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Effects of Compex as a Warm up for Glenohumeral Range of Motion

Cover Page Footnote
We would like to acknowledge Kelsey Robinson for her assistance in data collection.

Effects of Compex as a Warm-Up for Glenohumeral Range of Motion

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Purpose: Research regarding proper upper extremity warm-up protocols remains inconclusive, especially for electrical stimulation methods like the Compex Sport Elite® unit. The purpose of this study is to evaluate the acute effects of a single treatment of the Compex® using the pre-warm-up protocol on glenohumeral range of motion compared to a standardized upper body ergometer (UBE) warm-up protocol. **Methods:** Thirty-five healthy, young adults completed the study (19 men, 16 women; age=22±2y; height=172.1±9.4cm; mass=71.3±16.1kg; right-hand dominant=28; left-hand dominant=7). Participants came to the research laboratory on two occasions, at least 48 hours apart. Participants were randomly assigned the order to complete an upper body ergometer protocol (UBE) and Compex Sport Elite®. All participants completed both intervention conditions. The UBE protocol consisted of five minutes of arm cycling at a perceived intensity of "somewhat hard" or 13 on the rating of perceived exertion scale. The Compex Sport Elite® protocol was based on manufacturer guidelines. Electrical stimulation was delivered for 25 minutes. Dominant arm passive glenohumeral internal rotation (IROT) and external rotation (EROT) ROM were measured before, immediately after, and 30 minutes after intervention. The average of three trials was used. The Global Rating of Change (GROC) scale was used after both post-intervention ROM measurements. Outcome measures were recorded by a researcher blinded to the interventions. **Results**: No significant interaction effect (λ=0.97; $F_{(2,33)}$=0.54; p=0.59; ES=0.03) or main effects were observed for IROT. For EROT, no significant interaction effect was found (λ=0.88; $F_{(2,33)}$=2.18; p=0.13; ES=0.12); however we found a main effect of time (λ=0.77; $F_{(2,33)}$=5.03; p=0.12; ES=0.234). Follow-up pairwise comparisons indicated significant increase in EROT immediately post-intervention (1.508±.475; p=0.01) regardless of intervention. GROC values following dependent t-test resulted in no significant changes for either IROT or EROT (immediate post-intervention t_{34}=0.72, p=0.48; 30 minutes post-intervention t_{34}=0.59, p=0.56). **Conclusions:** No significant difference was found between the use of Compex® and UBE for warm-up of the glenohumeral joint. However, both interventions resulted in increased EROT immediately following application of intervention. Clinicians should select an intervention appropriate to meet patient goals, which may include a range of interventions or activities.

INTRODUCTION

Warm-up activities are commonplace in preparation for sport activity. Warm-up activities can include variation of exercises, methods, or exertion level to help prepare the body for physical activity.[1,2] The purpose of a warm-up period is to increase blood flow to the core and extremities, which may help prepare the body for activity.[2] Warm-up activities may also increase muscle elasticity, decrease muscle viscosity, increase metabolic activity, and increase individuals' preparedness for activity.[1, 2, 3] However, there is no consensus in the literature on the proposed effects of a warm-up on exercise performance. [2]

Currently, there are no accepted, universal warm-up protocols for the upper extremity.[2,3] This poses a problem for upper extremity dominate sports. Upper extremity dominate sports, like baseball and tennis, need a proper warm-up to protect the shoulder musculature from injury and ultimately improve athletic performance.[4] For instance, baseball pitchers' shoulders need to be prepared to be able to withstand forces as much as 108% of the athlete's bodyweight during the pitching motion.[5] A recent systematic review determined that an upper body warm-up should contain dynamic warm-up with high intensity exercises and static stretching to help improve performance, strength, and flexibility.[6] However, high intensity exercises may prematurely fatigue the musculature and inadvertently decrease performance prior to competition.[6,7]

In recent years, a number of commercial companies have attempted to create warm-up protocols to improve readiness for activity without potential performance decrements through the use of specific electrical stimulation waveforms. For instance, the Compex Sports Elite® is an electrical stimulation modality with a warm-up protocol. Specifically, the Compex Sports Elite® unit has a predetermined electrical stimulation waveform designed to enhance motor unit activation.[8] The specific setting, the "pre-warm-up" claims to reduce or eliminate the psychological, cardiovascular, and muscular fatigue which occurs during a traditional warm-up protocol with exercises.[8] However, these claims remain unsubstantiated with research. Therefore, the purpose of this study was to evaluate the effect of Compex Sport Elite® pre-warm-up setting on glenohumeral internal (IROT) and external (EROT) rotation range of motion (ROM) compared to an upper extremity warm-up protocol using an upper body ergometer (UBE). We hypothesized that the electrical stimulation warm-up protocol would not result in statistically significant differences compared to an UBE protocol for measures of IROT and EROT ROM.[9]

METHODS

Participants

Thirty-five healthy, young adults volunteered for this study (19 men, 16 women; age=22±2y; height=172.1±9.4cm; mass=71.3±16.1kg; right-hand dominant=28; left-hand dominant=7). To be eligible for study, participants could not have a current or six month history of upper extremity injury nor participate in intercollegiate baseball. Potential participants were excluded if they participated in intercollegiate baseball due to the wide use of the Compex Sport Elite® unit as part of their regular healthcare. Participants were required to report to the research laboratory two times with at least 48 hours between sessions. Prior to starting the study, participants read and provided signed informed consent. This study was approved by the XXX Institutional Review Board.

Instrumentation

We utilized a digital inclinometer (Digital Inclinometer, Baseline Evaluation Instruments, White Plains, NY) to measure glenohumeral IROT and EROT ROM. The digital inclinometer has been found to have a high intrarater reliability for EROT (0.98) and IROT (0.97) of the GH joint.[10] Additionally, we created a purpose-built sleeve with hook and loop fasteners to secure the inclinometer to the participants for measurement (Figure 1).

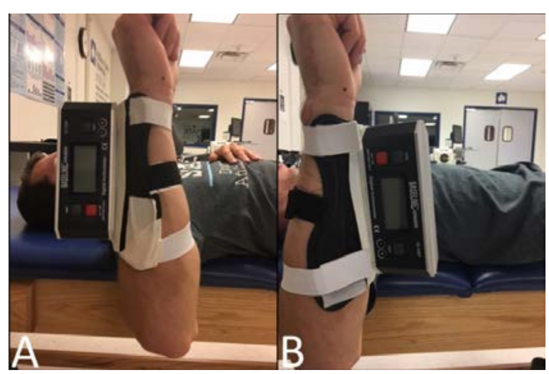

Figure 1. Purpose-built sleeve to secure digital inclinometer for glenohumeral external (A) and internal (B) rotation.

We utilized the Global Rating of Change (GROC) scale to collect information on the participant's perceived rating of change following each of the interventions. The GROC is a scale ranging from a very great deal worse (-7) to a very great deal better (7)) with 0 representing no change. This allows the participant to rate how the treated body area feels after applying the intervention. The GROC has been found to be a valid and reliable patient rated outcome measure (ICC=0.74-0.90).[11]

We utilized an UBE (PRO2® Total Body, SciFit, Tulsa, OK) to apply a standard, exercise-based warm-up protocol. Participants sat in the UBE with their feet flat on the ground and in a position which allowed the elbows to flex to approximately 90° and fully extend when moving through the "cranking" motion.[9]

We utilized a commercially available electrical stimulation unit (Compex Sports Elite®, Compex, Vista, CA) to apply the electrical stimulation "pre-warm-up" protocol. The electrical stimulation unit is comprised on a portable stimulator, three electrode pads, and three electrode leads to connect the stimulator with the electrode pads. Application of electrodes were applied following the manufacturer's only shoulder pad placement recommendations, which is the upper trapezius placement.[8] Stimulation waveforms were applied to the participant's dominant arm. To prepare the skin to electrode placement, the skin was cleaned with isopropyl alcohol and allowed it to dry. One electrode pad (Easy Snap 2x4, Compex, Vista, CA) was placed on the upper trapezius just superior to the head of the humerus. Two electrodes (Easy Snap 2x2, Compex, Vista, CA) were applied in two locations: one superficial to the belly of the supraspinatus muscle and one superficial to the belly of infraspinatus muscle near the spine of the scapula.

Tasks

Upon arrival to the research laboratory participants read, were explained, and provided signed consent to participate. Participants then completed a demographic form and height and mass measurements were taken.

To measure glenohumeral IROT and EROT ROM, the inclinometer and purpose-built sleeve was placed on the anterior forearm, two centimeters distal from the head of the radius. The participant laid supine and placed in 90º of shoulder abduction and 90º elbow flexion with the forearm in a neutral position.[12] Glenohumeral IROT and EROT ROM measurements were collected before, immediately after intervention (t=0 minutes), 30 minutes after intervention (t=30 minutes) for each of the interventions. We collected GROC scores following each of the post-intervention time points (t=0 and t=30 minutes).

During the application of the UBE warm-up protocol, participants were seated as described above and asked to pedal at an intensity of "somewhat hard" or 13 on the Borg's rating of perceived exertion scale. After preparing the participant (described above), the Compex Sport Elite® was applied using the "pre-warm-up" protocol and the "shoulder" body region was selected for application. Per the manufacturer's recommendation, the intensity adjusted to the participant's "maximum tolerance."

Procedures

We utilized a random, single-blinded, repeated measures, crossover design. The single-blind designed required two research team members with distinct roles. One researcher was responsible for the application of the interventions while a second researcher was in charge of all measurement. Only the researcher applying the interventions and the participant knew what intervention the participant had received. Our independent variables included intervention (Compex or UBE) and time (pre-intervention, immediately post-intervention, and 30 minutes post-intervention). Our dependent variables included dominant limb glenohumeral IROT and EROT ROM (degrees) and Global Rating of Change scores (score).

Prior to the start of the study, each participant provided written informed consent. Following the consent process, participants completed the demographic questionnaire and had their height (cm) and mass (kg) collected. The research team member in charge of measurement was located in a private exam room away from the intervention application location so this team member would have no knowledge of the intervention to be applied. All measurements were taken in this private exam room. Next, participant's completed the pre-intervention ROM measurements on their dominant limb. To measure glenohumeral IROT, the researcher slowly moved the participant into glenohumeral internal rotation while carefully maintaining the 90°/90° shoulder/elbow angle. The researcher also visually confirmed that no excessive horizontal abduction/adduction occurred during movement. Internal rotation was continued until an end range of motion was felt or the humeral head moved anteriorly. Each measurement was completed and recorded three times. The same measurement procedures were repeated for the glenohumeral external rotation measurements. Following pre-intervention measurements, the participant was led to the intervention area by the researcher in charge of intervention. The participants were randomly assigned an intervention order (Compex first or UBE first). Every participant received both interventions.

During the Compex® intervention, participants sat on the edge of a padded table with their arms to their side. Following the above described preparation and application of the electrode pads and waveform selection, the participant was instructed how to change the intensity and that the intensity level should be "…strong and on the edge of being uncomfortable" throughout the intervention. During the application, participants were instructed to sit quietly and upright with minimal movement. The Compex Sport Elite® intervention lasted 24 minutes.

During the UBE intervention, participants sat quietly on the UBE for 19 minutes with no movement. This "rest" period was chosen due to the relative lengths of the UBE and Compex® interventions. Following the 19 minute "rest" period, the participant began hand peddling at a moderate perceived intensity or a score of a 13 on the Borg Rating of Perceived Exertion (RPE) scale.[9] The participant was instructed to maintain this intensity for the entire five minute warm-up period. The total length of the UBE intervention was 24 minutes (19 minutes of "rest" followed by 5 minutes of hand peddling).

Following the intervention, the participant was led back into the measurement exam room by the researcher in charge of intervention. The participant then completed follow-up ROM measurements and GROC measurements immediately post-intervention (t=0 minutes) and 30 minutes post-interventions (t=30 minutes) using the procedures detailed above. The participant was instructed to stay still for the 30 minute rest period.

At the completion of the 30 minute post-intervention measurement, the participant was scheduled for his/her second session a minimum of 48 hours following the completion of the first session. During the second sessions, all procedures remained the same except that no consent process occurred and the participant completed the reciprocal intervention not applied during session one.

Statistical Analysis

Data were collected and entered into a custom spreadsheet (Excel 2013, Microsoft Corp., Redmond, WA) and analyzed using commercially available statistics software (SPSS v23, IBM Inc. Chicago, IL). We completed two, 2 (intervention) x 3 (time) repeated measures ANOVA to compare changes in IROT and EROT for UBE and Compex®. Follow-up pairwise comparisons with Holms' Sequential Boneferroni adjustments were also completed. To measure perceived rating of change, we utilized dependent t-test on the GROC scores at t=0 minutes and t=30 minutes post-intervention.

RESULTS

For IROT, there was no significant time by condition interaction identified (Wilks' λ=0.97; $F_{(2,33)}$=0.54; p=0.59; ES=0.03) or main effects for time (Wilks' λ=0.88; $F_{(2,33)}$=2.19; p=0.13; ES=0.12) nor condition (Wilks' λ=0.96; $F_{(2,33)}$=1.54; p=0.22; ES=0.04) was observed (Figure 2).

For EROT, there was no significant interaction effect (Wilks' λ=0.88; $F_{(2,33)}$=2.18; p=0.13; ES=0.12) or a main effect of condition (Wilks' λ=1.00; $F_{(2,33)}$=0.18; p=0.68; ES=0.01) identified. However, we found a significant main effect of time (Wilks' λ=0.77; $F_{(2,33)}$=5.03; p=0.01; ES=0.23). Follow-up pairwise comparisons identified a significance increase in EROT immediately post-intervention compared to pre-intervention (1.51 degrees±0.48; p=0.01) (Figure 3).

For the GROC scale, dependent t-test resulted in no significant differences between Compex® or UBE conditions at immediate post-intervention (t_{34}=0.72, p=0.48) or 30 minutes post-intervention (t_{34}=0.59, p=0.56).

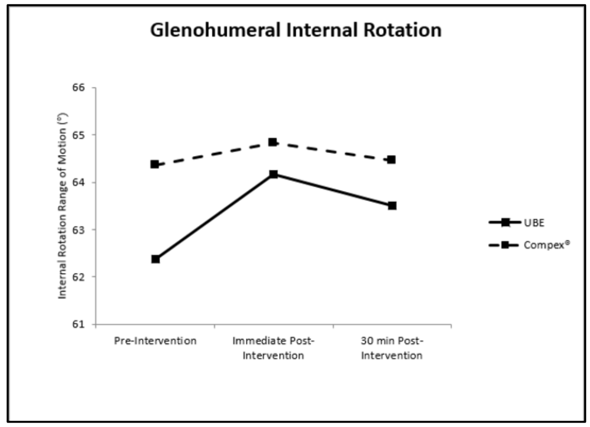

Figure 2. Glenohumeral internal rotation measurements at time = 0. Post, and 30-minute Post Intervention. No significant interaction effects we identified. Upper Extremity Ergometer, °= degrees.

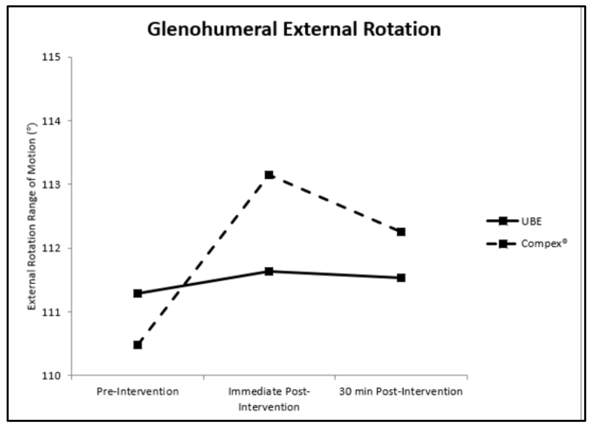

Figure 3. Glenohumeral external rotation measurements at time = 0, Post, and 30-minute Post Intervention. No significant interaction effects we identified. UBE + Upper Body Ergometer, °= degrees.

DISCUSSION

This project examined the effect of the Compex Sport Elite® as a warm-up protocol for glenohumeral ROM when compared to a traditional cardiorespiratory warm-up program using an UBE. We hypothesized that no statistically significant differences in ROM between the Compex® and UBE protocol would be observed. Our results showed that neither Compex® nor UBE produced any statistically significant effects in ROM. There was significant main effect of time on EROT immediately following the warm-up protocol regardless of the intervention utilized. Compex® produced greater changes in EROT than IROT immediately after application. However, participants experienced greater changes in IROT than EROT immediately after completing the UBE protocol. Overall, these results suggest that neither of the protocols utilized in the present study produce statistically or clinically significant changes in glenohumeral range of motion.

It is proposed that a temperature increase in tissue could lead to increase ROM measurements immediately after UBE. When an individual performs an UBE protocol, metabolic activity increases and causes an increase in blood flow and muscle temperature.[1,2] Increases in tissue temperature could decrease viscous resistance in muscles and joints.[2] Increasing blood flow to the shoulder musculature could allow the participants experience increases in IROT measurements. However, muscle blood flow and viscous resistance were not measured in the present study, making it difficult to draw conclusions on if these changes existed in the present study.

The effectiveness of an active warm-up protocol for ROM is still inconclusive in the literature. Previous work examining if passive or active warm-up activities before stretching improved plantar flexion ROM found that the active warm-up protocol of active heel raises had increased plantarflexion ROM by 4.9º, but the thermal ultrasound (passive warm-up) group increased plantar flexion ROM by 7.35º.[13] Passive deep heating showed greater ROM versus an active warm-up. More research needs to be conducted on the effectiveness of active warm-up activities on ROM.

The effects of passive and active warm up have been compared.[14] Cornelius and Hands tested the effects of active and passive warm-up on hip range of motion. Patients either were either in a warm whirlpool set at 106-110ºF for 20 minutes, stationary biked for 20 minutes, or had no warm-up at all.[14] After the warm-up and three sets of slow-reversal-hold-relax proprioceptive neuromuscular facilitation technique, mean hip flexion range of motion values were 124.0º ± 11.0º for whirlpool, 127.6º ± 16.6º for the stationary bike, and 118.9º ± 10.8º for the control group.[14] No significant difference was found between warm-up groups ($F(2,51)=1.09$, $p=.34$).[14] Even though no significant difference was found, the stationary bike had improved hip flexion ROM better than the whirlpool and no warm-up group. These results were similar to the results in our study. There were no differences in the passive and active warm-ups; however, more research needs to be conducted on this topic.

There were observable differences in ROM from pre-intervention and immediate post-intervention between Compex® and UBE. We believe this is due to how the participant completed each protocol. For the UBE, the participant is using their arms more in IROT when cranking the bike forward. It is currently unknown why the Compex® only has increases in EROT. The pad placement is over the middle fibers of the trapezius musculature, none of which helps with EROT of the shoulder in the supine position. However, the path of the electrical current could stimulate some fibers of the teres minor, which is responsible for shoulder EROT. Clinicians need to understand how the specific warm-up activity or protocol affects the patient and if it follows patient goals.

LIMITATIONS

One limitation is that our study was not double-blinded. Although the investigators were blinded to the intervention, the participants knew which intervention they were receiving. Another limitation is that the electrode pad placement was not in an ideal location to affect the shoulder musculature. Although we followed the manufacturer's recommendations, the electrode pad placement was located over the trapezius muscle, which does effect IROT and EROT rotation musculature.

CONCLUSIONS

In the development of warm-up protocols for specific sport populations, clinicians should utilize practice-based evidence, systematic evidence, patient values, and clinical expertise as no "gold standard" currently exists. Additionally, there is a need for more practice-based evidence to support or refute the use of specific warm-up protocols. Since research it is still inconclusive in the research, clinicians should choose a warm-up based on the patient's goals.

Future research is needed to examine the effect of a variety of recently developed clinical practice tools on both isolated measures of performance and functional performance outcome measures.

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