



NEAR-INFRARED SPECTROSCOPY TO GUIDE INTER-SET RECOVERY DURATIONS IN HIGH-LOAD BARBELL

BENCH PRESS: COMPARING PRIME MOVER AND ASSISTANCE MUSCLE

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Background

- Near-Infrared Spectroscopy (NIRS) is a non-invasive technique used to monitor muscle oxygenation in real time. It uses specific light wavelengths to measure oxygen levels in muscle tissue, providing continuous data on muscle performance, fatigue, and recovery.
- Muscle oxygen saturation (SmO₂), measured via NIRS, offers valuable insights into muscle metabolism—particularly phosphocreatine recovery during resistance exercise.
- SmO₂ levels typically decrease during intense exercise and rise during recovery, supporting processes like phosphocreatine resynthesis. By tracking these changes, NIRS helps optimize recovery times and training protocols. It can identify when muscles are sufficiently reoxygenated, enhancing both recovery and performance.
- SmO₂ can also guide optimal inter-set recovery durations, ensuring muscles are adequately recovered between sets to maximize performance.
- However, it remains unclear whether monitoring the prime mover muscle is essential, or if an assisting muscle could serve as a reliable indicator of recovery.

Purpose

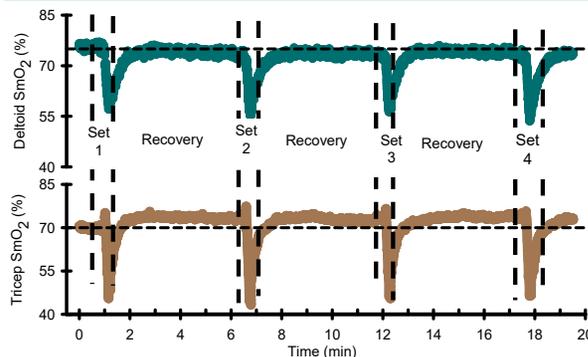
The purpose of this study was to examine SmO₂ during high-load barbell bench press in a prime mover (anterior deltoid) or an assistance muscle (triceps) to guide inter-set rest durations compared to a 5-minute inter-set duration (ABS).

Subject Characteristics

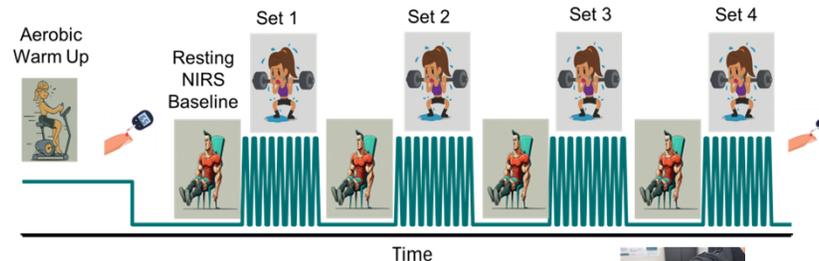
N	Age (yrs)	HT (cm)	WT (kg)	Predicted 1-RM (lbs)*	85% Predicted 1-RM (lbs)**
6	23.6 ± 5.8	166.6 ± 10.0	87.5 ± 29.0	168.1 ± 77.8	145 ± 66.3
M=3 F=3					

Data presented as mean ± sd. *One RM prediction test was performed prior to experimental conditions and calculated from load and repetitions to fatigue. ** 80% Predicted 1-RM was rounded up to the nearest 5 lbs to use as load in experimental condition.

Representative Data for TSI and HHH



Methods



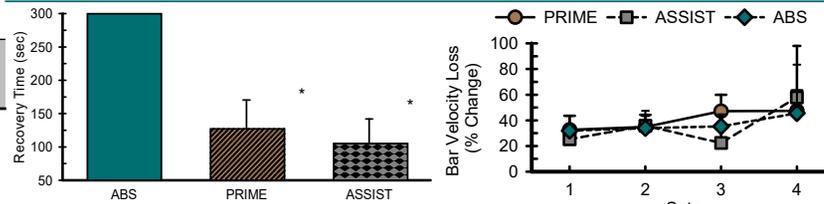
- Experimental conditions (PRIME, ASSIST, ABS) were performed in a random order.
- A continuous wave NIRS device was placed on anterior deltoid and triceps and was recorded continuously. Before the first set, participants rested seated, and the final 30 seconds were averaged as a baseline to normalize NIRS values.
- An arm-supported rest was done to establish a SmO₂ baseline (BSL).
- Participants performed 4 sets of 4 repetitions of barbell bench press at 85% 1-RM, with concentric phase as fast as possible.
- The only difference between conditions was the inter-set recovery duration.



Inter-set Rest Duration

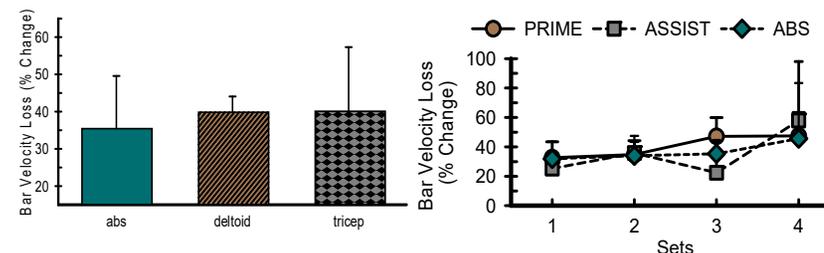
- ABS Condition Rest Duration** – 5-minute inter-set recovery.
- PRIME Condition Rest Duration** – SmO₂ of the anterior deltoid was monitored in real-time, and inter-set recovery ended when SmO₂ reached BSL for 5 seconds.
- ASSIST Condition Rest Duration** – SmO₂ of the triceps was monitored in real-time, and inter-set recovery ended when SmO₂ reached BSL for 5 seconds.
- All inter-set recoveries were in the seated position. At the end of the inter-set recovery, the participant was instructed to start the next set within 30 seconds. Recovery duration was time from the end of the set to when the participant was instructed to begin the next set.

Recovery Duration



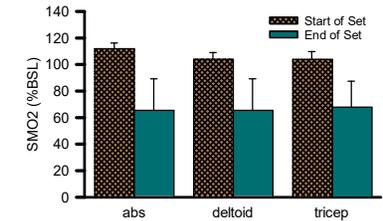
Recovery durations for PRIME and ASSIST were from the last repetition until a BSL was observed. All ABS recoveries were 300 seconds by design. Mean recovery duration is the average duration over the four sets. Data are mean ± SD. * = different from ABS (p<0.05); a = different from 1 (p<0.05)

Bar Velocity Loss



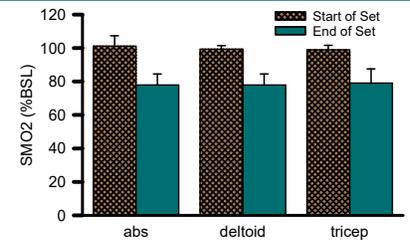
Bar velocity loss is change in bar velocity during the concentric component from the first rep to the last rep. Mean velocity loss is bar velocity loss averaged over the four sets. Data are mean ± SD.

Deltoid SmO₂



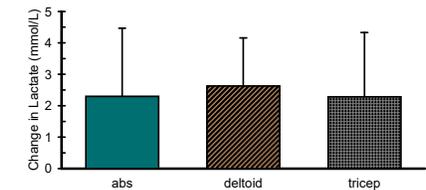
Deltoid SmO₂ at the end of inter-set recovery (Start of Set) and the end of the set in each condition (ABS, PRIME, ASSIST). Data are mean ± SD and displayed as a percent of the resting baseline.

Triceps SmO₂



Triceps SmO₂ at the end of inter-set recovery (Start of Set) and the end of the set in each condition (ABS, PRIME, ASSIST). Data are mean ± SD and displayed as a percent of the resting baseline.

Lactate



Change in Lactate is the difference in blood lactate from after warm-up immediately prior to set 1 (Pre) and immediately following set 4 (Post). Data are mean ± SD. a = all conditions are different from pre (p<0.05)

Conclusion

- NIRS-guided inter-set recovery resulted in shorter rest durations compared to a fixed 5-minute recovery period.
- There was no difference between monitoring the prime mover (PRIME) and an assisting muscle (ASSIST).
- Muscle oxygenation levels were similar across all conditions during both exercise and recovery, indicating no significant differences in metabolic stress or phosphocreatine resynthesis.
- SmO₂-guided recovery during high-load barbell bench press reduced inter-set rest time without affecting fatigue, metabolic stress, or blood lactate levels.

Practical Applications

- Practitioners can monitor either the prime mover or an assisting muscle to assess recovery, whichever is more convenient, with no changes in muscle stress or performance.
- NIRS enables real-time tracking of muscle oxygenation and deoxygenation during exercise, allowing practitioners to adjust inter-set recovery duration, based on objective physiological data.
- By identifying when muscle oxygen levels return to baseline, practitioners can reduce unnecessary recovery time and improve training efficiency through SmO₂-guided recovery.