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The Acute Effects of Inhibitory Kinesio Taping on Sensorimotor Integration at the Shoulder Girdle in Healthy Subjects

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ABSTRACT

Objective: To investigate the acute effects of inhibitory Kinesio taping (iKT) on shoulder proprioception, activity of scapular stabilizer muscles, and scapular kinematics in healthy young adults.

Methods: A quasi-experimental repeated measures study was conducted. Twenty-two healthy volunteers were recruited. Surface electromyography and an optical motion capture system were synchronized to record the activity of scapular stabilizer muscles and scapulohumeral kinematics during shoulder proprioceptive tasks without visual feedback. Volunteers were treated with Kinesio taping applied at 25 percent of its maximum stretchability on their dominant upper trapezius muscle. Participants performed five active shoulder repositioning tasks at 100° in both frontal and scapular planes. The measurements were repeated without iKT applied.

Results: Generalized linear mixed effects model revealed a statistically significant main effect of iKT on scapular posterior tilt during arm abduction at 100° ($p < 0.05$). Tukey (HSD) pairwise comparisons showed a significant increase of scapular posterior tilt in the iKT condition compared to no-tape in the frontal plane ($p < 0.05$). Finally, no statistically significant main effects of the treatment, the plane of motion, nor factors interaction on shoulder repositioning absolute error nor the activity ratio of the lower trapezius as scapular stabilizer were observed.

Conclusion: The results suggest that iKT modulated sensorimotor integration at the shoulder girdle reflected in a significant increase in posterior scapular tilt and showed a trend to increase both the activity ratio of the lower trapezius as a scapular stabilizer and shoulder repositioning absolute error during arm abduction at 100°. This finding may have clinical meaning since posterior tilting of the scapula increases the subacromial space increases, where a reduced subacromial space contributes to an increase in the risk of injury of the rotator cuff tendon during over-shoulder arm raising in the frontal plane.

ACKNOWLEDGMENT

Firstly, thank you so much to Jamis, my lovely wife, my daughter Camila, and my son Nicolás for supporting and encouraging me to reach my goals and follow my dreams; definitely, they are a wonderful team!

Also, I want to thank Edgardo and Felipe, (my partners) for helping me to keep on the right path during this project. Besides, I would like to say thank you to both professors from Universidad de Valparaíso, Dr. Ignacio Castellucci for trusting me and allowing conducting my experiment in the world-class lab you manage granted by FONDEQUIP EQM180112 (focused on researching human movement); and Dr. Chiayu Chiu for your guidance and commitment.

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It has been a long journey!!

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1. Background

1.1 Sensorimotor system and sensorimotor integration

The *sensorimotor system* encompasses a highly distributed circuitry that includes somatic mechanoreceptors imbibed in skin, tendons, and muscles (Ruffini endings, Golgi tendon organ, and muscle spindles, respectively) as well as structures allocated in the central nervous system (spinal cord, the brainstem, the cerebral cortex, the cerebellum, and basal ganglia) (Gritsenko et al., 2007; Riemann & Lephart, 2002a). Once sensory information from the periphery reaches central nervous system structures, the s*ensorimotor integration* process produces task-specific motor output based on the selective and rapid ensemble of afferent cues from cutaneous and muscle mechanoreceptors as proprioceptive sources produced (Sangani et al., 2015; Smith, 1978). As a result, the successful production of goal-directed upper and lower limb movements necessary for interacting with our environment is provided (Ellenbecker et al., 2012; Myers et al., 2009).

1.2 Shoulder girdle and shoulder joint

The *shoulder girdle* is responsible for most of the upper limb's movements *and* consists of the proximal humerus, the scapula, and the clavicle. It connects the upper limb to the thorax and provides an extensive range of motion for the hand to locate itself in space to accomplish work, sports, and daily activities (Ahmad et al., 2014; Bogunovic et al., 2022). It exhibits a particular anatomy since no actual bony articulation exists between the scapula and the thorax and shows tremendous mobility and instability (Dalla Pria, 2022; Kreitner & Löw, 2000).

As part of the shoulder girdle, the *shoulder joint* is one of the best examples of the importance of the integration of sensory and motor information by providing accurate arm motions that rely on a coordinated activity among scapular stabilizer muscles, and a stable and optimum scapular kinematics (Myers et al., 2009). However, postural demands like those exerted in daily activities related to hand-handling electronic devices help to set muscle dysfunction like imbalance among scapular stabilizer muscles, such as the upper and lower trapezius, and serratus anterior muscles (Soliman Mohamed et al., 2020). This muscle dysfunction leads to scapular kinematics abnormalities (Ludewig & Cook, 2000a) and impairs shoulder proprioception in healthy subjects (J. J. Lin et al., 2011).

1.3 Proprioception at the shoulder joint

Described by Sir Charles Sherrington (1906) as the sixth sense, *proprioception* is the sense that allows us to perceive the location, movement, and action of parts of the body (Scott Kelso et al., 1980; Tuthill & Azim, 2018). It plays a critical role in sensorimotor control for maintaining joint stability (Riemann & Lephart, 2002b). Like other joints, shoulder proprioception is coded by somatic mechanoreceptors (Gandevia et al., 2002; Moon et al., 2021; Riemann & Lephart, 2002b) that work as transducers with the capability to convert the physical stimulus such as skin stretching or muscle lengthening into a specific neural signal that reaches structures at the central nervous system, such as the thalamus, the parietal cortex, the frontal cortex, and cerebellum (Gritsenko et al., 2007; Hao et al., 2015; Jerosch et al., 1996). Proprioception provides essential guidance to the shoulder girdle through feedback regarding arm positioning in space (active or passive joint position sense), movement (kinesthesia), sense of force or effort (Röijezon et al., 2015), and sense of joint velocity (Ager et al., 2017). Also, collectively, proprioception is essential to scapulohumeral neuromuscular control throughout movements of the inherently unstable glenohumeral (GH) joint (Ahmad et al., 2014) while also playing a crucial role in our daily lives by guiding our interactions with the world around us (Dalla Pria, 2022). Usually, proprioception is assessed through active joint position sense (AJPS), that is the ability to determine a segment position in space (Myers & Lephart, 2000), through joint positions matching tasks, performed actively (Ager et al., 2017; Vafadar et al., 2015).

1.4 Scapular kinematics

During arm motions such as abduction or elevation, scapular kinematics reproduce upward rotation, posterior tilting, and external rotation over the back of the thorax (Ludewig & Cook, 2000a; Ludewig & Reynolds, 2009a). The classical description of coordinated scapular and humeral motion is known as *scapulohumeral rhythm* which refers to the shoulder range of motion from 0º – 180° divided into three distinct phases (Inman et al., 1996). During the first stage 0º – 30° and 0º – 60° most of the motion occurs at the glenohumeral joint. In the second phase (81.8º to 139.1°) the movement is mainly at the level of the scapulothoracic joint. Finally, in the third stage (140º – 180°), most movement occurs at the glenohumeral joint (Bagg & Forrest, 1988; Inman et al., 1996).

Besides, concerning the plane of motion, the scapular plane (with the arm 30 and 40 degrees in between the frontal and the sagittal plane with the thumb positioned upward) (An et al., 1991; Wang et al., 2017) allows the optimum alignment of the humeral head respect to the scapular fosse, resulting in the most efficient configuration of the shoulder girdle for upper limb positioning in space from neuromuscular and mechanics perspective (Berme et al., 1985; Borsa et al., 2003; Dvir & Berme, 1978). Thus, biomechanics advantages are granted to the scapular plane compared to the frontal plane.

1.5 Scapular stabilizer muscles

Scapular neuromuscular control is vital in optimizing scapular kinematics during upper limb movements (Ebaugh & Spinelli, 2010; Mottram, 1997). Nevertheless, the optimum neuromuscular control can be disrupted by postural demands (Soliman Mohamed et al., 2020) that would lead to developing muscle imbalance reflected in scapular kinematics abnormalities (Ludewig & Cook, 2000a) and subsequently impaired movement accuracy (J. J. Lin et al., 2011). In this regard, the upper and lower trapezius, and serratus anterior muscles act together as scapular stabilizers to allow the best fitting between the scapular fosse and the humeral head during arm elevation tasks (Ludewig & Cook, 2000a; Ludewig & Reynolds, 2009a). Previous research has reported that scapular motions are directly related to the activity of a particular stabilizer muscle; for instance, the upper trapezius and serratus anterior promote the scapular upward rotation (Borstad & Ludewig, 2002; Ludewig & Cook, 2000a) while the lower trapezius is involved in the scapular posterior tilt (Kim et al., 2021). Then, the scapular stabilizer activity ratio of the lower trapezius will reveal its contribution concerning the posterior tilting of the scapula (Yoo, 2017).

1.6 Kinesio taping (KT)

Kinesio taping (KT) also known as the elastic or neuromuscular taping technique is widely used by therapists to prevent and treat musculoskeletal conditions such as joint overload and muscular imbalance (Cupler et al., 2020; Williams et al., 2012). KT is a non-invasive, stretchable, hypoallergenic, self-adhesive, and made cotton tape that mimics the mechanical properties of the skin (Kase et al., 2003; Tunakova et al., 2017). Despite the mechanism of action of KT remains unknown, based on the latter quality, it has been proposed that KT increases the activity of cutaneous mechanoreceptors modulating (1) pain sensation, (2) vascular function, (3) muscle activity, (4) proprioceptive feedback, and (5) joint kinematics (Kase et al., 2003; Meeusen et al., 2022).

1.6.1 Inhibitory KT (iKT)

The inhibitory taping technique has been proposed as an affordable therapeutic method to decrease muscle activity (Davison et al., 2016). It is achieved by taping the muscle belly from insertion to origin and the elastic tape applied at 15 – 25% of its maximum stretchability (Kase et al., 2003). Some groups have explored iKT effects on the neuromuscular control of the scapula with converse outcomes. Earlier, Alexander et al. (2003) reported an inhibitory effect of scapular taping by a decreased amplitude of the spinal excitability of the lower trapezius. Hsu et al. (2009) reported that inhibitory taping on the lower trapezius increases the upper trapezius excitation during the lowering phase of the arm. Clemente et al. (2016) published that taping on the lower trapezius following the inhibitory pattern did not promote changes in the neuromuscular activity in both the upper and lower trapezius. Reynard et al. (2018) reported that the inhibitory taping on the upper trapezius reduced its neuromuscular activity.

Moreover, Dhein et al. (2020) and Erik Giphart et al. (2013) have reported differences in lower trapezius activity when the scapular and frontal planes of motion are compared while arm elevation tasks such as shoulder repositioning angles are performed.

1.6.2 KT and neuromuscular activity

Generally speaking, two main effects of taping have been reported depending on the direction and amount of stretching involved in the technique. On one hand, the facilitatory variant implies applying KT at 50 – 75% of its maximum stretchability from the origin to the insertion of the muscle treated, while the inhibitory technique involves KT applied at 15 – 25% of its maximum stretchability in a reverse direction (Kase et al., 2003). Sartre et al. (2013) and Davison et al. (2016) showed that inhibitory taping application decreased the electromyographic activity while Tsai et al. (2018) and Mostaghim et al. (2016) found improvements in muscle performance with facilitatory KT application. Also, Hsu et al. (2009) and Reynard et al. (2018) observed that the activity of the upper trapezius was remotely modulated following taping on the lower trapezius and deltoid anterior, respectively. Finally, Snodgrass et al. (2018) reported that therapeutic taping on the scapula led to the earlier onset of the upper trapezius and the lower trapezius contractions in healthy subjects during abduction and flexion of the glenohumeral joint, respectively.

1.6.3 KT and scapular kinematics

Joint kinematics adjustments such as posture alignment improvement, shoulder range of motion increment, and smoothing the patellofemoral kinematics following KT have been reported (Christou, 2004; Lewis et al., 2005; Whittingham et al., 2004). Mottram (1997) was the first to propose taping usage as a feasible and effective method to facilitate and improve scapular motor control giving proprioceptive cues a critical role. Also, concerning rehabilitation De Oliveira et al. (2019) reported that the subacromial space increased by KT, and accordingly Han et al. (2015) the scapular position was corrected. However, Shaheen et al. (2013) reported that KT inconsistently affects the scapular kinematics in asymptomatic subjects, reflecting variations between upward rotation, external rotation, and posterior tilt depending on planes of motions of the glenohumeral joint. Furthermore, Clemente et al. (2016) published that KT applied on the lower trapezius provided a direct mechanical effect on the scapular motion reflected in increasing the posterior tilting of the scapula. Additionally, in a systematic review, Yildiz et al. (2019) reported that the scapular corrective taping technique might alter the three-dimensional scapular kinematics by increasing the scapular upward rotation, while the posterior tilting of the scapula was modulated inconsistently.

1.6.4 KT and shoulder proprioception

In the face of Dr. Kenso Kase's proposal about cutaneous mechanoreceptors activation following KT intervention, several studies have explored the acute effects of different taping techniques on shoulder proprioception. However, all of them imply not only somatosensory stimuli but also biomechanics constraints by wrapping the shoulder joint.

Shi et al. (2018) reported that a combination of Y and I scapular KT immediately decreased scapular reposition errors at 30, 60, 90, and 120 degrees; however, the arm was fixed into a customized device minimizing kinematics variability during arm movements. Along the same line, Lin et al. (2011) reported that the taping condition improved proprioceptive performance during 90° shoulder flexion replication tasks in the sagittal plane of motion; nevertheless, KT was applied from the upper back to the chest crossing more than only one muscle stretched at its maximum. Similarly, Lindsay et al. (2015) reported that KT (Y and I technique) effect on shoulder repositioning tasks at 50° and 110° did not promote changes; however, it caused a negative effect by increasing the AE values during the repositioning task at 90° in the scapular plane. Conversely, Park et al. (2020) reported that the taping condition significantly decreased the shoulder reposition error at 90° and 110°, but not at 50° during performing the motor task without visual feedback in the scapular plane.

1.7 Rationale of the Study

Technological devices like smartphones, personal computers, and tablets are part of people's daily lives for several hours interacting for work, learning, and fun. This interaction exerts postural demands that lead to an overload of shoulder girdle complex and surrounding muscles (Jacobs, 2020; Kelson et al., 2019). The evidence states that postural demands promote muscle imbalance among scapular stabilizer muscles facilitating the upper trapezius and inhibiting the lower trapezius (Page et al., 2010; Soliman Mohamed et al., 2020). Besides, the plane of motion leads to different scapular positioning with the humerus determining differences in scapular muscle activities when scapular and frontal planes of motion are compared during arm elevation tasks (Dhein et al., 2020; Erik Giphart et al., 2013). Thus, scapular stabilizer imbalance can explain altered *scapular kinematics* during arm elevation (Ludewig & Cook, 2000b; Ludewig & Reynolds, 2009b) promoting soft tissue injury over time that may affect the accuracy and consistency of repeated motor tasks (Niessen et al., 2009). Therefore, the overactivity of the upper trapezius could be decreased by applying the inhibitory taping technique following Dr. Kenso Kase's directions.

Closely related to joint kinematics, proprioception plays a critical role in human movements. Muscle spindles and cutaneous mechanoreceptors provide proprioceptive information related to joint positioning in space. They sense muscle lengthening and skin stretching, respectively, contributing to the optimal execution of desired movements (Collins, 2009; Tuthill & Azim, 2018). Then, sensory information from the periphery travels through afferent pathways until reaches the central nervous system (CNS). At this level, all inputs are integrated to elicit the efferent motor responses (neuromuscular control) vital to coordinated movement patterns and functional stability (Matthews, 1988; Riemann et al., 2002).

Interestingly, to prevent or treat neuromusculoskeletal conditions, therapists widely use neuromuscular taping techniques. Available reports provide Kinesio taping technique (KT) positive effects changes in proprioceptive behavior, muscle activity, and joint kinematics by promoting and increasing cutaneous mechanoreceptor signaling (Cai et al., 2016; Cho et al., 2015; Cupler et al., 2020; Shaheen et al., 2015).

1.8 Research Question and Hypotheses

To the best of our knowledge, no studies have addressed the effects of iKT applied on the dominant upper trapezius muscle on shoulder proprioception, scapular kinematics, and the neuromuscular activity of the lower trapezius as a non-treated muscle. Then, the following question came up Does the inhibitory Kinesio taping modulate sensorimotor integration at the shoulder girdle in healthy young adults?

This study aimed to investigate the acute effect of iKT on shoulder proprioception, scapula kinematics, and scapular neuromuscular control in healthy young adults. Thus, we hypothesized that applying a unique strip of neuromuscular tape on the dominant upper trapezius muscle following inhibitory principles would (1) remotely increase the neuromuscular activity of the lower trapezius (LTr), (2) increase the scapular posterior tilting of the scapula (PT), and (3) decrease the shoulder repositioning absolute error (AE). All significant changes in AE, LTr, and PT will be observed while performing shoulder repositioning tasks in the frontal plane.

1.9 Relevance of the Study

Exploring the acute effects remotely evoked by iKT on the activity of lower trapezius, scapular kinematics, and shoulder proprioception may contribute to supporting a prophylactic usage of inhibitory neuromuscular taping technique in clinical settings.

2. Methods and materials

2.1 Participants

Twenty-two healthy volunteers (8 females) recruited through a public announcement on social media and by flyers participated in the study (mean (standard deviation), age = 25.0 (5.39) years, height = 170.9 (6.73) cm, weight = 74.9 (12.6) kg). The criteria for participants' inclusion were as follows (1) those between the ages of 18 to 35, (2) those who self-reported as right-handed, and (3) those who could perform shoulder abduction and flexion normally. Volunteers were excluded if (1) they self-reported having a recent history (<6 months) or current diagnosis of neuromusculoskeletal disorders on the neck, shoulder, or upper back, and (2) they self-reported previous allergies or skin sensitivity to adhesive tape. Participants were informed at the beginning of the study that they could discontinue participation at any time during the experiments. Besides, participants got explained the details but not the purpose of the experimental procedure.

2.2 Experimental design

A quasi-experimental, repeated measures study was conducted at the Ergonomics and Biomechanics Laboratory in the Faculty of Medicine at Universidad de Valparaíso – Chile. All participants who accomplished the inclusion criteria were submitted to no-tape and iKT measurements. All procedures were conducted in accordance with the Declaration of Helsinki and approved by the Bioethics for the Research Board of the Faculty of Medicine at Universidad de Valparaiso – Chile (approval number 09/2020).

2.3 Procedure

2.3.1 Active joint position sense

To explore shoulder proprioception the active joint position sense test (AJPS) results in an affordable, feasible, and reproducible method that allowed computing accuracy of the arm repositioning in space (Ager et al., 2017; Vafadar et al., 2015). To demonstrate to participants the desired target angles an iPhone 7 (Apple Inc. USA) used as a digital goniometer (yROM Goniometer, © 2014-2022 Healthcare Technologies LLC, USA) was attached to the lateral aspect of participants' arms. Target angles to be replicated were (i)

50° of shoulder abduction, (ii) 100° of shoulder abduction in the frontal plane, (iii) 50° of shoulder elevation, and (iv) 100° of shoulder elevation were asked to be replicated in the scapular plane. All AJPS tasks considered the anatomical position as the start position in both frontal and scapular planes of motion (Carnevale et al., 2021). To avoid promoting motor learning AJPS tasks were randomly performed following audio cues such as "get ready - place your arm at fifty degrees – hold (3 seconds) – go back to the start position – get ready – place your arm at hundred degrees – hold (3 seconds) – go back to the start position", and so on. AJPS tasks were performed five times at each pre-determined angle in frontal and scapular planes without visual feedback. To compute the end-point position of the hand in space the humeral kinematics were tracked as previously done by Warner et al. (2012).

2.3.2 Inhibitory Kinesio Taping (iKT)

The iKT was achieved by applying a unique "I" strip of KT (Leukotape K, 3M, Germany) at 25 percent of its maximum stretchability on the dominant upper trapezius. iKT covered the skin over the upper trapezius from its insertion to its origin. The distance from the upper trapezius's origin to insertion was determined by measuring the distance from the lateral aspect of the acromion to the spine process of the fifth cervical vertebrae in anatomical position (Bridges & Bridges, 2016). The final length of the KT to achieve the iKT technique was computed following a simple three-rule method as described by Jesus et al. (2017). Before applying iKT participant's skin was cleaned with disposable tissue paper wet in alcohol to improve tape adhesivity. Moreover, both KT edges, "the anchors" were applied with no tension while participants rotated their heads to the right and flexed their necks (Bridges & Bridges, 2016) (Figure 1). As soon as iKT was applied 30 minutes of resting was set to promote taping activation as suggested by Bruce et al. (2017). iKT was applied by a physical therapist with experience in the inhibitory technique.

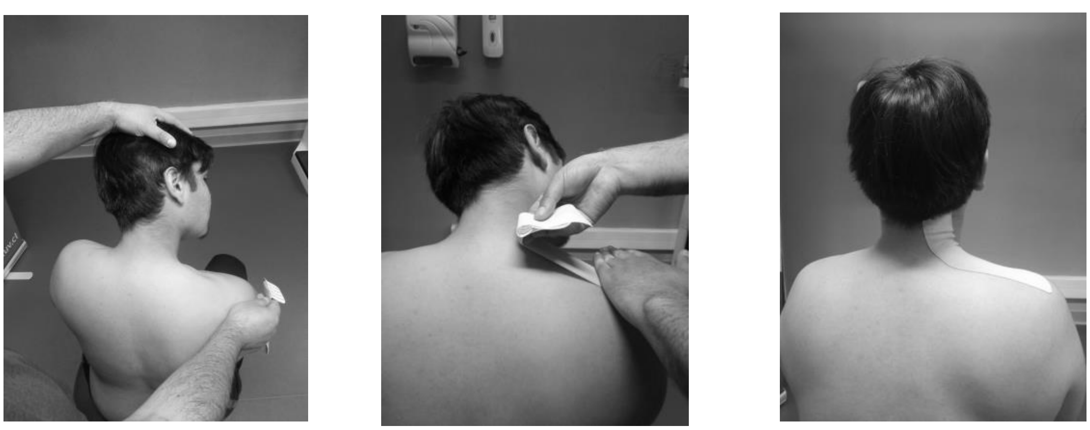

Figure 1. The inhibitory Kinesio taping (iKT) technique is applied to the upper trapezius muscle (Bridges & Bridges, 2016).

2.4 Data collection

Data collection occurred from May 12 to June 5, 2022. In the familiarization sessions, before being assessed, all participants read and completed the informed consent and intake forms. Also, they were weighed and measured in height. Females wore sports tops and males were bare-chested. Participants with long hair were advised to tie their hair above shoulder height. The surface electromyography data of scapular stabilizer muscles were recorded with a sampling frequency of 2000 Hz, and humeral and scapular kinematics data were collected with a sampling frequency of 100 Hz. All data were recorded in a single session that lasted 80 minutes.

2.4.1 Humeral and scapular kinematics

The humeral and scapular kinematics were recorded by using a motion capture system VICON (Vicon Motion Systems Ltd., Oxford, UK) which can detect the spatial displacement of markers placed on participants (Gómez Echeverry et al., 2018). Fourteen retroreflective markers on anatomical landmarks and a scapular locator method to determine the shoulder movement were placed replicating the protocol developed by Warner et al. (2012, 2015) (Figure 2). Before placing markers, participants' skin was cleaned with disposable tissue paper wet in alcohol to improve double-sided tape adherence used to markers attachment. To standardize the collection of kinematics data a static and dynamic participants' calibration was performed (Warner et al., 2015). The same investigator placed markers on the right scapular region to avoid bias. All humeral (Figure 3) and scapular (Figure 4) kinematics data were collected from the start position (anatomical position) to the target angles previously shown (50 or 100 degrees).

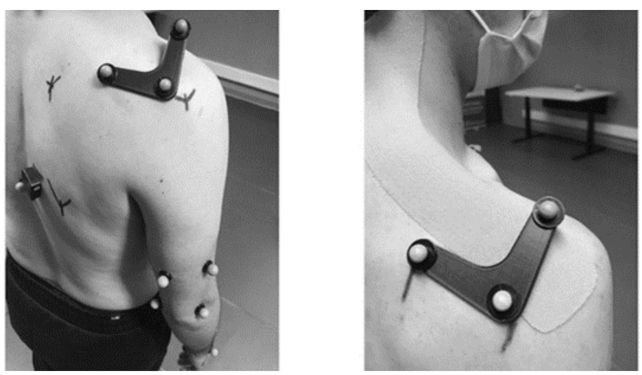

Figure 2. ***Left****: Actual retroreflective markers placement on anatomical landmarks with no tape.* ***Right****: Acromion Markers Cluster (AMC) stuck to the posterior aspect of the acromial spine under iKT condition.*

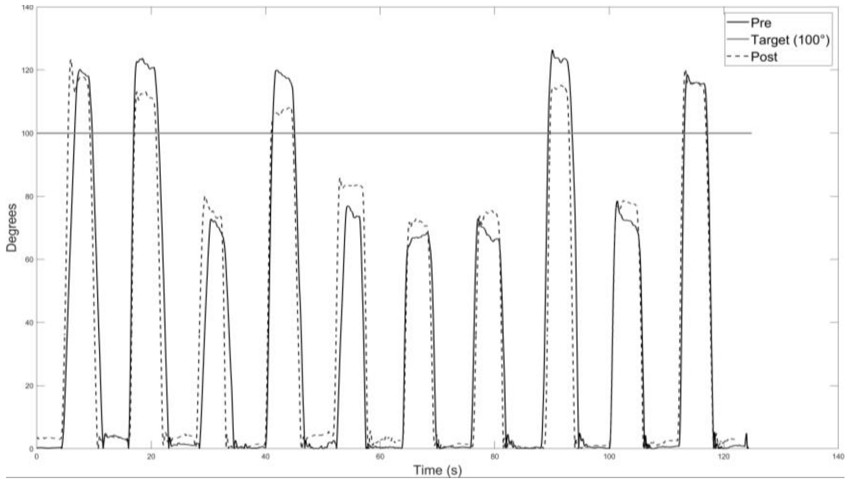

Figure 3. Raw data of humeral kinematics during arm abduction of one participant while performing shoulder repositioning tasks at 50° and 100° degrees in the frontal plane. Gray line: target angle to be replicated (100°). Dotted line: iKT. Data is informed in degrees.

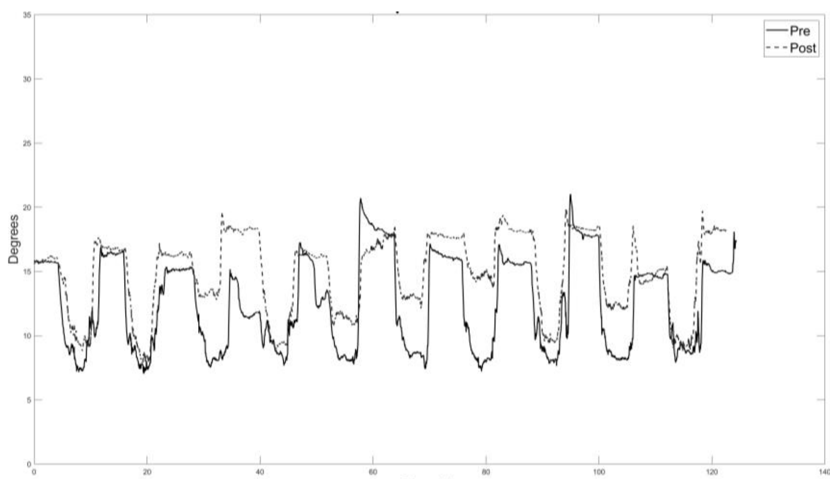

Figure 4. Raw data of scapular kinematics during arm abduction of one participant while performing shoulder repositioning tasks at 50° and 100° in the frontal plane. Dotted line: iKT. Data is informed in degrees.

2.4.2 Surface electromyography of scapular stabilizer muscles

To assess the neuromuscular activity of scapular muscles surface electromyography (sEMG) has been adopted as a non-invasive and reliable methodology (Ekstrom et al., 2005; Hackett et al., 2014). Muscle activity of the lower trapezius and serratus anterior (lower fibers) muscles was collected using two Trigno wireless sensors (Delsys, Inc., Natick, MA, USA) (Figure 5). Before placing wireless electromyography sensors, participants' skin was cleaned with disposable tissue paper wet with alcohol to improve double-sided tape adhesion and increase signal capture (Delsys Inc. & Inc., 2018).

Participants performed a 3-second of maximum isometric voluntary contraction (MVIC) against maximum manual resistance (applied by the first author to avoid bias) (Ekstrom et al., 2005) with a 1-minute pause between each MVIC maneuver (Norcross et al., 2009). The dynamic muscle activities were recorded from the start position (anatomical position) to reach the target angle previously shown (50 or 100 degrees) (Figure 6).

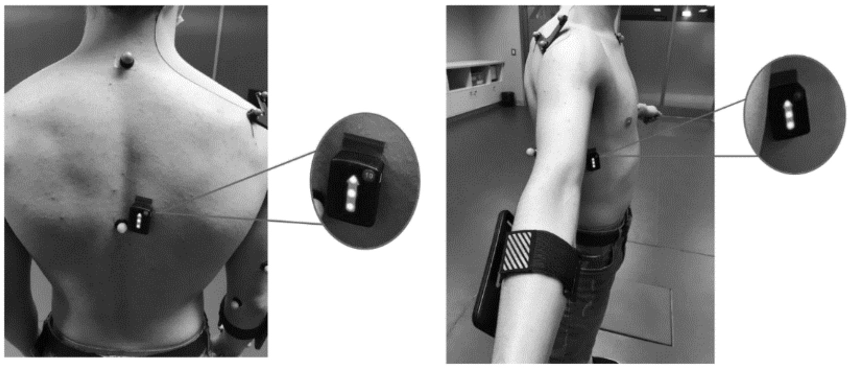

*Figure 5. Actual participant showing: **Left**, Trigno Avanti sensor attached to the lower trapezius muscle. **Right**, the Trigno Avanti sensor is attached to the serratus anterior muscle; the iPhone 7 was attached to the posterior aspect of the participant's forearm.*

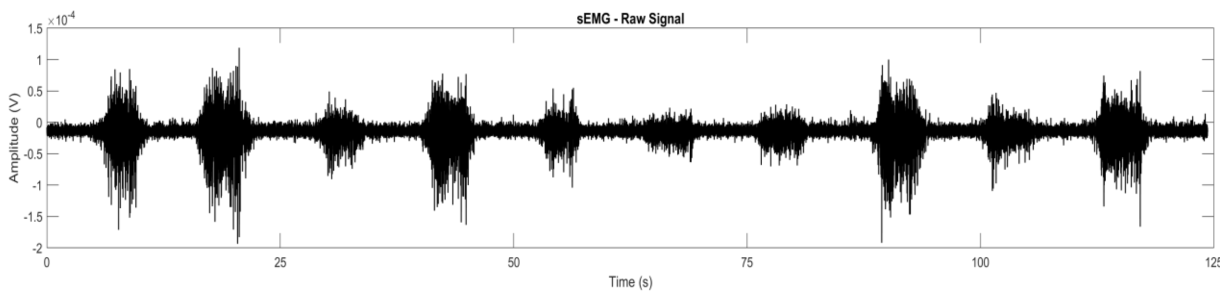

Figure 6. Raw *surface electromyography (sEMG) data from the lower trapezius muscle during no-tape. Data is presented in amplitude (Volts).*

2.5 Data processing

2.5.1 Humeral and scapular kinematics

Both humeral and scapular kinematics reconstruction was performed based on the definition of a local joint coordinate system for each rigid body: thorax, clavicle, scapula, humerus (option 1), and humerus (option 2) (Wu et al., 2005). All markers placed on participants' anatomical landmarks were labeled following the protocol developed by Warner et al. (2012, 2015) (Figure 7). Once humeral and scapular kinematics from shoulder repositioning tasks at 100° were reconstructed, data were filtered by implementing a 4-order Butterworth filter with a cutoff frequency of 10Hz (Crenna et al., 2015). Then, to calculate the range of motion performed for each participant in every single trial in both planes of motion for no-tape and iKT conditions data were submitted to a custom script on MATLAB (Version: 9.13 (R2022b)). Next posterior scapular tilt and humeral abduction and elevation were computed in degrees (Figure 8). For each participant the shoulder repositioning absolute error was calculated as the absolute value from the difference between the reproduced angle and the theoretical preset angle to be achieved (Vafadar et al., 2015) (Equation 1).

A B

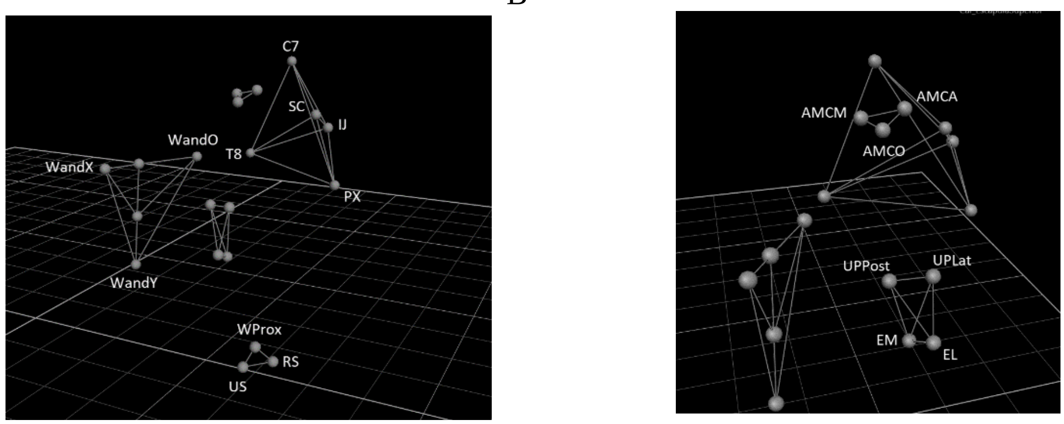

Figure 7. Actual labeling of markers placed on anatomical landmarks. Panel A: C7: 7th cervical vertebrae; PX: xiphoid process; IJ: sternal notch; SC: sternoclavicular joint; T8: 8th thoracic vertebrae; US: ulnar styloid; RS: radial styloid; Wprox: proximal wrist's aspect; WandX, WandO, and WandY: calibration wand. Panel B: AMCA, AMCM, and AMCO: acromion cluster markers; EL: lateral humeral epicondyle; EM: medial humeral epicondyle; UPLat: lateral arm's aspect; UPPost: posterior arm's aspect.

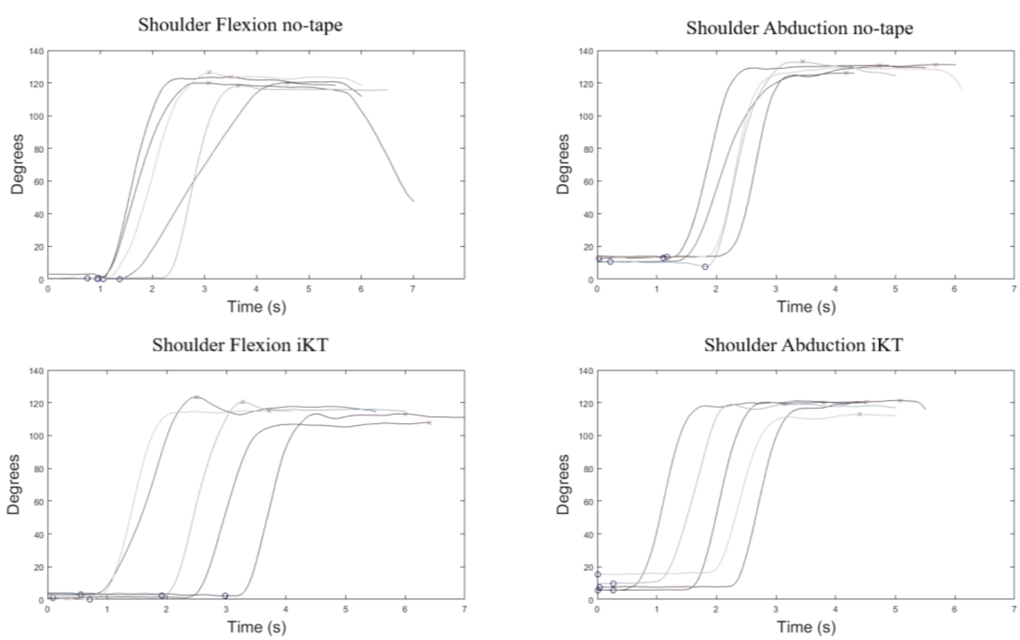

Figure 8. Actual humeral kinematics filtered by a 4-order Butterworth with a cutoff frequency of 10 Hz during AJPS at 100 degrees. Shoulder flexion refers to shoulder elevation in the scapular plane. Shoulder abduction refers to shoulder elevation in the frontal plane.

$$AE = \frac{\sum|Ap-Ar|i}{n}$$

Equation 1. Shoulder repositioning absolute error (AE) equation. Preset Angle (Ap), Reproduced Angle (Ar), Trial number (i), and Number of Trials per angle, per condition, per participant (n) (Vafadar et al., 2015).

2.5.2 Activity ratio of the lower trapezius as a scapular stabilizer

Dynamic surface electromyography (sEMG) data of both lower trapezius and serratus anterior (lower fibers) were submitted to a custom script on MATLAB for the frequency spectral analysis by applying a Fast Fourier Transform (Angelova et al., 2018; Ogino & Kozak, 1983). Later, a 4-order Butterworth bandpass filter with a low cutoff frequency of 40Hz, and a high cutoff frequency of 160Hz was implemented and then the signal was full-wave rectified with a Root Mean Square (RMS) with the time interval set to 30 milliseconds. Later the dynamic sEMG data of the lower trapezius were normalized against the maximum voluntary isometric contraction (MVIC). The normalized lower trapezius activity value was informed as a percent of the MVIC taken as a reference (100%). The normalized serratus anterior activity was obtained in the same manner. Later, the activity ratio of the lower trapezius as a scapular stabilizer (LTr) was calculated as the ratio of the normalized lower trapezius activity divided by the addition of the normalized lower trapezius activity and the normalized serratus anterior activity (Yoo, 2017) (Equation 2) (Figure 9).

$$LTr = \frac{(LTn)}{(LTn+SAn)} \times 100\%$$

Equation 2. Activity ratio of the lower trapezius as a scapular stabilizer (LTr). LTn normalized lower trapezius activity; SAn, normalized serratus anterior activity (Yoo, 2017).

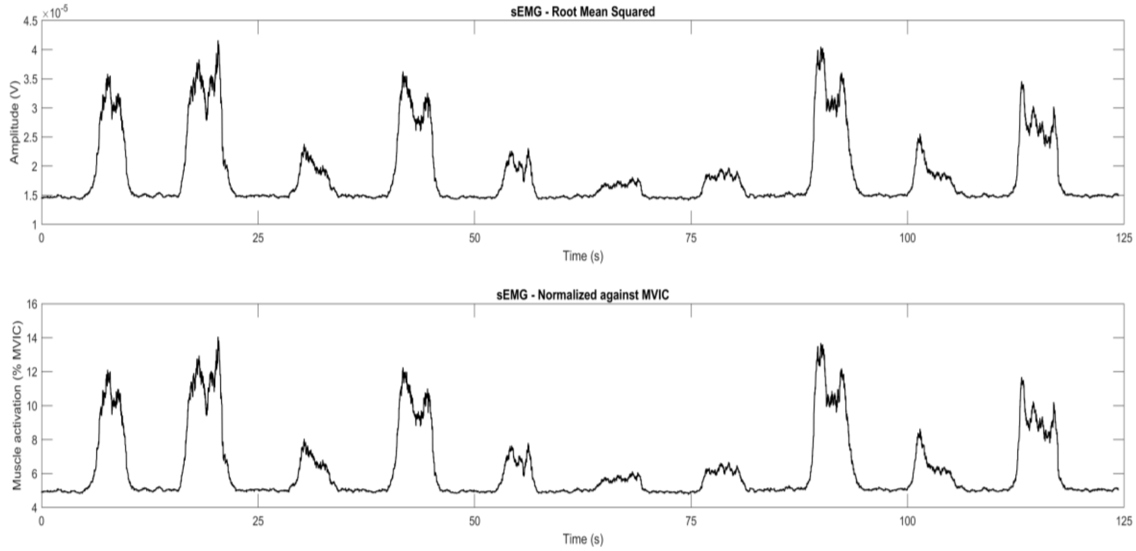

Figure 9. Upper panel: Root mean square value of the activity of the lower trapezius during AJPS at 100°, informed in amplitude (Volts). Lower panel: Normalized surface electromyography of the lower trapezius activity during AJPS at 100°, informed as a percentage of the maximum voluntary isometric contraction.

2.6 Data Analysis

To determine the acute effects of iKT as an independent variable on the ratio activity of the lower trapezius as a scapular stabilizer (LTr), scapular posterior tilt (PT), and shoulder repositioning absolute error (AE), as dependent variables the Generalized Linear Mixed Effects Model (GLMEM) for repeated measures was fitted and processed using the GraphPad Prism (version 9.3 for Windows, GraphPad Software, San Diego, California USA, www.graphpad.com”). The model included the treatment, the plane, and the treatment*plane interaction as fixed factors. Subject variability was defined as the random effect to account for repeated measures (Lo & Andrews, 2015). For each subject, five replicates from all dependent variables were averaged before model fitting. When GLMEM revealed statistically significant effects of fixed factors or factors interaction on response variables, data were submitted to Tukey (HSD) for mean pairwise comparisons. Finally, an alpha value of 0.05 was set for statistical significance (Midway et al., 2020).

3. Results

Table 1 and Table 2 show demographic characteristics of participants submitted to shoulder proprioception and scapular kinematics, and surface electromyography analysis, respectively.

Table 1. Demographic characteristics of participants submitted to shoulder proprioception and scapular kinematics analysis.

	Age (years)	Weight (kg)	Height (m)	Body mass index (kg/m^2)

Group (n=21)	24.1 (5.48)	74.3 (12.6)	1.70 (0.07)	25.7 (3.93)
Males (n=14)	24.78 (5.42)	75.6 (10.9)	1.74 (4.38)	25.5 (3.44)
Females (n=7)	22.00 (5.97)	72.1 (15.7)	1.66 (0.07)	26.0 (5.44)

Note: Data are expressed as Mean (Standard deviation).

Table 2. Demographic characteristics of participants submitted to scapular stabilizer muscles analysis.

	Age (years)	Weight (kg)	Height (m)	Body mass index (kg/m^2)
Group (n=20)	24.5 (5.59)	73.4 (12.2)	1.70 (0.07)	25.5 (4.00)
Males (n=14)	24.8 (5.42)	75.6 (10.9)	1.74 (4.38)	25.5 (3.44)
Females (n=6)	23.2 (6.77)	68.0 (14.5)	1.61 (0.05)	26.3 (5.43)

Note: Data are expressed as Mean (Standard deviation).

3.1 Activity ratio of the lower trapezius as a scapular stabilizer at 100° (LTr100)

Due to technical issues, two participants were excluded from the statistical analysis. Table 2 shows the demographic characteristics of participants submitted to statistical analysis. Table 3 shows the mean values of LTr_{100}. The *interaction* ($F_{(1,19)} = 0.1478$, $p = 0.7022$) resulted in no significant effect on LTr_{100}. Furthermore, there were no significant main effects of the *treatment* ($F_{(1,19)} = 2.5357$, $p = 0.1171$) nor *plane of motion* ($F_{(1,19)} = 0.6765, p = 0.4144$) on LTr_{100}. Tukey (HSD) for no-tape and iKT comparisons did not reveal a statistically significant difference in mean values (Figure 10).

Table 3. Descriptive statistics of the activity ratio of the lower trapezius as a scapular stabilizer at 100° (LTr_{100}).

	LTr_{100} (%)	
Treatment	Frontal plane	Scapular plane
no-tape	43.7 (10.1)	42.6 (10.8)
iKT	45.2 (9.56)	43.8 (9.51)

Note: no-tape refers to pre-treatment; iKT refers to inhibitory Kinesio taping. LTr is informed as a percentage of the ratio of the lower trapezius and serratus anterior activity. Data are expressed as Mean (Standard deviation).

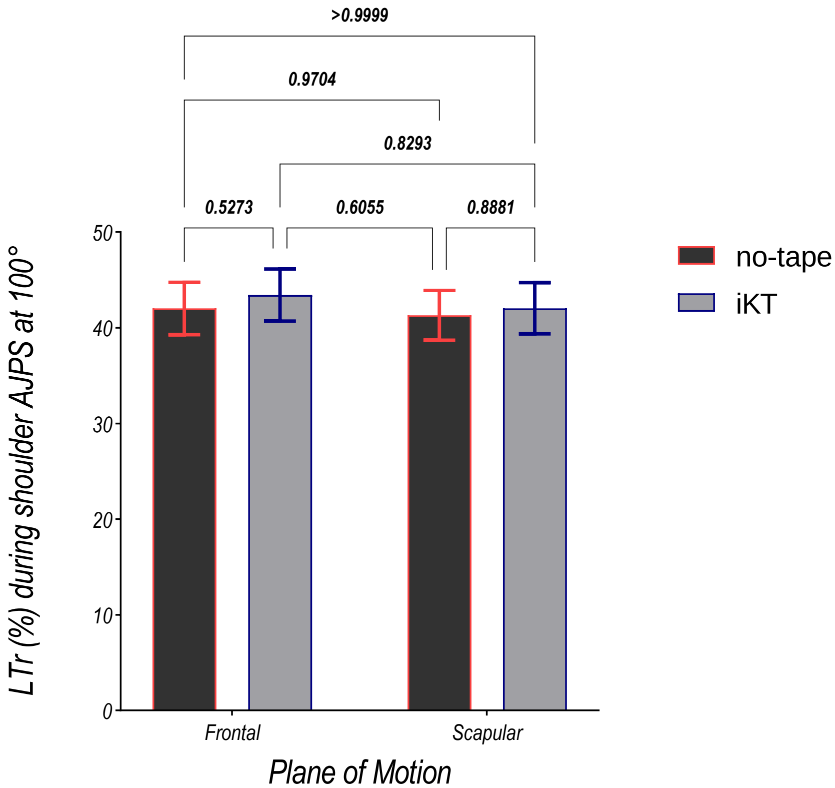

Figure 10. Tukey (HSD) for pairwise comparisons did not reveal a statistically significant difference of mean in values for the activity ratio of the lower trapezius as a scapular stabilizer (LTr) when no-tape (black bar) and iKT (gray bar) in both planes of motion were compared. p < 0.05 was set for statistical significance. Data showed as Mean ± S.E.M.

3.2 Scapular posterior tilt (PT_{100}) at 100°

Due to technical issues, one participant was excluded from the analysis. Table 1 shows the demographic characteristics of participants submitted to statistical analysis. Table 4 shows the mean values of PT_{100}. The *interaction* ($F_{(1,20)} = 3.409$, $p = 0.0797$) resulted in no significant effect on PT_{100}. However, there were significant main effects of the *treatment* ($F_{(1,20)} = 7.514$, $p = 0.0126$) but no *planes of motion* ($F_{(1,20)} = 0.7995$, $p = 0.3819$) on PT_{100}. Tukey (HSD) for no-tape and iKT comparisons revealed a statistically significant difference in mean values during arm abduction ($t_{(40)} = 4.638$, $p = 0.0111$) (Figure 11).

Table 4. Descriptive statistics of posterior scapular tilt at 100° (PT_{100}).

	PT_{100} (°)	
Treatment	Frontal plane	Scapular plane
no-tape	8.46 (2.95)	8.90 (3.48)
iKT	12.1 (5.98)	9.84 (4.74)

Note: no-tape refers to pre-treatment; iKT refers to inhibitory Kinesio taping. PT is informed in degrees. Data are expressed as Mean (Standard deviation).

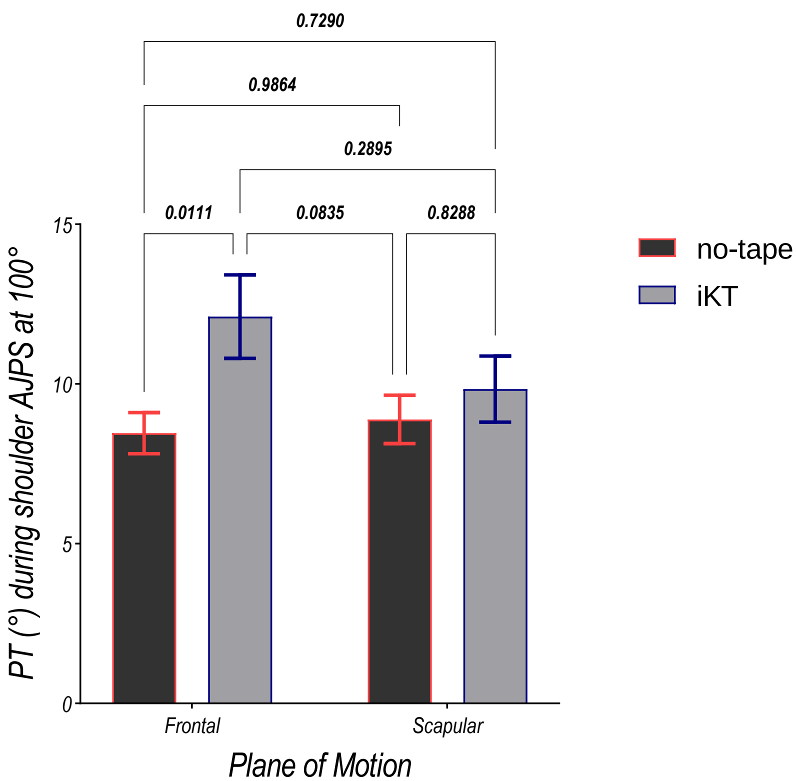

Figure 11. Tukey (HSD) for pairwise comparisons revealed a non-statistically revealed statistically significant difference in mean values for posterior scapular tilt when no-tape (black bar) and iKT (gray bar) in both planes of motion were compared. $p < 0.05$ was set for statistical significance. Data showed as Mean ± S.E.M.

3.3 Shoulder repositioning absolute error (AE_{100}) at 100°

Due to technical issues, one participant was excluded from the analysis. Table 1 shows the demographic characteristics of participants submitted to statistical analysis. Table 5 shows the mean values of AE_{100}. The *interaction* ($F_{(1,20)} = 0.1418$, $p = 0.7105$) resulted in no significant effect on AE_{100}. Furthermore, no main effect of the *treatment* ($F_{(1,20)} = 0.3196$, $p = 0.5781$) nor *plane of motion* ($F_{(1,20)} = 0.6084$, $p = 0.4445$) on AE_{100} were observed. Tukey (HSD) for no-tape and iKT comparisons did not reveal a statistically significant difference in mean values (Figure 12).

Table 5. Descriptive statistics of shoulder repositioning absolute error at 100° (AE_{100}).

	AE_{100} (°)	
Treatment	Frontal plane	Scapular plane
no-tape	18.9 (11.5)	18.0 (13.2)
iKT	21.2 (17.0)	18.6 (12.9)

Note: no-tape refers to the control condition; iKT refers to inhibitory Kinesio taping. AE is informed in degrees. Data are expressed as Mean (Standard deviation).

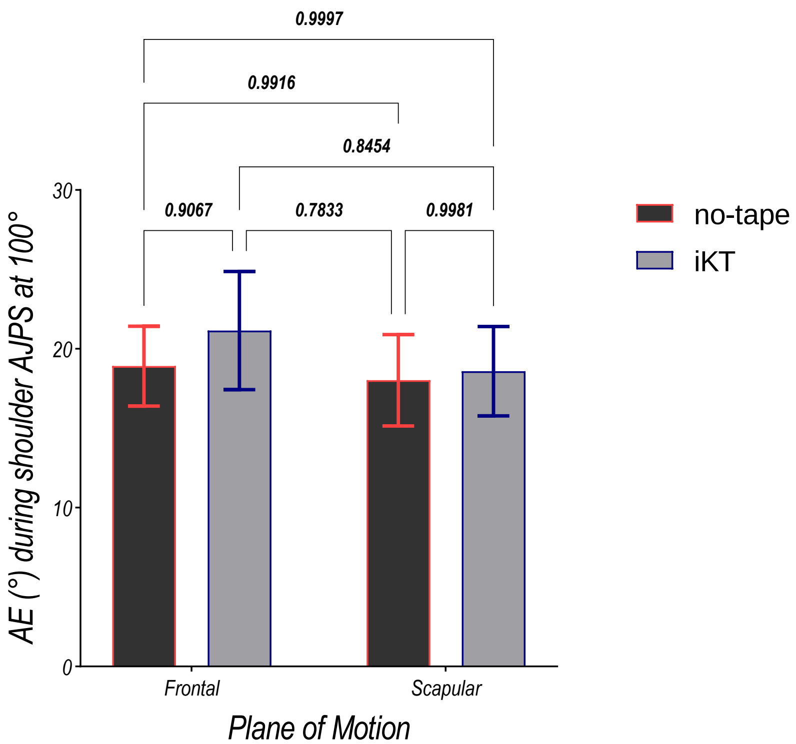

Figure 12. Tukey (HSD) for pairwise comparisons did not reveal a statistically significant difference in mean values for the shoulder repositioning absolute error (AE) when no-tape (black bar) and iKT (gray bar) in both planes of motion were compared. $p < 0.05$ was set for statistical significance. Data showed as Mean ± S.E.M.

4. Discussion

Although the mechanism of action behind Kinesio taping (KT), including iKT, remains unknown several investigations have described its effects in healthy and clinical populations. Previous studies reported positive effects in shoulder proprioception, scapular kinematics, and activity of scapular stabilizer muscles by wrapping the shoulder girdle or shoulder joint in healthy subjects (Aarseth et al., 2015; Keenan et al., 2017; J. J. Lin et al., 2011; Park et al., 2020). Nonetheless, we applied a unique strip of KT at 25 percent of its maximum stretchability on the dominant upper trapezius (Bridges & Bridges, 2016) instead of wrapping the shoulder joint.

Furthermore, it is not possible to ignore 2 natural phenomena: (1) motor redundancy principles (M. L. Latash, 2012), and (2) muscle synergy theory (Abd et al., 2021) that happen without controlling during voluntary movements.

4.1 Kinesio taping and activity ratio of the lower trapezius as a scapular stabilizer

Unlike previous research, we collected and reported neuromuscular activities from the lower trapezius and serratus anterior (lower fibers) as non-treated muscles by iKT but not the upper trapezius as the treated muscle. Different from previous studies, we reported the effects of iKT evoked on the activity ratio of the lower trapezius as a scapular stabilizer (LTr) instead of the isolated activity of the lower trapezius. The LTr value reflects the activity of the lower trapezius related to the activity of the serratus anterior giving this analysis a functional point of view since both muscles work coupled during scapular motions during arm elevation tasks (Yoo, 2017). Despite we did not observe a significant increment of the LTr, a main effect of taping compared to the plane of motion was revealed ($p < 0.0220$). This result goes in the same line as previous observations reported by Huang et al. (2019), J. J. Lin et al. (2011), and Silva et al. (2019). However, there are huge differences when the technique of taping among experimental designs is compared.

Moreover, regarding the plane of motion Ludewig et al. (1996) reported variability of the lower trapezius activity between and within healthy subjects while performing arm-raising from 0° to 140° comparing the frontal to the scapular plane. Similarly, we also found a range of variability for the isolated lower trapezius activity and LTr from 60% and 65% when the shoulder reached 100° of abduction and elevation, respectively. Nevertheless, a larger increment in the LTr response to iKT in the frontal plane was computed (Table 3). This finding is consistent with the evidence that when the arm is moved from the frontal toward the scapular plane the best alignment of scapular stabilizer muscles is set facilitating a better muscle torque than those produced in the frontal plane (Borstad & Ludewig, 2002; Michiels & Grevenstein, 1995; Tsuruike & Ellenbecker, 2019) explaining that minus changes would be observed in the scapular plane as we found.

As the upper and lower trapezius and serratus anterior muscles work coordinated to provide the optimum neuromuscular control of the scapula, our result can be explained by considering that iKT could promote the inhibition of spinal motoneuron pools at the upper trapezius in response to afferent signals from cutaneous mechanoreceptors (Alexander et al., 2003). This would remotely increase the sensitivity of neural synapses of motor unit firing patterns of the lower trapezius and serratus anterior (Alexander et al., 2008; M. L. Latash, 2012; M. L. Latash & Zatsiorsky, 2016). An example of the role played by cutaneous afferent was reported by Lowrey et al. (2010) who informed that a reduction in afferent input to higher structures at the central nervous system by cooling the skin altered the firing response of a portion of spindles by decreasing motoneuron output during ankle motions.

4.2 Kinesio taping and scapular posterior tilt

Clemente et al. (2016) reported that KT supplied a direct mechanical effect on the scapular motion by increasing scapular posterior tilt (PT). We also found that iKT promoted a statistically significant increase in PT in the frontal plane (p = 0.0111) (Figure 11). However, we applied iKT on the upper trapezius instead of applying it on the lower trapezius. Therefore, a direct mechanical effect of iKT on the lower trapezius and subsequent increase in posterior scapular tilt (PT) is not possible to be granted.

Also, the scapular plane provides the best fitting between the humeral head and the scapular fosse (Hamill et al., 2013; Johnson et al., 1994; Kempf et al., 1999), reflecting biomechanics advantages during arm elevation compared to the frontal plane (Ludewig et al., 2009). Thus, as expected, like Shaheen et al. (2013) and Keenan et al. (2017) we did not find effects of iKT in the PT during arm elevations in the scapular plane (p = 0.3819).

Then, the plane of motion where the shoulder was moved provides an explanation, being possible to postulate that iKT modulated the spatial alignment of the scapular girdle mirrored by a significant increase in the PT compared to no tape (p = 0.0111) while arm motions were performed in the frontal plane (Table 4). Then, our finding can be partially explained on one hand, based on LT increase, since it is the primary muscle involved in the scapular kinematics promoting PT. Although the change observed in the isolated ratio of the lower trapezius activity was not statistically significant in response to iKT (Table 3) it could be enough to promote a significant PT increase. On the other hand, PT can increase based on a postural effect evoked by afferent cues following iKT application on the upper trapezius muscle.

4.3 Kinesio taping and the shoulder repositioning absolute error

Bravi et al. (2016) applied iKT at 25% and Z. M. Lin et al. (2021) applied iKT at 20% of its maximum stretchability promoting somatosensory stimuli instead of biomechanics constraints. They reported non-statistically significant improvements in sensorimotor performance and proprioceptive feedback.

In the same line as Aarseth et al. (2015) who added biomechanics constraints by wrapping the shoulder joint, we observed that iKT impaired shoulder proprioception at 100° in the frontal plane (Table 5). In contrast, J. J. Lin et al. (2011) informed that scapular taping (from the lower trapezius to the sub-clavicle zone) applied at its maximum stretchability improved shoulder proprioceptive feedback; however, participants did not reproduce a predetermined target angle. In the same line, Park et al. (2020) applying a large strip of KT (from the arm to the chest) found that KT significantly decreased the shoulder reposition error at 90° and 110° without visual feedback in the scapular plane; however, no amount of tension was reported. Moreover, Keenan et al. (2017) did not report aid or impairment on shoulder proprioception while the arm was abducted at 90° and 120° of following KT compared to placebo with no amount of tension stated.

An explanation of why iKT impaired shoulder proprioception arises when considering (1) KT applied at 50 percent of its maximum stretchability resulted in skin deformation (Cimino et al., 2018; Pamuk & Yucesoy, 2015), (2) skin is compressed on the upper trapezius and stretched on the lower trapezius during over shoulder abduction and elevation of the arm in both planes of motion (Carnevale et al., 2021), and (3) the presence of Piezo2 mechanotransduction channel imbibed in the skin, linked to low-threshold cutaneous mechanoreceptors (Merkel, Meissner, and Ruffini) and activated by skin stretching (Anderson et al., 2016) that works as the first link in the proprioceptive pathway (Nagel & Chesler, 2022; Woo et al., 2015). Therefore, is it possible to speculate that iKT determines a new pattern of skin compression and stretching during shoulder motions that would send unusual proprioceptive cues by modulating Piezo2 activity and sensory cues from cutaneous mechanoreceptors that reach brain structures involved in sensorimotor integration. This novel afferent information would determine an increase in AE at 100° in healthy subjects (Figure 12).

5. Limitations

The current study only assessed the immediate effects of iKT. Besides, there is no standardized methodology to determine the percentage of tension. Lacking randomization and not including sham-taping to compare meant that an unbiased response to the taping could not be obtained. Finally, postural alignment was not standardized, and screening for scapular dyskinesis was not performed. The results cannot be extrapolated to symptomatic populations.

6. Conclusion

To address our research question, our results suggest that iKT modulated sensorimotor integration at the shoulder girdle in healthy young adults while performing shoulder active proprioception tasks in the frontal plane.

As a non-statistically significant increase in the ratio activity of the lower trapezius as a scapular stabilizer was observed, our first hypothesis is rejected. Regarding scapular kinematics, iKT promoted a statistically significant increase in the scapular posterior tilt allowing accepting our second hypothesis. Finally, we did not observe a statistically significant decrease in the shoulder repositioning absolute error; in contrast, we found an increment in the error; thus, our third hypothesis is rejected.

The finding about scapular posterior tilt would have a clinical meaning by increasing the subacromial space and minimizing the risk of injury for the rotator cuff tendon. Nonetheless, we must be cautious to interpret this result as is possible to speculate that iKT would initiate a new postural realignment by setting a new scapular position at rest and while performing arm abduction and elevation tasks.

7. Projections

Further efforts are needed to quantify how much tension is transferred into the skin from the elastic taping applied. Also, to determine whether a threshold of tension concerning the density of cutaneous mechanoreceptor exists and its effects on the spinal excitability of treated and non-treated muscles may contribute to support the prescription as a prophylactic or therapeutic usage in healthy and clinical populations.

Also, exploring sensory and motor pathways through imaging to look for evidence of short-term neuroplasticity following skin stretching associated with somatosensory cues may contribute to shedding some light on the mechanism of action of the elastic taping techniques.

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8. Appendix

8.1 Bioethical Committee Authorization

Universidad de Valparaíso CHILE

FACULTAD DE MEDICINA
Comité de Bioética
para la Investigación

ACTA DE EVALUACIÓN BIOÉTICA No. 09/2020

I. El Comité de Bioética de la Facultad de Medicina de la Universidad de Valparaíso, con la presencia de Eva Sotelo Trujillo, profesora de Castellano, Presidenta; Paulina Hurtado Arenas, enfermera, Vicepresidenta; Angelo Bartsch Jiménez, kinesiólogo, Secretario Ejecutivo; Paula Eherenfeld Valenzuela, matrona; Patricia Herrera Sepúlveda, educadora de párvulos; y Daniela López Espíndola, tecnóloga médico, en su sesión del día 09 de abril del año 2020, declara haber evaluado el protocolo experimental del proyecto "*Kinesiology taping* como modulador de la Interacción sensorio-motriz reflejado en la optimización del control motor de hombro durante la tarea de replicación de ángulos", presentado por el investigador responsable, Raúl Figueroa Cortés, kinesiólogo y estudiante del Magíster en Ciencias Biológicas, Mención Neurociencias de la Facultad de Ciencias de la Universidad de Valparaíso, y por su director de tesis, Héctor Castellucci, kinesiólogo y académico de la Escuela de Kinesiología, adscrito a esta Facultad.

II. Para su evaluación el Comité de Bioética revisó los siguientes antecedentes:

1. Protocolo N° 060/ 2019 versión en español.
2. Hoja Informativa y Acta de Consentimiento Informado, versión en español, cuyos destinatarios son estudiantes de la Facultad de Medicina.
3. Currículum Vítae del investigador responsable, de su director de tesis y de la coinvestigadora, Chiayu Chiu.
4. Carta de autorización del Sr. Andrés Orellana Uribe, Director de Escuela de Kinesiología de la Universidad de Valparaíso.
5. Constancia de toma de conocimiento del Dr. Antonio Orellana Tobar, Decano de la Facultad de Medicina de la Universidad de Valparaíso.
6. Instrumentos: - de recolección de datos
   - Cuestionario "Autoreporte – Criterios de Inclusión"

III. En la valoración bioética del proyecto, el Comité consideró que dicha propuesta cumple con los principios éticos necesarios para su realización, entre otros, los de beneficencia y atención a potenciales riesgos; se concluyó que su pertinencia fundamental radica en:

1. El diseño se ajusta a las Normas de Investigación en Seres Humanos.
2. El estudio propuesto permitirá determinar el impacto agudo del efecto de la tensión del KT sobre la integración sensorio-motriz del complejo articular del hombro, reflejado en los movimientos de la escapula, la actividad electromiográfica de músculos periescapulares y la precisión y consistencia en el posicionamiento del miembro superior dominante durante la tarea de replicación de ángulo realizado por estudiantes de la Facultad de Medicina de la Universidad de Valparaíso.
3. El Consentimiento Informado da cuenta de la finalidad de la investigación en forma

COMITÉ DE BIOÉTICA PARA LA INVESTIGACIÓN - FACULTAD DE MEDICINA
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COMITÉ DE BIOÉTICA FACULTAD DE MEDICINA UNIVERSIDAD DE VALPARAÍSO

Universidad de Valparaíso CHILE

FACULTAD DE MEDICINA
Comité de Bioética
para la Investigación

clara; explicita y respeta la voluntariedad del(a) posible participante, además de ofrecerle la oportunidad de retirarse en cualquier momento sin que ello le revista algún perjuicio; asegura la confidencialidad de los datos y de la identidad del sujeto; se precisa que no existen riesgos, ni costos involucrados como tampoco remuneración por participar; especifica en qué consistirá la colaboración del sujeto, señalando tiempo que involucrará la aplicación de las pruebas y mediciones. Así también, el investigador da a conocer su teléfono e E–mail de contacto para ubicarlo en caso de cualquier consulta o duda. Cabe destacar que este Consentimiento Informado tiene vigencia de un año; para el año 2021, el investigador responsable deberá solicitar su renovación al finalizar el año 2020.

4. Los antecedentes curriculares del Investigador Principal garantizan la ejecución del estudio dentro de los marcos éticos y técnicos aceptables.
5. Los miembros del Comité declararon no tener conflicto de interés.

IV. Por lo anterior, el Comité de Bioética de la Facultad de Medicina aprueba el presente protocolo de investigación que podrá ejecutarse entre los años 2020 y 2021 si las condiciones sanitarias del país lo permiten, dado la posibilidad de contagio por COVID-19; de ser posible, por tanto, este estudio será efectuado en la Facultad de Medicina de la Universidad de Valparaíso por el grupo investigador, liderado por Raúl Figueroa Cortés, kinesiólogo y estudiante del Magíster en Ciencias Biológicas, Mención Neurociencias de la Facultad de Ciencias de la Universidad de Valparaíso. La ejecución del protocolo también queda sujeta a la aprobación que otorgare el Comité Ético-Científico del centro asistencial, si correspondiere. Las eventuales modificaciones que pudiera sufrir el protocolo al que serán sometidos los participantes deberán ser evaluadas por este Comité y aprobadas previo a su aplicación. La vigencia de esta Acta es de 2 años; el investigador responsable deberá transmitir informe de estado de avance del estudio al término de cada año de ejecución, en caso de que su estudio se lleve a cabo por un periodo superior a un año, y el informe final, cuando el estudio finalice.

Firma en representación del Comité de Bioética de la Facultad de Medicina.

COMITÉ DE BIOÉTICA · FACULTAD DE MEDICINA · UNIVERSIDAD DE VALPARAÍSO

Eva Sotelo Trujillo
Presidenta

Viña del Mar, 09 de abril de 2020

C/C. Secretaría CBI-FAMED

8.2 *Informed Consent Form*

Universidad
de Valparaíso
CHILE

ACTA DE CONSENTIMIENTO INFORMADO

Estudiantes de la Universidad de Valparaíso

Yo,.., C.I......................... DECLARO que el investigador principal, estudiante tesista de postgrado y kinesiólogo Raúl Figueroa, junto a Héctor Castellucci, kinesiólogo y académico de la Escuela de Kinesiología, y a Chiayu Chiu, investigadora del Centro Interdisciplinario de Neurociencia de Valparaíso, me han informado en forma completa en qué consiste la investigación "*Kinesiology taping* como modulador de la interacción sensorio-motriz reflejado en la optimización del control motor de hombro durante la tarea de replicación de ángulos", que se llevará a cabo en las dependencias de la Escuela de Kinesiología de la Universidad de Valparaíso, ubicada en calle Angamos 655 Reñaca, Viña del Mar. Entiendo que mi participación consistirá en permitir la recolección de información antropométrica (talla, estatura, entre otras), posicionar marcadores adhesivos sobre algunas de referencias anatómicas de mi tronco, hombro y brazo dominante, además, de la fijación de electrodos inalámbricos sobre dos músculos relacionados funcionalmente con mi escápula, finalizando con la ejecución de movimientos voluntarios de mi extremidad superior dominante, que me serán explicados y demostrados en la sesión informativa. Estoy en conocimiento de que toda la actividad tendrá una duración aproximada de 2 horas. Conforme con lo explicado en la Hoja Informativa del presente documento, entiendo que poseo el derecho de revocar mi consentimiento sin que esta decisión pueda ocasionarme algún perjuicio.

De acuerdo con lo declarado por mí en este documento, firmo aceptando voluntariamente mi participación en esta investigación. Recibo una copia completa de este documento.

COMITÉ DE BIOÉTICA
FACULTAD DE MEDICINA
UNIVERSIDAD DE VALPARAÍSO

Nombre y Firma del Participante	Nombre y Firma del Investigador Responsable
C.I.:	C.I.
Fecha:	Fecha:

Nombre y Firma del Director del Establecimiento o de su Delegado
C.I.
Fecha:

COMITÉ DE BIOÉTICA
FACULTAD DE MEDICINA
UNIVERSIDAD DE VALPARAÍSO

Viña del Mar, ... de .... de 2020

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8.3 *Flyer for participants' recruitment*