completed by Grant, et al. it was found that a smaller bar diameter resulted in the greatest maximal voluntary contraction (MVC) but had the lowest neuromuscular activation.[25] In contrast to Grant's findings, the study completed by Fioranelli and Lee discovered that bar diameter had no significant effect on isometric, unilateral MVC.[26] Also during a one repetition maximum study which tested to discover a change in load found no difference between the bar widths when using a standard Olympic, two inch and three inch bars.[27] While MVC was unaffected, the Fioranelli study was able to determine that neuromuscular activation was greater during an isometric contraction when the bar was smaller.[26]

There can be other variations on the bench press which can activate muscles more than the standard positioning. Another modification of the bench press can be changing hand position. Typical hand positioning during the bench press is pronation, which is when the palms are facing down or away from the head. The triceps brachii muscles had increased activation when the hands were pronated.[16] Supination is when the palms are facing up or towards the head. The muscles whose activation increased when the hands were supinated were the biceps brachii and the clavicular portion of the pectoralis major. One muscle that had no increase in activation with the change hand positions was the sternocostal portion of the pectoralis major.[16] Mobile parts on the bar may also have an influence on which muscles are activated effectively, but more research is necessary in this area.

Summary

The literature demonstrates that the musculature of the upper extremity works together in a unique way to produce a wide range of motion. In order for muscles to contract there must be a signal sent efferently from the brain, and initiating the upper extremity to complete a fluid motion. The standard Olympic bar bench press is most frequently used to strengthen the upper body, but the controversy is that there are different variations that may be more efficient than the Olympic bar. Evidence is needed to show the different variations of bench press compared to one another to discover which is more effective. As athletics continue to progress there will be a greater need to strengthen muscles effectively. For this reason individuals are developing many new variations on strength training programs.

APPENDIX B

The Problem

THE PROBLEM

The purpose of this study was to test the claims of the Isobar® Lite manufacturer that their bar is superior to the standard Olympic bar in terms of muscle activation. This study investigated if the claims are in fact true; therefore, changing the public's perception of the Olympic bar bench press. Additionally, the researcher investigated the effectiveness of the bench press in muscle activation.

Definition of Terms

The following operational terms were defined for this study:

1) Delayed Onset Muscle Soreness (DOMS) – Muscle soreness that peaks 24-96 hours after activity and can last up to 7-10 days.[27] It can cause increased muscle swelling, stiffness, tension and resistance to stretching.[28] DOMS can be a result from small tears in the tissue or from disruption of the connective tissue during eccentric exercise.[27,28]
2) Maximum Voluntary Isometric Contraction (MVIC) – Normalized the data collected by the EMG machine.[7,29] Served as the reference value to compare the peak

muscle activity levels which occurred during the two bar exercises.[7]

3) Muscle Activation – The level of recruitment of muscle as sent via the afferent nerve pathway from the brain measured by EMG.[6]

4) Strength – In this study, strength was the subject’s ability to lift 65% of their one repetition maximum for three repetitions. Generally, strength was defined as the ability of the neuromuscular system to produce inner tension and exert resistance against an external force.[30]

5) Weight Lifting- The bench press is the only lift completed in this study. When this term is used, it refers to the proper technique of the bench press.

Basic Assumptions

The following were basic assumptions of this study:

1) There was no evidence that the volunteers would respond differently than random subjects.

2) The subjects answered truthfully on the demographic sheet.

3) The equipment was working correctly and properly calibrated.

4) The subjects were not suffering from DOMS due to the 1 RM test completed for baseline purposes.

5) The subjects were physically active with no prior history of upper body injury, and performed to the best of their ability during the experiment.

Limitations of the Study

The following were possible limitations of the study:

1) The equipment used in the experiment may not have been state of the art. The equipment that was available for this study may not have been the newest version available. This will not affect the study because the equipment that was used was still reliable and valid.

2) The participants did not have a large amount of experience using the Isobar® Lite.

3) Participants may have been suffering from DOMS during the experiment.

4) The bars were of different weights (Isobar® Lite - 23 pounds Olympic Bar- 45 pounds) but the total weights were the same. In order to equalize weight on each bar a one pound cuff weight was added to each end of the Isobar® Lite.

5) Two different facilities were used in testing subjects, which may have effected subject

concentration. Although there were two testing facilities, the same facility was used for one person during all of the testing completed on the second day.

6) During the study, the electrodes over the infraspinatus muscle may have come in contact with the bench causing interference. Even though this happened the data was still reliable due to the removal of data that occurred during the interference.

Delimitations of the Study

The following were the delimitations of the study:

1) The subjects were college students aged 18-24, from California University of Pennsylvania.
2) Pertained to an injury free populace.
3) Active individuals.
4) Experience with weight lifting.

Significance of the Study

The bench press is normally used for strengthening the upper body but with new developments in strength training it may not be the best option available. This study investigated the Isobar® Lite, one of these newer developments in strength training, to see if it was more effective in activating the muscles of the upper body. If it found that the Isobar® Lite was superior to the standard bar than it could transform the bench press exercise making it activate the muscles better. The Isobar® Lite could activate the more musculature quicker than the Olympic bar making the exercise time efficient.

APPENDIX C

Additional Methods

APPENDIX C1

Institutional Review Board –

California University of Pennsylvania

California University of Pennsylvania

Proposal Number 08-030
Date Received 12/1/08

expedite

PROTOCOL for Research Involving Human Subjects

Institutional Review Board (IRB) approval is required before beginning any research and/or data collection involving human subjects

(Reference IRB Policies and Procedures for clarification)

Project : Muscular Involvement During the Bench Press using the Isobar® Lite and Standard Olympic bar

Researcher/Project Director: Ashley L. Nonemaker

Phone # 240-409-8878 ***E-mail Address*** non4977@cup.edu

Faculty Sponsor (if required) Dr. Marc Federico

Department Health Sciences and Sports Studies

Project Dates September 2008 ***to*** May 2009

Sponsoring Agent (if applicable) ____________________

Project to be Conducted at Hamer Hall, California University of Pennsylvania

Project Purpose: ☒ ***Thesis*** ☐ ***Research*** ☐ ***Class Project*** ☐ ***Other***

Keep a copy of this form for your records.

Required IRB Training

The training requirement can be satisfied by completing the online training session at http://cme.nci.nih.gov/ *. A copy of your certification of training must be attached to this IRB Protocol. If you have completed the training at an earlier date and have already provided documentation to the California University of Pennsylvania Grants Office, please provide the following:*

Previous Project Title ____________________

Date of Previous IRB Protocol ____________________

1. *Provide an overview of your project-proposal describing what you plan to do and how you will go about doing it. Include any hypothesis(ses)or research questions that might be involved and explain how the information you gather will be analyzed. For a complete list of what should be included in your summary, please refer to Appendix B of the IRB Policies and Procedures Manual*

The purpose of this study is to investigate the difference in muscle activation during the bench press when using a standard Olympic bar and an Isobar® Lite. The electromyographical (EMG) activity will be measured to evaluate the activation of specific muscles during this exercise.

Hypotheses:

The following hypotheses were based previous research and the researcher's intuition based on a review of the literature.

1. There is no significant difference in peak muscle activation during eccentric or concentric contractions with the different bar types.
2. There is no significant difference in average muscle activation during eccentric or concentric contractions with the different bar types.

Procedure:

Once approval by the Institutional Review Board at California University of Pennsylvania is received and informed consent and a demographic sheet are obtained, there will be an explanatory session to inform the volunteers of the process. Volunteers will be chosen by searching the campus of California University of Pennsylvania to find volunteers. To minimize the risk of injury these volunteers will disqualified from the study to if they had a recent injury to the upper extremity in which they received medical attention, no prior experience with the bench press exercise, if they do not meet the demographic standards or if the volunteer has any other condition that may affect performance. Some of these conditions can include rotator cuff tear/surgery, shoulder dislocation, total shoulder arthroscopy, anterior capsular shift and biceps brachii rupture. This could also include any disease or systemic conditions that may affect performance or worsen with participation. Before completing the study there will be a pilot study preformed.

The volunteers will next be asked to estimate what their 1 repetition maximum (1RM) would be and this will be called the perceived maximum. The perceived maximum is the estimated value of the 1RM based upon the volunteers' prior experience performing the bench press exercise. Volunteers will peddle the Upper Body Ergometer (UBE) for five minutes at a moderate workload speed of 60 revolutions per minute (rpm). The warm up will continue after a one minute rest with a set of five bench press repetitions at 50% of the perceived maximum. During the period of rest, the volunteer will be allowed to perform light stretching of the upper extremity of my choosing.

The researcher will now determine the volunteers 1 RM using the Olympic bar. Their perceived maximum weight will be placed on the bar for the first lift. The subjects will be asked to lift the bar. If the subject can only lift the bar for one repetition then ten pounds will be added to the bar and the volunteer will be asked to lift the bar again. If they cannot lift the bar then the earlier weight is determined to be their 1 RM. This procedure is repeated until the 1 RM is determined. It is expected that several attempts of the bench press exercise may need to be performed to determine 1 RM. The goal will be to find the volunteer's 1RM within 3-5 tries with a ten-pound increment of weight added after each successful lift until a lift attempt fails. During every 1RM attempt there will be two spotters closely observing to assist the lifter with bar replacement. The spotters will be positioned at either end of the bar and will follow the bars' path with their hands keeping the bar within reach. To ensure proper spotting technique I will provide a brief instruction so that expected spotting technique will be achieved. The positioning of the spotters will allow them to utilize their entire body to support the weight in the case of the volunteer dropping the bar. The spotters would be able to support the weight of the bar so the volunteer could move from under the bar.

The 1RM for each volunteer will be recorded on a sheet with their corresponding subject number. While waiting to complete their 1RM the volunteers will have an opportunity to practice using the Isobar® Lite [Santa Barbara, CA]. Seven days following the 1RM completion, the volunteers will return at a time designated by the researcher where they will complete a warm-up session utilizing the UBE and one warm up set on each of the two bars. The UBE portion of the warm up will be a five minutes session as performed in the 1 RM testing. The bench press warm up exercises will lift either 50% of their 1 RM or 45 pounds (the weight of the bar alone), whichever is greater. The volunteers will complete two sets of ten repetitions (one set with each bar) with a metronome. The metronome will be used during the warm up as practice performing the bench press in a controlled and uniform manner by giving the volunteer an auditory command as to when to begin each phase of the lift. The metronome will beep indicating to the volunteer to begin the concentric (up) phase of the lift, and then beep a second time to indicate when to begin the eccentric (down) phase. The volunteers will be randomly assigned to two groups, one will complete the Olympic bar lift first and the second will complete the Isobar® Light lift first. The sites for the electrodes will be prepared in a standard fashion to decrease impedance and then the electrodes will be placed over the motor points in each muscle belly being tested. An electronic biaxial goniometer will also be applied to the subject's arm to measure the angle of the arm when a peak muscular contraction occurs.

Once electrodes are in place, the BIOPAC MP150® [Goleta, CA] is turned on and connected to the laptop computer with the Acqknowledge® software [Goleta, CA] the participant will start the activity. The volunteers will complete an isometric contraction so that an EMG value for a maximal contraction can be recorded. Each volunteer will do an isometric contraction three times for each muscle. The highest value for each muscle will be recorded as the maximal voluntary isometric contraction (MVIC). The procedures will be repeated identically for both bars. They will lie on a horizontal bench and grab the Olympic bar outside the knurl. The knurl is the location on the bar where the smooth portion of the bar ends and a textured area begins. The volunteer will then lift the bar off the rack and hold the bar for 2-3 seconds with their elbows extended. The bar will be lowered until it gently touches the volunteer's chest, pause for one second, and then lifted back up to the beginning position. The bench motion should be completed in a slow and controlled manner, taking four seconds on the descent and three seconds when extending elbows up. To keep the movements uniform, there will be a metronome to keep a beat. There will be a spotter assisting the lift to maintain the volunteer's safety. The volunteers will complete three repetitions at 65% of their maximal contraction. As the volunteer is lifting, the EMG machine was recording the activation of four muscles. The hand placement on the mobile parts of the bar was the only difference between the experiments with the two bars.

Data Analysis:

The research hypotheses will be analyzed using a multivariate repeated measures 2x2x4 analysis of variance. All data will be analyzed by Statistical Package for Social Sciences (SPSS) version 16.0 for Windows at an alpha level of 0.05. All EMG scores will be reported as percentage of maximal voluntary contraction.

2. *Section 46.11 of the Federal Regulations state that research proposals involving human subjects must satisfy certain requirements before the IRB can grant approval. You should describe in detail how the following requirements will be satisfied. Be sure to address each area separately.*

    a. *How will you insure that any risks to subjects are minimized? If there are potential risks, describe what will be done to minimize these risks. If there are risks, describe why the risks to participants are reasonable in relation to the anticipated benefits.*

    There will be minimal risks which will be monitored by taking every precaution possible. This study will use non-injured, physically active participants so to decrease the likelihood of injury. Volunteers will be disqualified from this study if they have no prior experience doing the bench press. During the activity there will a spotter to assist the participant if they are unable complete the lift. If at any time the subject begins to experience pain or discomfort they can discontinue the lift immediately. In the event of an injury there will a Certified Athletic Trainer present to evaluate and provide treatment to the subject. The risk to the participants is reasonable with respect to the benefits because the risk is very low. Also, this study can change the way the bench press is viewed and change how people strength train.

    b. *How will you insure that the selection of subjects is equitable? Take into account your purpose(s). Be sure you address research problems involving vulnerable populations such as children, prisoners, pregnant women, mentally disabled persons, and economically or educationally disadvantaged persons. If this is an in-class project describe how you will minimize the possibility that students will feel coerced.*

    The subjects will be volunteers from the student population enrolled in Health Sciences and Sports Studies classes of the California University of Pennsylvania campus. The study will be announced in multiple health related classes and emailed to students in these classes to obtain an even sample of the test population. The potential subject will in no way be coerced to participate in this study. I will not have any research problems pertaining to vulnerable populations because my subjects will be college aged students that will not include prisoners, pregnant, mentally disabled, educationally or economically disadvantaged people.

    c. *How will you obtain informed consent from each participant or the subject's legally authorized representative and ensure that all consent forms are appropriately documented? Be sure to attach a copy of your consent form to the project summary.*

    The informed consent will be distributed prior to participation during an informational meeting. This paper will inform the participant about the procedure and purpose of the study and their role.

    d. *Show that the research plan makes provisions to monitor the data collected to insure the safety of all subjects. This includes the privacy of subjects' responses and provisions for maintaining the security and confidentiality of the data.*

To monitor the data collection only the researcher and the research advisor will have access to it. The subjects' names will never appear on the data and they will also be assigned a number to keep the subjects' results anonymous. The data will remain in a secure location where only the researcher has access to it.

3. *Check the appropriate box(es) that describe the subjects you plan to use.*

☒ *Adult volunteers*	☐ *Mentally Disabled People*
☒ *CAL University Students*	☐ *Economically Disadvantaged People*
☐ *Other Students*	☐ *Educationally Disadvantaged People*
☐ *Prisoners*	☐ *Fetuses or fetal material*
☐ *Pregnant Women*	☐ *Children Under 18*
☐ *Physically Handicapped People*	☐ *Neonates*

4. *Is remuneration involved in your project?* ☐ *Yes or* ☒ *No. If yes, Explain here.*

5. *Is this project part of a grant?* ☐ *Yes or* ☒ *No If yes, provide the following information:*

   Title of the Grant Proposal ____

   Name of the Funding Agency ____

   Dates of the Project Period ____

6. *Does your project involve the debriefing of those who participated?* ☐ *Yes or* ☒ *No*

   If Yes, explain the debriefing process here.

If your project involves a questionnaire interview, ensure that it meets the requirements of Appendix __ in the Policies and Procedures Manual.

Project Director's Certification

Program Involving HUMAN SUBJECTS

The proposed investigation involves the use of human subjects and I am submitting the complete application form and project description to the Institutional Review Board for Research Involving Human Subjects.

I understand that Institutional Review Board (IRB) approval is required before beginning any research and/or data collection involving human subjects. If the Board grants approval of this application, I agree to:

1. Abide by any conditions or changes in the project required by the Board.
2. Report to the Board any change in the research plan that affects the method of using human subjects before such change is instituted.
3. Report to the Board any problems that arise in connection with the use of human subjects.
4. Seek advice of the Board whenever I believe such advice is necessary or would be helpful.
5. Secure the informed, written consent of all human subjects participating in the project.
6. Cooperate with the Board in its effort to provide a continuing review after investigations have been initiated.

I have reviewed the Federal and State regulations concerning the use of human subjects in research and training programs and the guidelines. I agree to abide by the regulations and guidelines aforementioned and will adhere to policies and procedures described in my application. I understand that changes to the research must be approved by the IRB before they are implemented.

Professional Research

Project Director's Signature | Department Chairperson's Signature

Student or Class Research

Student Researcher's Signature

Supervising Faculty Member's Signature if required | Department Chairperson's Signature

ACTION OF REVIEW BOARD (IRB use only)

approved as amended

The Institutional Review Board for Research Involving Human Subjects has reviewed this application to ascertain whether or not the proposed project:

Chair IRB

01-21-09

APPENDIX C2

Informed Consent Form

Informed Consent

Ashley Nonemaker, ATC a graduate student at California University of Pennsylvania has requested my participation in a research study. The title of the research is "Muscular Involvement During the Bench Press using a Isobar® Lite and Standard Olympic Bar."

I have been informed that the purpose of this study is to compare the relative muscle activation of select upper extremity muscles of active college students during the bench press comparing the Olympic bar to the Isobar® Light. Muscle activation will be determined by measuring the muscle activity of select muscles via surface electrodes.

I know that I fit the following requirements of all potential subjects. The subjects will include California University of Pennsylvania students aged 18-24 years old. Subjects also must be injury-free to the upper extremity within the past six months, physically active, and have basic knowledge of weight lifting. To be considered physically active the volunteer must engage in some sort of physical activity that raises the heart rate at least three times a week. The volunteer who has the basic knowledge of weight lifting is someone who has participated in a formalized weight-training program in the past. The subject must also currently lift weights or previously lifted weights. I acknowledge that all my participation will be on a voluntary basis and I may choose to discontinue participation at any time.

During this study my participation will involve a one repetition maximum (1 RM) bench press test, a maximum voluntary isometric contraction (MVIC), a bench press test with weight 80% of my 1 RM with the Olympic bar and the Isobar® Lite. An isometric contraction is a muscular contraction that creates tension in a muscle without lengthening or shortening the muscle. I will next be asked to estimate what my 1 RM is and this will be called the perceived maximum. The perceived maximum is the estimated value of the 1 RM based upon prior experience performing the bench press exercise.

As part of my warm up I will peddle the Upper Body Ergometer(UBE)for five minutes at a moderate workload speed of 60 revolutions per minute (rpm). The warm up will continue after a one-minute rest with a set of five bench press repetitions at 50% of the perceived maximum. During the period of rest, I will be allowed to perform light stretching of the upper extremity of my choosing.

The researcher will now determine my 1 RM using the Olympic bar. My perceived maximum weight will be placed on the bar for the first lift. Then I will be asked to lift the bar. If I can only lift the bar for one repetition then ten pounds will be added to the bar and I will be asked to lift the bar again. If I cannot lift the bar then the earlier weight is determined to be my 1 RM. This procedure is repeated until the 1 RM is determined. It is expected that several attempts of the bench press exercise may need to be performed to determine 1 RM. The goal will be to find the my 1 RM within 3-5 tries with a ten pound increment of weight added after each successful lift until a lift attempt fails. During every 1 RM attempt there will be two spotters closely observing to assist me with bar replacement. The spotters will be positioned at either end of the bar and will follow the bars’ path with their hands keeping the bar within reach. To ensure proper spotting technique the researcher will provide a brief instruction so that expected spotting technique will be achieved. The positioning of the spotters will allow them to utilize their entire body to support the weight in the case I dropping the bar. The spotters would be able to support the weight of the bar so I can move from under the bar.

The data collection will include 2 meetings each one week apart. The first meeting I will attend will have an informational session, where my 1 RM will be recorded and I will practice using the Isobar® Lite. This session will last approximately 20-30 minutes. The duration of the second meeting will be approximately 45 minutes and this is when I will complete the exercises with the Olympic bar and the Isobar® Lite.

On the second day, I will be expected to complete three maximal isometric contractions, lasting six seconds each, for each muscle being tested where the researcher will use the best value for each muscle. Prior to the testing I will complete a warm-up session utilizing the UBE and one warm up set on each of the two bars. The UBE portion of the warm up will be a five minutes session as performed in the 1 RM testing. The bench press warm up exercises will lift either 50% of their 1 RM or 45 pounds (the weight of the bar alone), whichever is greater. The Procedure for testing with the Olympic bar and Isobar® Lite will be as follows; I will lift the bar off the rack and hold the bar for 2-3 seconds with my elbows extended. The bar will be lowered until it gently touched my chest, pause for one second, and then lift back up to the beginning position. I will complete three repetitions at 80% of my maximal contraction as determined by my 1 RM with each bar.

I understand that there are possible discomforts or risks while participating in this study; however, every precaution will be taken to maintain my safety. Spotters will be present during every lift and if any discomfort is felt during the testing I will be able to stop immediately. I recognize that I may experience some mild muscle soreness after the 1 RM testing. If this occurs I can expect to receive treatment at the University’s Student Health Services or from Ashley Nonemaker, ATC in California University of Pennsylvania’s Athletic Training Room in Hamer Hall. I also understand that the researcher will properly and carefully attach the electrodes in a standard fashion to decrease impedance on the areas over the muscles being tested and that this may cause minimal discomfort. The electrodes will be placed on both the front and back of my upper arm, my shoulder blade and upper chest over the muscles which are being tested.

I understand that there are possible benefits of my participation in this study, which can contribute to advancing knowledge about muscular activation during the bench press. The fields of athletic training and strength and conditioning will benefit from this research because it will demonstrate a variation on the bench press, which will activate the specific muscles superiorly.

I understand that the results of this study may be published but my name and identity will remain confidential and never be revealed. All documents will remain in the possession of Ashley Nonemaker, the primary researcher, in a safe location at all times. The electronic files will be kept on the primary researcher’s personal computer to which only she has access and any necessary paper copies will be kept in a secure filing cabinet which only the primary researcher will have access. The filing cabinet is located at the researcher’s personal residence. The only people that will have access to the information will be the primary researcher and her research advisor, Dr. Marc Federico. I know that I will be assigned a subject number and all of my data will be associated with this number. Only the primary researcher will be able to link the subject number with my name, which will keep my identity secure. The documents will be kept until the thesis is successfully defended. The hard copies will be shredded and disposed of and the electronic copies will be completely deleted from the researcher’s personal computer.

I have been notified that I will not be receiving any compensation for my participation in this study. If I have any further questions, they can be directed to and answered by:

Ashley Nonemaker
947 Cross Street, Apt #6
California, PA 15419
Non4977@cup.edu
(240)-409-8878

Dr. Marc Federico
Department of Health Science and Sport Studies
Federico@cup.edu
(724)-938-4356

I have read and understood the above information. The procedures and risks of the study were explained to me. I knowingly assume the risks involved and understand that I am a volunteer and may withdraw my consent discontinuing my participation at any time without penalty and loss of benefit to myself. In signing this consent form, I am not waiving any legal claims or rights. A copy of this consent form will be given to me upon my request.

____ ______________

Subject’s Signature Date

I certify that I have explained to the above individual the purpose, potential benefits and possible risks associated with their participation in this research, I have answered any questions and have witnessed the above signature.

____ ______________

Researcher’s Signature Date

Institutional Review Board (IRB) approved of this research and is effective from 01/30/2009 and expires on 01/29/2010.

Appendix C3

Demographic Information Sheet

Demographic Information

Subject Number: _____________

1. Gender:

   ☐ Male ☐ Female

2. What is your current age?

   ☐ 18 ☐ 19 ☐ 20 ☐ 21

   ☐ 22 ☐ 23 ☐ 24 ☐ Other _______

3. Do you currently participate in physical activity?

   ☐ Yes ☐ No

4. What type of activities do you currently participate in?

   ☐ Cardiovascular Exercise ☐ Sports (Team or Individual)

   ☐ Weight Lifting ☐ Aerobics

   ☐ Other ___________________

5. How many times a week do you currently engage in at least 30 minutes of physical activity?

   ☐ 0-2 ☐ 3-4 ☐ 5-7

6. Do you have any medical conditions that prevent you from participating in strength training activities?

☐ Yes ☐ No

If you answered **Yes**, please explain:

____

____

____

7. Have you had any type of injury to the upper extremity or chest in the past six months that resulted in medical services?

☐ Yes ☐ No

If you answered **Yes**, please explain:

____

____

____

Appendix C4

Individual Data Collection Sheet

Individual Data Collection Sheet

Subject Number: ______ Dominant Arm: ______

RM Date: ______ Test Date: ______ 1st Bar: ______

1 Rep Max	65% of 1 RM	Pec MVC	Inf MVC	Bic MVC	Tri MVC

Visual Analogue Scale

0 1 2 3 4 5 6 7 8 9 10

No Pain ... Worst Pain Possible

		Olympic Bar				Isobar			
		P	**I**	**B**	**T**	**P**	**I**	**B**	**T**
Peak	**con.**								
	ecc.								
Avg.	**con.**								
	ecc.								
over all	peak								
	avg.								

Comments:

Figure 3. Individual Data Collection Sheet

Appendix C5

Isobar® Example Lift

Figure 4. Exaggerated Motion with an Isobar® During the Incline Bench Press[31]

Appendix C6

Isobar® Lite Hand Position Example

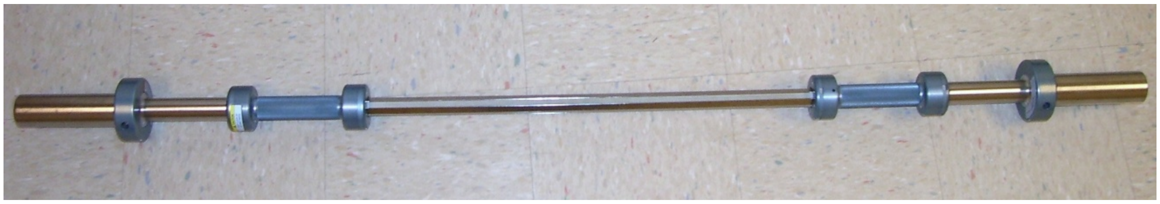

Figure 5. Isobar® Lite with Handles Positioned at the Furthest Points

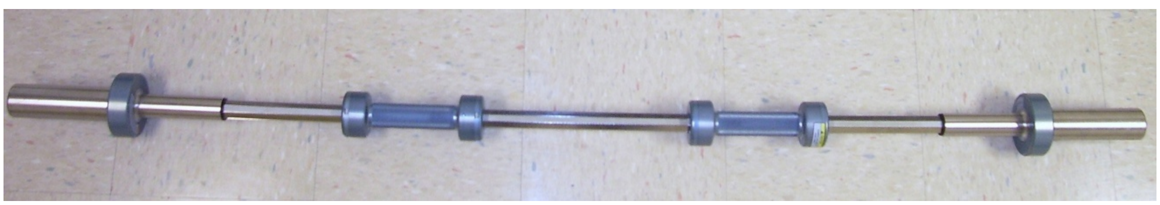

Figure 6. Isobar® Lite with Handles Positioned at the Test Lift Starting Position

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ABSTRACT

Title: MUSCULAR INVOLVEMENT DURING THE BENCH PRESS USING THE ISOBAR® LITE AND STANDARD OLYMPIC BAR

Researcher: Ashley L. Nonemaker

Advisor: Dr. Marc Federico

Date: May 2009

Research Type: Master's Thesis

Purpose: To investigate the effect of mobile parts on muscle activation of the upper extremity during the bench press.

Problem: There are claims that the variations are more effective than the standard bench pressing technique. There has not been any research in the area of mobile parts on the bar.

Method: A descriptive study investigated physically active, injury-free individuals. Testing took two days a minimum of seven days apart. The first day a one repetition maximum test and introduction to the Isobar Lite was completed. During the second day, data was collected using pre-gelled Ag-AgCl surface electrodes placed over the subject's dominant arm pectoralis major, infraspinatus, biceps brachii and triceps brachii's motor points. The subjects completed one set of three repetitions with 65% of their 1 RM with each bar. These electrodes were connected to the Biopac MP150 electromyography machine and the data was managed using Acqknowledge Software. A peak and average activation measurement was taken for each muscle during eccentric and concentric contractions for three repetitions. This was repeated for both bars in a random order. For each muscle the

data's absolute value was taken and smoothed.

Findings: The data was analyzed by using a multivariate, repeated measures 2x2x4 ANOVA. There was no significant difference found with the peak muscle activation comparing both bars (α=0.466). There was a significant difference found between all muscles except between the triceps and biceps brachii in the peak results. There was also no significant difference between bars found with the average muscle activation (α=0.134). Significant differences were found between triceps brachii and both infraspinatus and pectoralis for average muscle activation. A significant difference was found between eccentric and concentric contraction in the pectoralis major and infraspinatus average muscle activation. All significances were tested at a ($\alpha \leq 0.05$). There was also no significance found in the overall peak (α=0.19) and average (α=0.119) muscle activation between bars.

Conclusions: Mobile parts on the bar does not increase peak or average muscle activation as compared to the standard bar. Future testing could include investigating different lifts, variable manipulation with the Isobar or investigation of other bench press variations.