Effect of Kinesio Taping on Hand Sensorimotor Control and Brain Activity

Zen-Ming Lin 1, Jeng-Feng Yang 2, Yin-Liang Lin 1, Yueh-Chen Cheng 3, Chien-Ting Hung 4, Chen-Sheng Chen 1 and Li-Wei Chou 1,*

1 Department of Physical Therapy & Assistive Technology, National Yang Ming Chiao Tung University, Taipei City 112, Taiwan; joy26427@gmail.com (Z.-M.L.); yllin1020@nycu.edu.tw (Y.-L.L.); cschen0623@nycu.edu.tw (C.-S.C.)
2 Department of Physical Therapy, College of Medicine, National Cheng Kung University, Tainan City 701, Taiwan; jf.yang@mail.ncku.edu.tw
3 Blue Ocean Aurora Group, Taipei City 122, Taiwan; cyc1012@gmail.com
4 Department of Rehabilitation, Country Hospital, Taipei City 106, Taiwan; chien1974@gmail.com
* Correspondence: lwchou@nycu.edu.tw; Tel.: +886-2-2826-7092

Abstract: Kinesio taping has been used to improve sensorimotor control performance. In this study, we explored the effect of Kinesio taping with different tensions on hand force control, joint proprioception, reaction time and brain activity. This was an observational study with a single-group, repeated-measures design. Twenty-four healthy participants (12 women) randomly assigned to three wrist/finger flexor taping conditions: (1) taping with 20% additional tension (taping20), (2) taping with neutral tension (tapingN), and (3) without taping (control). Grip force and wrist joint proprioceptive senses, reaction time, and force control performance were recorded in each of the taping conditions. An EEG of the bilateral sensorimotor cortex and an EMG of the right finger flexors were recorded to investigate changes in brain activity and functional connectivity between the brain and muscles (coherence). Our results indicated that taping significantly improved the joint position sense for participants with an error >3° (control vs. tapingN vs. taping20: 4.1° ± 1.04° vs. 2.6° ± 0.97° vs. 2.1° ± 0.91°; p = 0.001). In addition, Kinesio taping-induced improvements in force control were moderately correlated with decreases in the EEG beta band power. In conclusion, Kinesio taping could improve the joint proprioceptive sense, and taping-induced improvement in force control is likely due to neural desynchronization in motor cortex.

Keywords: Kinesio taping; proprioception; neuromuscular control; EEG; EMG

1. Introduction

Kinesio taping is commonly used in sports and clinical settings [1] to deal with impaired proprioceptive sense and sensorimotor control due to injury, fatigue, or aging [2]. Previous studies have demonstrated that Kinesio taping can improve muscle strength, proprioception and performance [3–9]. However, there were some studies that failed to find significant improvements in sensorimotor control with Kinesio taping [10,11]. In fact, a recent systemic review indicated that there is still a lack of compelling evidence for the effectiveness of Kinesio taping in sports performance [12].

Sensorimotor control involves the integration of sensation and movement information in the central nervous system to enable proper proprioceptive senses, reaction time and force control during the execution of motor tasks [13]. Applying Kinesio tape on skin surface can stimulate cutaneous receptors. It has been reported that cutaneous mechanoreceptors provide the central nervous system with essential kinematic information of movement [14,15], and disrupted cutaneous input had a negative impact on sensorimotor control [16].

Kinesio tape can be applied at different tension levels clinically. Some studies conducted experiments with the natural tension of the tape, while other studies extended
the length of the tape (hence increasing the tension of the tape) and then applied it onto the skin [9,17,18]. It has also been suggested that the activation of cutaneous receptors increases muscle spindle sensitivity and improves sensorimotor control [19], but recent evidence further indicates that cutaneous and proprioceptive inputs play different roles in sensorimotor integration [20]. It is still unclear how the level of tape tension influences sensory input to the central nervous system and the effectiveness of Kinesio taping on sensorimotor performance.

Sensory afferent inputs can induce activities in the central nervous system. Through applying sensory-level electrical stimulation (Stancak et al., 2003) and vibration-induced tactile sensation (Salenius et al., 1997) to the finger, previous studies demonstrated that sensory afferent inputs induced immediate event-related dysynchronization (ERD) followed by event-related synchronization (ERS) in EEG alpha and beta bands in the contralateral sensorimotor cortex. In addition, electrical stimulation applied to the forearm enhanced EEG beta band ERD, as well as the functional connectivity between the sensorimotor cortex and the finger muscle (corticomuscular coherence, CMC) [21,22]. CMC reflects the physiological status of the neuromuscular system [23,24]. It has been demonstrated that motor training increases CMC [25] and lesions to the central nervous system decreases CMC [26–28]. Whether and how Kinesio taping applied to the limb influences the central nervous system and the functional connectivity between the sensorimotor cortex and muscles remains unclear.

Here, we systemically examined how different tensions of Kinesio taping influences hand sensorimotor control, including joint and muscle force proprioceptive senses, reaction time, and changes in motor cortical activity and the functional connectivity between motor cortex and muscles. We hypothesized that Kinesio taping could improve sensorimotor control and influence brain activity. Moreover, additional tension could achieve greater improvements in sensorimotor control than neutral tension.

2. Materials and Methods

We recruited 24 right-handed adults (12 men, 12 women). The inclusion criteria were as follows: healthy adults between the ages of 20 and 40 years. The exclusion criteria were as follows: (1) pain in the hand, wrist, or forearm; (2) musculoskeletal disorders of the upper extremities in the past 6 months; (3) any central nervous system disorders; (4) abnormal sensation; (5) muscle fatigue in the upper extremities; (6) allergic to Kinesio tape; and (7) open wound on the ventral side of the forearm. Our study protocol was approved by the Institutional Review Board of National Yang-Ming University (YM108058E), and the participants gave their informed consent prior to participation in the experiments. (Clinical Trial Registration: NCT03909880, July 2019).

This was an observational study with a single-group, repeated-measures design. Participants were subjected to three taping conditions in a random order and underwent tests after each taping process. All tests were completed on the same day. Each participant received three taping conditions in random order: (1) taping with 20% additional tension (taping20), (2) taping with neutral tension (tapingN), and (3) without taping (control). Y shape Kinesio tape (Kinesio Holding Corp., Albuquerque, NM, USA) was applied onto the skin above finger flexors, with anchor set at the wrist and the tape was extended to the tendon region of finger flexor (Figure 1). For the tapingN condition, Kinesio tape was applied onto the skin with its neutral tension (without stretching the tape). For the taping20 condition, the 2 ends of the tape (~5 cm) were kept tension-free and 20% extra tension was applied to the middle area of the tape. Outcome measures (below) were recorded immediately after the tape was applied. The rest time between conditions was 5 min.

To determine the effects of Kinesio taping on sensorimotor control and brain activities, we compared the following outcome measurements before and after taping:

- Joint position sense

A joint angle gauge (SS20L/21L; BioPAC Systems Inc., Santa Barbara, CA, USA) was placed across the dorsal midline of the wrist, from the midline of the forearm, through
the capitate bone, to the third metacarpophalangeal joint. The gauge was connected to an electrical signal acquisition system (CED Power1401 mk II; Cambridge Electronic Design, Cambridge, UK), and the associated Spike7 software displayed joint angle data on a computer screen. The participants practiced 15° wrist flexion for 1 min with visual feedback from the computer screen. Next, the participants performed 15° wrist flexion with their eyes closed. When they considered their wrist flexion angle to be 15°, they pressed a customized button to record the angle. This process was repeated five times.

- Force sense

![Figure 1. The 3 Kinesio taping conditions. From left to right: (1) taping with 20% additional tension (taping20), (2) taping with neutral tension (tapingN), and (3) without taping (control).](image)

A Jamar dynamometer (G200; Biometrics Ltd., Newport, UK) with a signal acquisition system (CED Power1401 mk II) was used to record and display grip force data on the computer screen. The participants’ maximal grip force was first determined by averaging 3 maximal voluntary isometric contractions (MVIC). Next, the participants practiced generating a grip force of 20% MVIC for 1 min with visual feedback from the computer screen. Next, the participants performed grips with 20% MVIC with their eyes closed. When they considered the force to be 20% MVIC, they pressed a customized button to record the force level. This process was repeated five times.

- Reaction time

A Jamar dynamometer (G200; Biometrics Ltd., Newport, UK) and a pair of silver chloride disposable surface electromyography (EMG) electrodes (on finger flexor muscle belly, inter-electrode distance = 2 cm) with the reference electrode (on the ipsilateral acromion) were used to record grip force and muscle activity. Data were processed using a signal acquisition system (CED Power1401 mk II, UK). The sampling rate for force and EMG data collection was 1000 Hz. EMG data were bandpass filtered at 10–400 Hz for noise removal, followed by signal rectification and a 10 Hz linear envelope process for data smoothing. Force signals were low-pass filtered at 40 Hz to remove noise.

During the test, the examiner pressed a customized button to produce a beep sound. The participants were instructed to grip the dynamometer promptly when hearing the sound. This process was repeated five times. The customized button sent a transistor-transistor logic (TTL) pulse to the signal acquisition system when pressed, which was stored as a time mark/event along with the force and EMG signals.

- Force control and corticomuscular functional connectivity

Participants were asked to perform the grip force control task to maintain grip force at 20% of MVC for 30 s while electroencephalography (EEG) and EMG were recorded simultaneously to determine functional connectivity between motor cortex and muscles. A Jamar dynamometer (G200; Biometrics Ltd., Newport, UK) and a pair of surface EMG
electrodes (on finger flexor muscle belly, inter-electrode distance = 2 cm) with a signal acquisition system (CED Power1401 mk II) were used to record and display grip force and muscle activity data on the computer screen. Identical force and EMG signal processing procedure was conducted as described above in the “Reaction Time” section. In addition, during the force control task, EEG of the bilateral sensorimotor cortex was recorded (actiCAP; Brain Products GmbH, Gilching, Germany). Conductive gel was added for each electrode and the impedance was monitored throughout the experiment to ensure good signal quality (<10 kΩ). The sampling rate for EEG data collection was 1000 Hz.

All data were analysed using MATLAB software (MathWorks, Natick, MA, USA). The performance of joint position sensing was determined by calculating the difference between the targeted joint angle (15°) and the actual joint angle participants generated. The value was defined as the angular error, and the values of five measurements were averaged for statistical analysis. The performance of FS was determined similarly as JPS. We calculated the difference between the targeted grip force (20% maximal voluntary contraction—MVC) and the actual force level participants generated. The value was defined as the force error, and the values of five measurements were averaged for statistical analysis.

The performance of reaction time was determined by calculating the time delay between the time mark created by pressing the customized button and the onset of muscle activation and force. To determine the onset of muscle activation, we first defined baseline EMG activity and baseline force level by calculating the average and standard deviation of the rectified EMG and force signals 1 s before the time mark. The onset of muscle activation was defined as EMG activity that exceeds the averaged plus 3 standard deviations of the baseline activity; the onset of muscle contraction was defined as force output that exceeds the averaged plus 3 standard deviation of the baseline level. Reaction time can be further divided into premotor time and electromechanical delay. Premotor time was determined by calculating the time difference between the time mark and the onset of EMG; electromechanical delay was determined by calculating the time difference between the onset of EMG and the onset of muscle force. The RT, premotor time and electromechanical delay were calculated and averaged across the 5 trials for statistical analysis.

Force control performance during grip force control task was determined by the difference between the participants generated and targeted grip force during the 30 s grip task. We calculated the root mean square error, as expressed in Equation (1)

$$\text{Root mean square error} = \sqrt{\frac{\sum_{t=1}^{n}(y_t - \hat{y}_t)^2}{n}}$$  

(1)

where n represents the total number of data items, $y_t$ represents the force level at each time point, and $\hat{y}_t$ represents the targeted force.

For EEG signals, we first applied a bandpass filter (3–60 Hz) and independent component analysis (ICA) to remove noise and eye movement artefacts from EEG data. Principal component analysis (PCA) was performed to identify principle components that represented 80% of the total EEG signal for each EEG data set. We next performed power spectrum analysis on each principle component and calculated the area for the alpha, beta, and gamma bands. In addition, EEG signals obtained from electrode C3 (representing hand area) were also analysed using power spectrum analysis and the areas for the alpha, beta, and gamma bands were calculated.

Changes in cortical activity with respect to Kinesio taping was determined by the changes in relative power for each EEG frequency band using Equation (2).

$$\text{Relative Power} = \frac{\text{Area of a frequency band}}{\text{Total area}} \times 100\%$$  

(2)

This calculation was performed for both C3 electrode and PCA results.

Corticomuscular connectivity was determined by calculating the level of co-modulation between motor cortex and muscles (corticomuscular coherence, CMC). An EEG from the
C3 electrode and an EMG of the finger flexor were recorded simultaneously during the 30 s grip control task. For coherence between the EEG and EMG, we used Equation (3) to calculate CMC:

\[
|C_{xy}(f)| = \frac{|P_{xy}(f)|^2}{P_{xx}(f)P_{yy}(f)}
\]  

(3)

P_{xx}(f) denotes the energy spectral density of an EEG signal, P_{yy}(f) denotes the energy spectral density of the EMG signal, and P_{xy}(f) denotes the energy spectral density (cross-PSD) between the two signals.

To determine if the value of CMC reaches physiological significance, we calculated the critical threshold (CT) using Equation (4):

\[
CT = 1 - (1 - \frac{\alpha}{100})^{\frac{1}{n-1}}
\]  

(4)

where \(\alpha\) represents the confidence interval (95%) and \(n\) represents the number of epochs analysed during CMC analysis.

We used a repeated-measures one-way analysis of variance to analyse the joint position sense, force sense, reaction time, force control performance, EEG, and CMC results under the three taping conditions, and Bonferroni test was used for post-hoc analysis. In addition, Pearson correlation was used to analyse the relationship between changes in FC performance and changes in EEG and CMC. The alpha level was set at 0.05.

3. Results

3.1. Subjects

This study recruited 24 healthy adults. The participants had an average age of 22.9 ± 1.57 years, average height of 167.5 ± 12.6 cm, and average weight of 67 ± 16.2 kg. All participants were right-handed.

3.2. Neuromuscular Function

3.2.1. Joint Position Sense

During the joint proprioception test, participants had an average angle error of 3.1° ± 1.41° under the control (no taping) condition, 2.4° ± 1.27° under the tapingN condition, and 2.4° ± 1.39° under the taping20 condition (Figure 2A) (Table 1). The angles did not differ significantly among the three conditions. Due to a wide range of distribution of the joint angle perception errors (1° to 6°) among our participants under the control condition, we then further divided the participants into two groups based on their JPS performances for a subgroup analysis. Participants with poorer JPS had an angle error of 4.1° ± 1.04° under the control condition, 2.6° ± 0.97° under the tapingN condition, and 2.1° ± 0.91° under the taping20 condition (Figure 2B). The post hoc analysis indicated that both tapingN and taping20 conditions had smaller joint angle perception errors compared with the control condition (\(p = 0.001\)), suggesting that for people with poorer JPS, taping with neutral tension or with 20% additional tension could both improve joint proprioception. Taping–induced improvements in JPS were not observed in participants with better JPS performance.

3.2.2. Force Sense

During the force proprioception test, the force error was 1.49 ± 0.95 kg under the control condition, 1.74 ± 1.4 kg under the tapingN condition, and 1.67 ± 1.09 kg under the taping20 condition. No significant difference was observed among the three conditions. The force accuracy error during the grip force maintenance test was 1.22 ± 0.62 N under the control condition, 1.19 ± 0.56 N under the tapingN condition, and 1.10 ± 0.65 N under the taping20 condition. These results indicate no significant difference between the conditions.
Figure 2. (A) Joint and force proprioceptive performance among 3 taping conditions. Neither joint nor force proprioception differed significantly among conditions. (B) Participants with poor joint proprioceptive sense showed improved smaller joint degree errors under the tapingN condition and taping20 condition compared with the control condition. * indicates significant difference between conditions ($p < 0.05$).

Table 1. Sensorimotor performance under the three different taping conditions.

|                                               | Control         | TapingN        | Taping20        | $p$ Value |
|-----------------------------------------------|-----------------|----------------|-----------------|-----------|
| Joint position sense (degree)                 | 3.1 (1.41)      | 2.4 (1.27)     | 2.4 (1.39)      | 0.138     |
| Force sense (kgw)                            | 1.49 (0.95)     | 1.74 (1.40)    | 1.67 (1.09)     | 0.582     |
| Premotor time (ms)                           | 149 (48)        | 152 (44)       | 161 (64)        | 0.337     |
| Electromechanical delay (ms)                 | 41 (10)         | 43 (12)        | 43 (13)         | 0.926     |
| Reaction time (ms)                           | 191 (10)        | 195 (46)       | 205 (68)        | 0.217     |
| Force accuracy (N)                           | 1.22 (0.62)     | 1.19 (0.56)    | 1.10 (0.65)     | 0.223     |

3.2.3. Reaction Time

The premotor time was $149 \pm 48$ ms under the control condition, $152 \pm 44$ ms under the tapingN condition, and $161 \pm 64$ ms under the taping20 condition. The electromechanical delay was $41 \pm 10$ ms under the control condition, $43 \pm 12$ ms under the tapingN condition, and $43 \pm 13$ ms under the taping20 condition. RT was $191 \pm 54$ ms under the control condition, $195 \pm 46$ ms under the tapingN condition, and $205 \pm 68$ ms under the taping20 condition. We did not observe differences in RT performance among the three taping conditions.

3.2.4. Force Control

During the 30 sec force control task, the force accuracy error was $1.22 \pm 0.62$ N under the control condition, $1.19 \pm 0.56$ N under the tapingN condition, and $1.10 \pm 0.65$ N under the taping20 condition. No significant difference was observed among the three taping conditions ($p = 0.223$).

3.3. Brain Activity and Functional Connectivity

For EEG and CMC analyses, the relative power of the PCA for the alpha, beta and gamma EEG frequency bands did not show differences among the three taping conditions (Table 2). The relative power of the C3 electrode for each frequency band also did not change with different taping conditions. In addition, we did not observe CMC changes with Kinesio taping. However, while investigating the relationship between cortical activation and neuromuscular performance with Kinesio taping, we found that under the tapingN condition that the more the EEG C3 beta band increased, the the better force control
(smaller force accuracy error) during the 30 sec FC performance test ($r = -0.434; p = 0.036$).

We further conducted a subgroup analysis that focused on participants who exhibited increased C3 beta power due to taping with neutral tension (responders, $n = 14$). For these 14 participants, the force accuracy error was $1.28 \pm 0.72$ N under the control condition and was improved to $1.11 \pm 0.68$ N under the tapingN condition, which was significantly smaller than that under the control condition (Wilcoxon signed-rank test; $p = 0.027$; Figure 3B).

Table 2. EEG and corticomuscular coherence values for the three different taping conditions.

|                | Control          | TapingN         | Taping20         | $p$ Value |
|----------------|------------------|-----------------|------------------|-----------|
| PCA-alpha      | 0.13 (0.05)      | 0.13 (0.06)     | 0.12 (0.056)     | 0.325     |
| PCA-beta       | 0.29 (0.093)     | 0.30 (0.06)     | 0.31 (0.06)      | 0.137     |
| PCA-gamma      | 0.24 (0.16)      | 0.21 (0.10)     | 0.23 (0.10)      | 0.685     |
| C3-alpha       | 0.14 (0.07)      | 0.14 (0.06)     | 0.12 (0.06)      | 0.610     |
| C3-beta        | 0.29 (0.05)      | 0.31 (0.08)     | 0.30 (0.06)      | 0.303     |
| C3-gamma       | 0.21 (0.10)      | 0.20 (0.10)     | 0.24 (0.11)      | 0.298     |
| CMC-alpha      | 0.04 (0.07)      | 0.03 (0.06)     | 0.06 (0.15)      | 0.864     |
| CMC-beta       | 0.21 (0.21)      | 0.20 (0.20)     | 0.27 (0.29)      | 0.727     |
| CMC-gamma      | 0.20 (0.19)      | 0.29 (0.28)     | 0.29 (0.28)      | 0.295     |

Figure 3. (A) Change of force accuracy error had a negative moderate correlation with change of beta power in the tapingN condition. (B) The responders showed less force accuracy error (mean ± standard deviation) under the tapingN condition. * indicates significant difference between conditions ($p < 0.05$).

4. Discussion

The main finding of our study is that Kinesio taping applied on the skin above the wrist/finger flexor muscles can improve the joint proprioceptive sense in healthy adults with poor joint proprioception. This study is also the first to report the effects of Kinesio taping on cortical activities. We observed that responders (participants with increased EEG beta power under the taping conditions) significantly improved in terms of the accuracy of force control under the taping conditions.

Muscle spindles and cutaneous receptors contributed to joint proprioceptive sensing [29–31]. Kinesio taping can be used as a form of tactile stimulation to overcome the attenuation of muscle activities following prolonged vibration [19], potentially due to the activation of gamma motor neurons and enhanced sensory afferent input (muscle spindle). Similar to previous observations [7], our study demonstrated the positive effects of Kinesio taping on joint proprioception. However, unlike our study, a previous study [32] did not...
observe joint proprioceptive sense improvement with Kinesio taping. This discrepancy could be due to participants’ joint proprioceptive performances between the previous and current study. The joint angle errors of the patients in the study by Lee et al. are quite small (1.8°) compared with that in the current study (3.1°). Our subgroup analysis revealed that Kinesio taping with neutral tension and 20% additional tension were both effective for individuals with a poorer joint proprioceptive sense, reducing joint angle by approximately 2°. Our findings were similar to a previous observation of patients with knee arthritis [33] and thus indicate that Kinesio taping is a suitable clinical alternative for improving the joint proprioceptive sense.

Previous studies have investigated the effects of Kinesio taping on the force proprioceptive sense. After applying Kinesio taping with 20–30% additional tension, the grip force proprioception of healthy participants and patients with “golfer’s elbow” could be significantly improved [8,9,34]. However, our results indicated that Kinesio taping with neutral or 20% additional tension did not improve grip force proprioception. Similar to the joint proprioceptive sense discussed above, we think participants’ proprioceptive performances played an important role in these inconsistent findings. The averaged grip force errors were approximately 3 kg for previous studies. In contrast, our participants had relatively small force sense errors, at 1.5 kg. Among our participants, three of them had poorer grip force perception (average force sense error 3 kg). For these participants, our results showed that Kinesio taping with neutral tension could reduce force sense errors by 50%, 78%, and 23%; under the taping with 20% additional tension, the force sense errors of these participants were reduced by 47%, 18%, and 59%. These observations suggested that there was a trend of improvement in force proprioception with Kinesio taping in individuals exhibiting poorer performances, and further investigation is required for confirmation.

Contrary to previous studies, the current study did not observe changes in EEG with additional sensory afferent input induced by Kinesio taping. This discrepancy could be due to two factors. First, previous studies observed the immediate responses of EEG. They found that ERD and ERS were completed in less than 1 s after electrical or mechanical stimuli [35,36]. However, due to the nature of taping application, we could only compare changes in EEG with and without taping. Second, previous studies conducted EEG recording during the resting state, while in the current study our participants performed a hand grip motor task. The EEG beta band power of the motor cortex would increase during a motor task compared with that under a resting condition [35,37,38]. The interaction or co-modulation between motor tasks and sensory input on EEG power is still unclear, but we think it could play a significant role in influencing the level of EEG beta power. Nevertheless, we observed a moderate correlation between the taping-induced improvement in force accuracy and the increase in the EEG (C3) beta band power. The EEG beta frequency band is related to the integration of afferent information in the sensorimotor cortex [39,40], and the decrease in EEG beta frequency band (event-related desynchronization, ERD) is related to the excitability of the motor cortex [41]. We believe that for the participants who had significant change in EEG beta band power with Kinesio taping, sensory afferent input induced by taping might be better integrated and subsequently improve participants’ performances.

5. Conclusions

This study demonstrated that Kinesio taping applied onto the skin above the wrist/finger flexor muscles can improve wrist joint proprioception in people with a poorer joint perceptive sense. In addition, the individuals with greater increases in the EEG beta band with Kinesio taping saw a greater improvement in force control performance.

Author Contributions: Conceptualization, Z.-M.L. and L.-W.C.; Data curation, Z.-M.L. and L.-W.C.; Formal analysis, Z.-M.L.; Investigation, L.-W.C.; Methodology, Y.-L.L. and C.-S.C.; Project administration, L.-W.C.; Resources, J.-F.Y., Y.-C.C. and C.-T.H.; Supervision, L.-W.C.; Validation, J.-F.Y., Y.-C.C. and C.-T.H.; Visualization, Z.-M.L. and J.-F.Y.; Writing—original draft, Z.-M.L., Y.-L.L. and C.-S.C.; Writing—review and editing, J.-F.Y., Y.-C.C., C.-T.H. and L.-W.C. All authors have read and agreed to the published version of the manuscript.
Funding: This research was funded by the Cheng Hsin General Hospital under Grant, grant number CY10909, and the Minister of Science and Technology, grant number MOST108-2314-B-010-043 in Taiwan.

Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Institutional Review Board of National Yang-Ming University (YM108058E).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author (L.-W.C.).

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Williams, S.; Whatman, C.; Hume, P.A.; Sheerin, K. Kinesio Taping in Treatment and Prevention of Sports Injuries: A Meta-Analysis of the Evidence for Its Effectiveness. *Sports Med.* 2012, 42, 153–164. [CrossRef] [PubMed]

2. Proske, U.; Gandevia, S.C. The Proprioceptive Senses: Their Roles in Signaling Body Shape, Body Position and Movement, and Muscle Force. *Physiol. Rev.* 2012, 92, 1651–1697. [CrossRef]

3. Siu, W.-S.; Shi, Y.-F.; Lin, H.-C. Effects of Kinesio Tape on Supporting Medial Foot Arch in Runners with Functional Flatfoot: A Preliminary Study. *Res. Sports Med.* 2020, 28, 168–180. [CrossRef]

4. Trecroci, A.; Formenti, D.; Rossi, A.; Esposito, F.; Alberti, G. Acute Effects of Kinesio Taping on a 6 s Maximal Cycling Sprint Performance. *Res. Sports Med.* 2017, 25, 48–57. [CrossRef]

5. Limmer, M.; Buck, S.; de Marées, M.; Roth, R. Acute Effects of Kinesio Taping on Muscular Strength and Endurance Parameters of the Finger Flexors in Sport Climbing: A Randomised, Controlled Crossover Trial. *Eur. J. Sport Sci.* 2020, 20, 427–436. [CrossRef] [PubMed]

6. Chang, H.-Y.; Chou, K.-Y.; Lin, J.-J.; Lin, C.-F.; Wang, C.-H. Immediate Effect of Forearm Kinesio Taping on Maximal Grip Strength and Force Sense in Healthy Collegiate Athletes. *Phys. Ther. Sport* 2010, 11, 122–127. [CrossRef]

7. Burfeind, S.M.; Chimera, N. Randomized Control Trial Investigating the Effects of Kinesiology Tape on Shoulder Proprioception. *J. Sport Rehabil.* 2015, 24, 405–412. [CrossRef] [PubMed]

8. Chang, H.-Y.; Cheng, S.-C.; Chou, C.-C.; Chou, K.-Y.; Gan, S.-M.; Wang, C.-H. The Effectiveness of Kinesio Taping for Athletes with Medial Elbow Epicondylar Tendinopathy. *Int. J. Sports Med.* 2013, 34, 1003–1006. [CrossRef]

9. Chang, H.-Y.; Wang, C.-H.; Chou, K.-Y.; Cheng, S.-C. Could Forearm Kinesio Taping Improve Strength, Force Sense, and Pain in Baseball Pitchers With Medial Epicondylitis? *Clin. J. Sport Med.* 2012, 22, 327–333. [CrossRef]

10. Bailey, D.; Firth, P. Does Kinesiology Taping of the Ankles Affect Proprioceptive Control in Professional Football (Soccer) Players? *Phys. Ther. Sport* 2017, 25, 94–98. [CrossRef] [PubMed]

11. Kang, F.-J.; Chiu, Y.-C.; Wu, S.-C.; Wang, T.-G.; Yang, J.-L.; Lin, J.-J. Kinesiology Taping with Exercise Does Not Provide Additional Improvement in Round Shoulder Subjects with Impingement Syndrome: A Single-Blinded Randomized Controlled Trial. *Phys. Ther. Sport* 2019, 40, 99–106. [CrossRef]

12. Reneker, J.C.; Latham, L.; McGlawn, R.; Reneker, M.R. Effectiveness of Kinesiology Tape on Sports Performance Abilities in Athletes: A Systematic Review. *Phys. Ther. Sport* 2018, 31, 83–98. [CrossRef] [PubMed]

13. Riemann, B.L.; Lephart, S.M. The Sensorimotor System, Part I: The Physiologic Basis of Functional Joint Stability. *J. Athl. Train.* 2002, 37, 71–79. [PubMed]

14. Edin, B.B.; Abbs, J.H. Finger Movement Responses of Cutaneous Mechanoreceptors in the Dorsal Skin of the Human Hand. *J. Neurophysiol.* 1991, 65, 657–670. [PubMed]

15. Edin, B.B.; Johansson, N. Skin Strain Patterns Provide Kinaesthetic Information to the Human Central Nervous System. *J. Physiol.* 1995, 487, 243–251. [CrossRef]

16. Choi, J.T.; Lundbye-Jensen, J.; Leukel, C.; Nielsen, J.B. Cutaneous Mechanisms of Isometric Ankle Force Control. *Exp. Brain Res.* 2013, 228, 377–384. [CrossRef]

17. Shakeri, H.; Soleimaniifar, M.; Arab, A.M.; Hamneshin Behbahani, S. The Effects of KinesioTape on the Treatment of Lateral Epicondylitis. *J. Hand Ther.* 2018, 31, 35–41. [CrossRef]

18. de Brito Macedo, L.; Richards, J.; Borges, D.T.; Melo, S.A.; Brasilheiro, J.S. Kinesio Taping Reduces Pain and Improves Disability in Low Back Pain Patients: A Randomised Controlled Trial. *Physiotherapy* 2019, 105, 65–75. [CrossRef]

19. Konishi, Y. Tactile Stimulation with Kinesiology Tape Alleviates Muscle Weakness Attributable to Attenuation of Ia Afferents. *J. Physiol. Med.* 2013, 16, 45–48. [CrossRef]

20. Piluzzi, G.; Ginatempo, F.; Mercante, B.; Cattaneo, L.; Pavesi, G.; Rothwell, J.C.; Deriu, F. Role of Cutaneous and Proprioceptive Inputs in Sensorimotor Integration and Plasticity Occurring in the Facial Primary Motor Cortex. *J. Physiol.* 2020, 598, 839–851. [CrossRef]

21. Lai, M.-I.; Pan, L.-L.; Tsai, M.-W.; Shi, Y.-F.; Wei, S.-H.; Chou, L.-W. Investigating the Effects of Peripheral Electrical Stimulation on Corticomuscular Functional Connectivity Stroke Survivors. *Top. Stroke Rehabil.* 2016, 23, 154–162. [CrossRef]
22. Xu, R.; Wang, Y.; Wang, K.; Zhang, S.; He, C.; Ming, D. Increased Corticomuscular Coherence and Brain Activation Immediately After Short-Term Neuromuscular Electrical Stimulation. Front. Neurol. 2018, 9, 886. [CrossRef] [PubMed]

23. Lattari, E.; Velasques, B.; Paes, F.; Cunha, M.; Budde, H.; Basile, L.; Cagy, M.; Piedade, R.; Machado, S.; Ribeiro, P. Corticomuscular Coherence Behavior in Fine Motor Control of Force: A Critical Review. Rev. Neurol. 2010, 51, 610–623.

24. Mima, T.; Hallett, M. Corticomuscular Coherence: A Review. J. Clin. Neurophysiol. 1999, 16, 501–511. [CrossRef] [PubMed]

25. Dal Maso, F.; Longcamp, M.; Cremoux, S.; Amarantini, D. Effect of Training Status on Beta-Range Corticomuscular Coherence in Agonist vs. Antagonist Muscles during Isometric Knee Contractions. Exp. Brain Res. 2017, 235, 3023–3031. [CrossRef]

26. Cremoux, S.; Tallet, J.; Dal Maso, F.; Berton, E.; Amarantini, D. Impaired Corticomuscular Coherence during Isometric Elbow Flexion Contractions in Humans with Cervical Spinal Cord Injury. Eur. J. Neurosci. 2017, 51, 610–623. [CrossRef] [PubMed]

27. Larsen, L.H.; Zibrandtsen, I.C.; Wienecke, T.; Kjaer, T.W.; Christensen, M.S.; Nielsen, J.B.; Langberg, H. Corticomuscular Coherence in the Acute and Subacute Phase after Stroke. Clin. Neurophysiol. 2017, 128, 2217–2226. [CrossRef] [PubMed]

28. von Carlowitz-Ghori, K.; Bayraktaroglu, Z.; Hohlefeld, F.U.; Losch, F.; Curio, G.; Nikulin, V.V. Corticomuscular Coherence in Acute and Chronic Stroke. Clin. Neurophysiol. 2014, 125, 1182–1191. [CrossRef]

29. Goodwin, G.M.; McCloskey, D.I.; Matthews, P.B. The Contribution of Muscle Afferents to Kinaesthesia Shown by Vibration Induced Illusions of Movement and by the Effects of Paralysing Joint Afferents. Brain 1972, 95, 705–748. [CrossRef]

30. Edin, B. Cutaneous Afferents Provide Information about Knee Joint Movements in Humans. J. Physiol. 2001, 531, 289–297. [CrossRef]

31. Tsay, A.J.; Giummarra, M.J.; Allen, T.J.; Proske, U. The Sensory Origins of Human Position Sense. J. Physiol. 2016, 594, 1037–1049. [CrossRef]

32. Lee, W.-H.; Kwon, O.-Y.; Yi, C.-H.; Jeon, H.-S.; Ha, S.-M. Effects of Taping on Wrist Extensor Force and Joint Position Reproduction Sense of Subjects With and Without Lateral Epicondylitis. J. Phys. Ther. Sci. 2011, 23, 629–634. [CrossRef]

33. Cho, H.; Kim, E.-H.; Kim, J.; Yoon, Y.W. Kinesio Taping Improves Pain, Range of Motion, and Proprioception in Older Patients with Knee Osteoarthritis: A Randomized Controlled Trial. Am. J. Phys. Med. Rehabil. 2015, 94, 192–200. [CrossRef]

34. Hosseini, S.M.; Salehi Dehno, N.; Rezaiian, F.; Kalantari, K.K.; Tabatabaei, S.M. Effect of Kinesio Taping Direction on Force Sense in Wrist Flexor Muscles in Healthy Persons. Res. Sports Med. 2019, 27, 273–282. [CrossRef]

35. Salenius, S.; Schnitzler, A.; Salmelin, R.; Joussmäki, V.; Hari, R. Modulation of Human Cortical Rolandic Rhythms during Natural Sensorimotor Tasks. Neuroimage 1997, 5, 221–228. [CrossRef] [PubMed]

36. Stancáč, A.; Svoboda, J.; Rachmanová, R.; Vrana, J.; Králík, J.; Tintera, J. Desynchronization of Cortical Rhythms Following Cutaneous Stimulation: Effects of Stimulus Repetition and Intensity, and of the Size of Corpus Callousum. Clin. Neurophysiol. 2003, 114, 1936–1947. [CrossRef]

37. Cassim, F.; Szurhaj, W.; Sediri, H.; Devos, D.; Bourriez, J.; Poirot, I.; Derambure, P.; Defelvre, L.; Guieu, J. Brief and Sustained Movements: Differences in Event-Related (de)Synchronization (ERD/ERS) Patterns. Clin. Neurophysiol. 2000, 111, 2032–2039. [CrossRef]

38. Stancáč, A.; Pfurtscheller, G. Desynchronization and Recovery of Beta Rhythms during Brisk and Slow Self-Paced Finger Movements in Man. Neurosci. Lett. 1995, 196, 21–24. [CrossRef]

39. Houdayer, E.; Labyt, E.; Cassim, F.; Bourriez, J.L.; Derambure, P. Relationship between Event-Related Beta Synchronization and Afferent Inputs: Analysis of Finger Movement and Peripheral Nerve Stimulations. Clin. Neurophysiol. 2006, 117, 628–636. [CrossRef]

40. Neuper, C.; Wörtz, M.; Pfurtscheller, G. ERD/ERS Patterns Reflecting Sensorimotor Activation and Deactivation. Prog. Brain Res. 2006, 159, 211–222. [CrossRef]

41. Takemi, M.; Masakado, Y.; Liu, M.; Ushiba, J. Event-Related Desynchronization Reflects Downregulation of Intracortical Inhibition in Human Primary Motor Cortex. J. Neurophysiol. 2013, 110, 1158–1166. [CrossRef] [PubMed]